

**Laboratoire de
Recherche en Informatique
2008-2013 report**



Dossier d'évaluation
d'une unité de recherche
Vague E : campagne d'évaluation 2013-2014

Nom de l'unité:	Laboratoire de Recherche en Informatique
Acronyme:	LRI
Nom du directeur pour le contrat en cours:	Philippe DAGUE
Nom du directeur pour le contrat à venir:	élections à venir

Type de demande: **Renouvellement à l'identique**

Choix de l'évaluation interdisciplinaire de l'unité de recherche: **Non**



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1/ Présentation de l'unité

LRI



Le LRI

Directeur: Philippe Dague

Le Laboratoire de Recherche en Informatique (LRI) est une unité mixte de recherche (UMR8623) de l'Université Paris-Sud et du CNRS. Créé il y a plus de 35 ans, il accueille plus de 240 personnes dont environ 110 permanents et 90 doctorants, organisés en huit équipes de recherche, une équipe administrative et une équipe technique. Six des équipes de recherche sont tout ou partie communes avec Inria Saclay qui est ainsi le partenaire privilégié du laboratoire. Le laboratoire est localisé sur le plateau du Moulon dans ses nouveaux locaux connexes du PCRI (avec Inria) depuis juin 2011 et de Digiteo Moulon (avec des équipes d'Inria, de l'IEF et du CEA) depuis début 2013.

Les thèmes de recherche du laboratoire couvrent un large spectre de l'informatique à dominante logicielle et incluent à la fois des aspects fondamentaux et des aspects appliqués : algorithmique, combinatoire, graphes, optimisation discrète et continue, programmation, génie logiciel, vérification et preuves, parallélisme, calcul à haute performance, grilles, architecture et compilation, réseaux, bases de données, représentation et traitement des connaissances, apprentissage, fouille de données, bioinformatique, interaction homme-machine, etc. Cette diversité est l'une des forces du laboratoire. Le laboratoire est présent dans de nombreux projets nationaux et internationaux (notamment la CCI ICT Labs de l'EIT). Il a une très forte activité de publication avec plus de 2000 publications en cinq ans et demi ainsi qu'une importante activité de production logicielle et de transfert.

Le LRI fait partie du réseau thématique de recherche avancée Digiteo, le seul en sciences et technologies de l'information et de la communication (STIC), et est partenaire de System@tic Paris-Région, pôle de compétitivité d'envergure mondiale. Le LRI est très impliqué dans les programmes des investissements d'avenir lancés en 2010 par le gouvernement français. C'est ainsi qu'il est porteur de l'Equipex Digiscope, du Labex Digicosme, qu'il participe à l'IRT SystemX et qu'il joue un rôle moteur dans l'Idex Paris-Saclay qui préfigure la future université Paris-Saclay qui va s'ouvrir en 2014 : il est actif dans la constitution du futur département STIC, émanation de Digiteo, et porte les projets de l'Ecole Doctorale STIC et du master informatique de l'université Paris-Saclay.



LRI

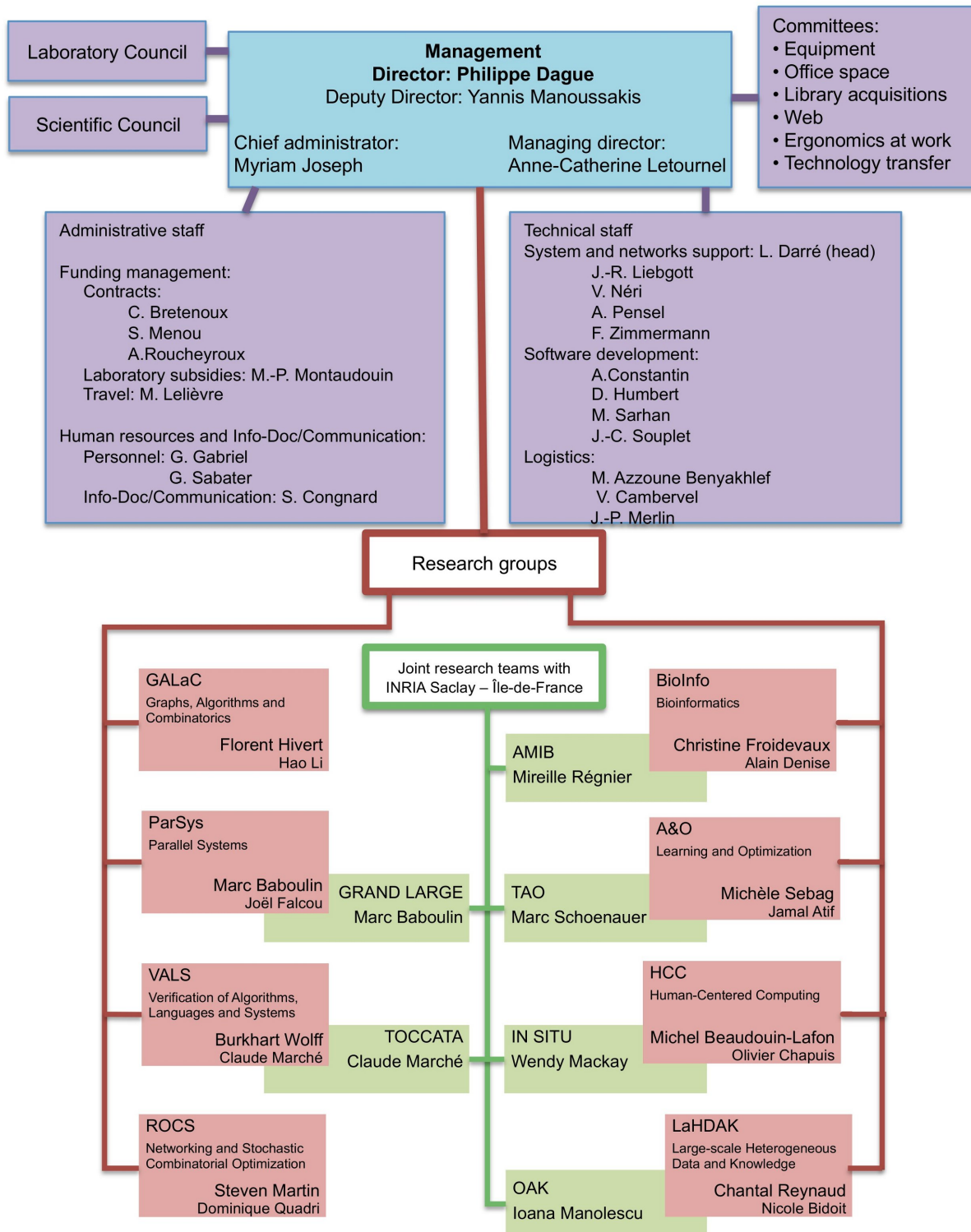
Director: Philippe Dague

LRI (Laboratoire de Recherche en Informatique) is the Laboratory for Computer Science at Université Paris-Sud, joint with CNRS, the National Center for Scientific Research. Founded more than 35 years ago, it has over 240 members, including about 110 faculty and staff and 90 Ph.D. students. LRI consists of eight research groups, supported by an administrative and a technical staff. Six of the research groups are totally or partially joint with Inria Saclay, making it the main partner of the laboratory. The laboratory is located on the Moulon plateau in its new connected buildings PCRI (with Inria) from June 2011 and Digiteo Moulon (with Inria, IEF and CEA groups) from the beginning of 2013.

The research themes addressed by LRI cover a wide spectrum of computer science ranging from fundamental to applied research: algorithms, combinatorics, graph theory, discrete and continuous optimization, programming, software engineering, verification and proofs, parallel systems, high performance computing, grids, architecture and compilation, networking, databases, knowledge representation and processing, machine learning, data mining, bioinformatics, human-computer interaction, etc. Such diversity is one of the strengths of the laboratory. The laboratory participates in a large number of national and international projects (notably the KIC ICT Labs from EIT). It is highly productive, with more than 2000 publications in five and a half years and an important activity of software development and transfer.

LRI is a partner in the research network Digiteo, the only one in Information Science and Technology (IST), and is a partner in System@tic Paris-Region, a world-class competitiveness cluster. LRI is strongly involved in the "investissements d'avenir" programs launched in 2010 by the French government. It leads the Equipex Digiscope, the Labex Digicosme, it participates to the IRT SystemX and is very active in the Idex Paris-Saclay which will give birth in 2014 to the new Paris-Saclay University: it plays an important role in setting the future IST department in the continuity of Digiteo and leads the projects of the IST Doctoral School and of the computer science master of the Paris-Saclay University

Laboratoire de Recherche en Informatique – UMR 8623



Le Laboratoire de Recherche en Informatique (LRI), créé il y a plus de 35 ans, est une unité mixte de recherche (UMR8623) de l'université Paris-Sud et du CNRS (INS2I).

Les thèmes de recherche du laboratoire couvrent un large spectre de l'informatique à dominante logicielle et incluent à la fois des aspects fondamentaux, historiquement présents dès l'origine, et des aspects appliqués, fruits volontaires de son évolution, qui co-existent le plus souvent au sein d'une même équipe, s'alimentant et se fertilisant l'un l'autre : algorithmique, combinatoire, graphes, optimisation discrète et continue, programmation, génie logiciel, vérification et preuves, parallélisme, calcul à haute performance, grilles, architecture et compilation, réseaux, bases de données, représentation et traitement des connaissances, apprentissage par machine, fouille de données, bioinformatique, interaction homme-machine, etc. Ces thèmes relèvent de la section 27 du CNU ainsi que de la section 06 du CoNRS, excepté l'interaction homme-machine et l'équipe InSitu correspondante qui sont rattachées à la section 07.

Le LRI, avec le département Communication Homme-Machine du Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur (LIMSI, UPR CNRS) qui mène des recherches en informatique sur des thèmes complémentaires (traitement du langage parlé, écrit et gestuel ; perception et interaction multimodales ; réalité virtuelle et augmentée), constituent les deux entités de recherche du département d'informatique de l'université Paris-Sud et représentent donc la recherche en Sciences et Technologies de l'Information et de la Communication (STIC) à Paris-Sud.

Une des spécificités du LRI est d'avoir tissé des collaborations étroites avec Inria dès la création et l'installation sur le plateau du Moulon du centre Inria Futurs, devenu Inria Saclay, ce qui s'est traduit par la création d'équipes-projets communes (EPC) entre le LRI et Inria dès 2004. C'est ainsi que sept des douze équipes de recherche qui structuraient le LRI depuis la rentrée 2007, étaient (totalement ou en partie) des EPC en 2008. Elles sont à présent six (deux se sont terminées ou séparées du LRI, une nouvelle a été créée en mai 2009 avec l'équipe Bioinformatique et son analogue du LIX, deux qui prenaient fin ont donné naissance à des nouvelles avec ou sans changement de périmètre, deux sont inchangées et prendront fin en 2014, enfin une se termine fin 2013 mais sera vraisemblablement remplacée par une nouvelle).

Avec l'intégration au LRI du personnel Inria des EPC, les effectifs du laboratoire avaient connu une forte hausse, passant de 181 à la rentrée 2006 à 280 à la rentrée 2007, dont 112 permanents. Si le nombre de permanents est resté stable durant la période 2008-2013 (entre 112 et 116, avec une baisse conjoncturelle à 109 à la rentrée 2012 due à des mutations et promotions externes de maître de conférences à professeur qui seront lissées lors des prochains recrutements), les effectifs totaux du laboratoire, après un pic à 282 à la rentrée 2009, ont baissé à 235 à la rentrée 2012, à cause essentiellement d'une diminution du nombre de doctorants.

Les principaux événements qui ont marqué l'évolution du LRI durant la période 2008 - mi 2013, outre les activités de recherche propres des équipes, sont les suivants :

- La mutation groupée pour le LIAFA, au 1er novembre 2010, du groupe d'algorithmique quantique de Miklos Santha, représentant la majorité de l'équipe Algo (que dirigeait alors Miklos) et la quasi-totalité de son potentiel de chercheurs, soit quatre DR et un CR CNRS (plus un PR externe faisant sa recherche au LRI ; le dernier membre du groupe restant au LRI ayant rejoint quant à lui le LIAFA comme PR en mutation à la rentrée 2012). Si l'on y ajoute la mutation concomitante d'un autre DR CNRS, celle un an auparavant d'un CR CNRS déjà pour le LIAFA et celle un an plus tard d'un autre CR CNRS, cela signifie qu'en l'espace de deux ans, 2009-2011, l'équipe Algo a vu ses effectifs de chercheurs CNRS passer de 8 à 0 et par la-même le laboratoire tout entier enregistrer une chute de plus de 30% de ces mêmes effectifs ! Dès la fin 2010, le directeur a donc entrepris, avec le soutien de l'INS2I, une action volontariste de refondation d'un axe fort en informatique fondamentale (existant par ailleurs dans d'autres équipes) au LRI, qui s'est traduite par le recrutement en deux ans de deux CR CNRS en théorie des graphes et de deux professeurs en combinatoire (action poursuivie cette année avec le recrutement d'un DR CNRS et la mutation au LRI d'un CR CNRS en algorithmique à la rentrée 2013).
- Le déménagement en deux temps de la totalité du laboratoire dans de nouveaux locaux : d'abord en juin 2011, après plusieurs années de retard, toutes les équipes sauf une du bâtiment historique dans la vallée (y compris l'équipe-projet propre Inria Aviz) ainsi que celles hébergées dans les locaux loués par Inria au Parc Club Université ont intégré le bâtiment PCRI (issu de l'ancien projet de Pôle Commun de Recherche en Informatique qui a constitué l'embryon du futur RTRA Digiteo) sur le plateau du Moulon, dont le maître d'ouvrage est l'université Paris-Sud et un tiers des surfaces des bureaux chercheurs est propriété d'Inria ; ensuite début 2013, la dernière équipe de la vallée a intégré le bâtiment connexe Digiteo Moulon (un des trois bâtiments de Digiteo Labs) dont le maître d'ouvrage est le CNRS, qui en

a confié l'exploitation à l'université Paris-Sud, et qui comprend des surfaces pour le CEA, pour Inria et pour Paris-Sud (LRI et une équipe de l'Institut d'Electronique Fondamentale) ; par la même occasion, une équipe du LRI et l'équipe propre Inria ont migré du PCRI vers Digiteo Moulon et une réorganisation partielle des équipes a eu lieu à l'intérieur du PCRI à la demande d'Inria qui souhaitait identifier précisément ses surfaces. Ces opérations de déménagement et plus encore de suivi des travaux de parfait achèvement, de mise en œuvre de travaux pour pallier des dysfonctionnements ou procéder à des aménagements pour le bien-être des chercheurs, d'exploitation au quotidien tant de la totalité du bâtiment PCRI que des surfaces LRI dans Digiteo Moulon ont mobilisé, et vont continuer encore de le faire, des moyens très importants, tant humains que financiers. Mais le LRI, réparti sur deux sites, vallée et plateau, depuis de nombreuses années, se trouve enfin réuni en un même lieu dans des bâtiments neufs, avec une marge d'accroissement de ses effectifs de quelques années.

- La participation du LRI, au titre de l'université Paris-Sud, au KIC (Knowledge and Innovation Community) ICT Labs de l'EIT (European Institute of Innovation and Technology), un des trois projets retenus en décembre 2009 pour 7 à 15 ans lors du premier appel de l'EIT. Le LRI fait partie du nœud français Paris-Saclay, un de ses membres est responsable de l'action line Digital Cities of the Future, il est présent tant en recherche, principalement au travers de l'équipe Réseaux mais aussi des équipes IASI et BD, qu'en formation, avec l'ouverture à la rentrée 2012 du master HCID (Human Computer Interaction and Design) assuré par l'équipe InSitu, qui offrira en seconde année la spécialisation Situated Interaction, et à la rentrée 2013 du master DSS (Distributed Systems and Services) où le LRI assurera la spécialisation Distributed Information Management sous la coordination de la responsable de l'équipe BD, ainsi qu'au programme de l'école doctorale.
- La très forte implication du LRI à tous les niveaux dans les programmes des investissements d'avenir, dont les premiers appels ont eu lieu en 2010. Il s'est appuyé pour cela sur ses partenariats au sein du RTRA (Réseau Thématique de Recherche Avancée) Digiteo dont il est, via Paris-Sud, un des membres fondateurs en 2006 et qui structure la communauté STIC de Saclay. Ceci s'est traduit par :
 - la coordination par un professeur du LRI de l'Equipex (Equipement d'Excellence) Digiscope, lauréat en janvier 2011 et lancé en mars 2011, impliquant pour 10 ans 11 laboratoires de 8 établissements et visant à développer une infrastructure de visualisation haute performance pour l'interaction collaborative avec des données massives et des plateformes de calcul, unique au monde de par sa puissance et sa richesse de configuration ;
 - la coordination par un professeur du LRI du Labex (Laboratoire d'Excellence) DigiCosme (Mondes numériques : données, programmes et architectures distribués), lauréat en janvier 2012 et lancé en mars 2012, impliquant pour 8 ans 14 laboratoires de 11 établissements réunissant près de 300 chercheurs et autant de doctorants, structuré en trois axes de recherche (SciLex sur la sécurité et la fiabilité du logiciel ; ComEx sur une science des réseaux à grande échelle ; DataSense, dirigé par un membre du LRI, sur la prise en compte de l'explosion des données pour l'apprentissage, la décision et l'interaction) et soutenant des actions de formation pour améliorer l'attractivité de l'informatique ;
 - la participation très active de plusieurs membres du LRI en 2010 et 2011 à l'élaboration d'un projet d'IRT (Institut de Recherche Technologique) qui a abouti à la labellisation en février 2012 et au conventionnement fin octobre 2012 de l'IRT SystemX dédié à l'Ingénierie Numérique des Systèmes du Futur au cœur des filières transport, communication, sécurité numérique et énergie et articulé en deux programmes et sept thématiques ; rassemblant d'ores et déjà 44 partenaires dont 35 industriels, l'IRT SystemX a comme rôle de faciliter le transfert de technologies et de compétences vers l'industrie ; deux membres du LRI participent déjà depuis début 2013 à une recherche avec un financement doctoral dans le projet Fiabilité et Sûreté de Fonctionnement de la thématique Systèmes Embarqués et le directeur fait partie du comité d'orientation du programme Technologies et Outils d'Ingénierie Numérique ;
 - la participation de plusieurs membres du LRI aux nombreux groupes de travail et instances qui ont élaboré le projet d'Idex (Initiative d'Excellence) Paris-Saclay, labellisé en février 2012, réunissant 2 universités, 10 grandes écoles et 6 organismes ou instituts ; dans la perspective de la création de l'université Paris-Saclay en 2014, deux membres du LRI ont été élus au sénat académique de la Fondation de Coopération Scientifique, et plusieurs autres sont très actifs dans l'organisation du futur département STIC de cette université, qui sera en grande partie l'émanation de Digiteo, ainsi que dans l'élaboration des maquettes des futurs master et ED STIC (coordonnés par deux professeurs du LRI).
- La restructuration interne du LRI menée de novembre 2012 à juin 2013. Le directeur l'a impulsée pour améliorer la gouvernance interne et la visibilité externe du laboratoire, la structure en réseau en douze équipes de recherche qui préexistait avant le présent quinquennal atteignant de ce point de vue ses limites. Il avait dans l'idée d'aboutir à une structure à deux niveaux. Mais après appropriation du

projet et débat au sein des équipes, trois paires d'équipes aux thématiques relativement proches et qui avaient déjà tissé des collaborations étroites ont décidé de fusionner. Trois autres équipes avaient de solides raisons scientifiques de rester telles quelles. Finalement, les trois dernières équipes se sont reconfigurées en deux équipes. C'est ainsi que le LRI est passé en juin 2013 de douze à huit équipes de recherche. Chaque équipe a structuré ses thèmes de recherche en termes d'activités, un même chercheur pouvant participer à plusieurs activités. Le règlement intérieur a été mis à jour, incluant les changements dans la gouvernance, notamment l'élection par chaque équipe d'un responsable et d'un responsable adjoint, qui s'est tenue cet été.

- Les équipes administrative et technique ont dû faire face à de nombreux changements de personnel, suite à des départs à la retraite et surtout à des mutations et promotions. Ceci a posé des problèmes compte tenu par ailleurs de l'accroissement significatif de la charge de travail reposant sur ces équipes, principalement dû à l'installation dans nos nouveaux locaux et à leur exploitation ainsi qu'à la diversification des tâches leur incombant. Les deux équipes y ont fait face par des remplacements de personnel, grâce notamment à la mise en place de postes en NOEMI par l'INS2I, une réorganisation interne et le recrutement de CDD financés sur le soutien de base du laboratoire. L'équipe technique s'est ainsi structurée en trois pôles : à côté du pôle traditionnel Système et réseaux, un renforcement notable du pôle Logistique et la création du pôle Développement logiciel réunissant à l'activité existante dédiée au Système d'information du laboratoire, deux nouvelles activités dédiées au développement et à la maturation de logiciels scientifiques et à la valorisation et au transfert. Ces deux activités, en plein essor et appelées à s'étendre, ont pu être lancées grâce au recrutement d'un ingénieur de recherche CNRS et à la mi 2013 d'un CLD de 30 mois attribué par l'INS2I.

1/ Présentation de l'unité

Politique scientifique

La politique scientifique de l'unité durant la période 2008-2013 a eu essentiellement deux volets : interne, de consolidation et développement de ses axes thématiques mais aussi de refondation voire de création de nouveaux axes ; local avec en particulier, à partir de 2010, l'implication très forte dans les programmes des investissements d'avenir et dans le montage de la future Université Paris-Saclay, affirmant le rôle moteur du LRI dans la structuration de la communauté STIC de l'Idex puis de sa continuation comme future Université.

La recherche au LRI

- Comme dit en introduction, un des principaux objectifs a été la refondation d'un axe fort, reconnu et visible en informatique fondamentale, suite au départ entre 2009 et 2011 des 8 chercheurs CNRS de l'équipe "Algorithmique et Complexité" (Algo), principalement dû à la mutation à la rentrée 2010 de tout le groupe d'algorithmique quantique pour le LIAFA. Des actions proactives en termes d'attractivité et de profilage de postes ont été menées qui ont été couronnées de succès avec le recrutement en 2011 et 2012 d'un CR1 et d'un CR2 CNRS en théorie des graphes, avec le fort soutien de l'INS2I, et de deux professeurs en combinatoire. Si l'on ajoute le recrutement en cette rentrée 2013 d'un DR2 CNRS spécialiste des aspects calculatoires, combinatoires et géométriques de l'optimisation linéaire, accompagné d'une chaire Digiteo de quatre ans, et la venue en mutation depuis le PRISM d'un CR1 CNRS en algorithmique, ainsi que, à la faveur de la restructuration des équipes qui s'est achevée en juin 2013, la réunion de la Théorie des graphes, qui était à cheval avec l'équipe "Théorie des Graphes et Optimisation Combinatoire" (GraphComb) et la création d'une activité Algorithmique des systèmes en réseau avec la venue de deux enseignants-chercheurs de l'équipe "Réseaux" et d'un de l'équipe "Parallélisme" (Parall), le tout constituant la nouvelle équipe "Graphes, Algorithmes et Combinatoire" (GALaC), on peut estimer que la refondation de l'informatique fondamentale est en grande partie achevée, même si les actions de consolidation ne devront pas être négligées.
- La mutation en 2010 de l'Ecole Normale Supérieure de Lyon au LRI, au sein de l'EPC "Apprentissage et Optimisation" (A&O / TAO), d'un CR1 CNRS section 41, développant actuellement un projet de théorie des probabilités et de l'information pour l'intelligence artificielle, avec notamment en vue le traitement

automatique du langage naturel, titulaire en 2011 de la médaille de bronze du CNRS (INSMI), procède de cette même démarche d'affirmation de thèmes forts en informatique fondamentale à la frontière avec les Mathématiques et d'attraction des meilleurs chercheurs. De fait, l'angle de recherche de A&O / TAO est à l'interface entre Informatique et Mathématiques : les approches proposées concernant l'apprentissage et l'optimisation en contexte incertain doivent être également bien fondées en termes probabilistes et algorithmiques. Cette équipe, qui présente une visibilité internationale dans le domaine des jeux (notamment le computer-Go), sait ainsi attirer des chercheurs du plus haut niveau.

- Un autre objectif prioritaire a été de consolider et élargir thématiquement et structurellement un axe fort en Masses de données. L'équipe "Intelligence Artificielle et Systèmes d'Inférence" (IASI) avait depuis très longtemps eu la volonté d'allier traitement des connaissances, son axe thématique propre, avec traitement des données, ce qui avait présidé à la constitution de l'EPC GEMO avec Inria, qui existait en 2008 et jouissait déjà d'une solide reconnaissance dans le domaine des Masses de données. Mais la partie stricto sensu Bases de données n'y était alors représentée que par Inria, l'équipe "Bases de données" (BD) du LRI étant restée en dehors de cette association. Aussi, lors du renouvellement de l'équipe-projet Inria GEMO arrivée à son terme, la direction du LRI et les membres de GEMO et BD ont souhaité déposer un projet d'EPC LEO qui élargisse les thèmes de recherche de GEMO en englobant, en plus de IASI (renforcée par le recrutement en 2010 d'un CR2 CNRS sur le thème des logiques de description), une grande partie de l'équipe BD avec à sa tête un nouveau responsable et renforcée par le recrutement d'un MCF (cette restructuration s'accompagnant d'évolutions de thématiques individuelles : migration d'un membre de BD vers l'équipe "Preuve de programmes" (Toccata) et de l'ex-responsable, devenu professeur émérite, vers l'équipe A&O). Après plus d'un an d'existence en interne comme équipe du centre Inria Saclay, LEO n'ayant finalement pas obtenu le statut d'EPI à cause essentiellement de sa thématique jugée trop large aux regards des critères des équipes-projets Inria, d'un commun accord un autre projet d'EPC plus focalisé, OAK, centré sur les bases de données complexes et reposant cette fois sur l'équipe BD, a alors été proposé et accepté comme EPI. Mais les deux équipes IASI et BD / OAK, qui avaient à présent tissé des collaborations étroites et des projets communs, ont naturellement fusionné lors de la restructuration du LRI en la nouvelle équipe "Données et Connaissances Massives et Hétérogènes" (LaHDAK). Le départ pour raison de promotion externe comme PR de deux MCF de IASI et d'un MCF de BD / OAK (heureusement compensé par le recrutement d'un PR) en cette rentrée 2013 fait néanmoins que la situation de certains axes de LaHDAK reste fragile et à consolider, notamment pour renforcer le thème du chercheur CNRS autour du raisonnement formel à base d'ontologies et la synergie entre raisonnement sur les données et sur les connaissances, ce pont étant principalement assuré jusque là par un des deux MCF de IASI qui est parti. Le thème qui était porté par l'autre MCF de IASI ayant quitté le LRI, à savoir le développement de solveurs SAT extrêmement efficaces sur des instances de problèmes industriels pour lequel il se situait au meilleur niveau international, ne pourra pas de fait, au moins dans un avenir proche, être reconduit (mais des activités sur les solveurs SMT ont lieu au sein de l'équipe "Vérification").
- Une autre action prioritaire qui a été menée est la création d'un axe en Calcul à haute performance (HPC). Il y a eu durant la période 2008-2013 pas mal de reconfigurations internes et mutuelles au sein des équipes "Parallélisme" (Parall) et "Architectures parallèles" (Archi), dues principalement aux évolutions à Inria des EPI "Grand Large" et "Alchemy" avec lesquelles elles étaient respectivement associées sous forme d'EPC : plusieurs chercheurs Inria de ces deux EPI sont partis vers d'autres structures Inria ; Alchemy s'est finalement terminée début 2011 et le LRI en a profité pour refonder l'équipe Archi autour des architectures parallèles et de la compilation et optimisation des programmes par l'apport de deux enseignants-chercheurs venant de Parall (dont l'un a pris la direction de l'équipe) et l'accueil en 2012 d'un enseignant-chercheur auparavant membre de l'équipe ACCIS de l'IEF ; Grand Large quant à elle s'est virtuellement terminée cette année (elle s'arrêtera officiellement fin 2013). Courant 2009, il a été décidé de renforcer l'axe HPC, présent jusque là dans Parall par un seul chercheur Inria, à côté de l'axe historique d'algorithmique distribuée : un recrutement d'un MCF couplé à une chaire Inria a eu lieu sur ce thème en 2010. Un projet de montage d'EPI associant entre autres ces deux chercheurs et deux mathématiciens du Laboratoire Jacques-Louis Lions à l'UPMC n'a hélas pas reçu le feu vert de l'INS2I, ce qui a conduit le chercheur Inria à quitter le LRI en 2012 pour aller monter son EPI à Rocquencourt. Voulant absolument pérenniser cet axe que le laboratoire considère comme stratégique, le LRI a promu professeur cette année 2013 notre collègue MCF qui avait pris entre temps la direction de l'équipe Parall. Celui-ci a déposé un projet d'EPC avec les membres de l'équipe Archi autour du HPC, de l'architecture et de la compilation. Approuvé cette fois par l'INS2I, nous avons bon espoir qu'il aboutisse à la création en 2014 d'une nouvelle EPC. Finalement, la restructuration cette année des équipes a naturellement abouti à la fusion des équipes Parall et Archi en une nouvelle équipe "Systèmes Parallèles" (ParSys). Bien entendu, cet axe HPC devra être consolidé en termes de recrutements futurs.

- Un axe pour lequel le LRI est internationalement reconnu et joue un rôle moteur dans l'environnement local est l'Interaction Homme-Machine (IHM). L'EPC "Interaction Située" (InSitu) a notamment renforcé son potentiel de recherche en recrutant durant la période 2008-2013 un CR2 CNRS et un CR2 Inria (mais a vu le départ d'un CR1 Inria) et un de ses chercheurs Inria a reçu un "advanced grant" de l'ERC en 2013 alors qu'un professeur avait été nommé membre senior à l'IUF en 2011. Outre le lancement du master HCID dans le cadre d'ICT Labs déjà signalé, on verra ci-dessous la forte implication de l'équipe dans les investissements d'avenir.
- Le développement de l'équipe "Bioinformatique" (Bioinfo), qui constitue avec son alter ego du LIX (Ecole Polytechnique et CNRS) l'EPI AMIB et est la seule EPC du LRI qui fasse partie d'une EPI inter-UMR, constituait également un objectif, de par le rôle qu'elle joue tant en recherche qu'en formation à l'interface des STIC et des Sciences de la Vie et les enjeux tant académiques que sociétaux évidents qui s'y rattachent. Elle a pu se renforcer en recrutant un MCF en 2010 et en accueillant en 2011 un DR CNRS émérite venant de l'Institut de Génétique et Microbiologie (IGM, UPSud et CNRS ; rappelons qu'un professeur de Bioinfo est à la fois membre du LRI et de l'IGM). Si l'année 2013 a vu le départ d'un MCF pour cause de promotion externe comme PR, elle a apporté la grande satisfaction d'un recrutement d'un CR2 CNRS en CID 51, le premier chercheur en poste de cette équipe qui prouve ainsi son attractivité.
- Les activités qui relèvent du génie logiciel au sens large représentent aussi un axe fort et reconnu du LRI, s'appuyant sur de la recherche fondamentale et riche en applications industrielles. Ces activités se sont partagées durant la période 2008-2013 entre l'EPC "Preuve de programmes" (EPI Proval puis renouvellement sous forme de l'équipe Inria Toccata en 2012, à périmètre constant, en attente de passer EPI) pour ce qui est de la vérification et l'équipe "Test Formel et Exploration de Systèmes" (ForTesSE) pour ce qui est du test. Malgré l'arrêt de l'activité autour de la programmation synchrone dû au départ en mutation en 2010 du professeur qui en était en charge, Toccata s'est renforcée avec tout particulièrement le recrutement de deux CR2 Inria en 2008 et 2012, s'ajoutant à celui de deux MCF en 2009 et 2010. L'activité importante autour des vérificateurs à base de solveurs SMT a été préservée par la promotion comme professeur en 2013 d'un MCF de l'équipe. L'équipe ForTesSE est quantitativement beaucoup plus petite : créée durant le précédent quadriennal, le professeur étranger recruté en 2008 avec le soutien d'une chaire Université et d'une chaire Digiteo en a pris la responsabilité (son responsable d'alors étant passé professeur émérite). Elle a été renforcée par le recrutement d'un MCF en 2009 mais en a perdu un autre par promotion externe en 2012. Il s'est noué des collaborations effectives entre membres de ces deux équipes et c'est tout naturellement qu'elles ont été les premières, lors de la restructuration de 2013, à souhaiter fusionner pour augmenter les synergies entre les activités de preuve, vérification, test. C'est ainsi qu'est née l'équipe "Vérification d'Algorithmes, Langages et Systèmes" (VALS) qui forme donc une EPC avec Toccata.
- Les deux derniers grands axes de recherche du laboratoire sont l'Optimisation Combinatoire d'une part et les Réseaux d'autre part. L'Optimisation Combinatoire a été durant toute la période considérée l'un des deux axes de l'équipe "Théorie des Graphes et Optimisation Combinatoire" (GraphComb), représenté en 2008 par le professeur responsable de l'équipe et un MCF recruté en 2007, qui faisait le pont entre les deux axes de l'équipe. Cet axe était clairement sous-critique en taille. Un renforcement a été programmé sous la forme du recrutement d'un second MCF en 2010, mais hélas le premier MCF est parti en mutation en 2012. Les liens entre Optimisation et Graphes n'étant plus vraiment opérationnels, il a été décidé à la faveur de la restructuration de 2013 d'entériner la séparation des deux axes en intégrant comme il a été dit plus haut la totalité de l'activité Graphes avec l'Algorithmique et la Combinatoire et de se concentrer sur un renforcement de l'Optimisation avec une focalisation sur l'Optimisation Combinatoire Stochastique, pour laquelle les travaux du groupe sont bien reconnus. Une première action dans la réalisation de cet objectif a été le recrutement en cette rentrée 2013 d'un MCF en mutation. Le DR2 CNRS, dont on a mentionné le recrutement à cette même rentrée dans l'équipe GaLAC, aura aussi sans nul doute des interactions fructueuses avec ce groupe. L'équipe "Réseaux", quant à elle, lors de l'arrivée à terme sous sa forme d'alors et le nécessaire renouvellement début 2011, centrée sur Inria Rocquencourt, de l'EPI Hipercom avec laquelle elle formait une EPC, est devenue une équipe propre du LRI et a privilégié un rapprochement avec Supélec pour former un axe fort "Réseaux-Télécoms" sur le plateau de Saclay. Cela s'est traduit par une tentative de montage par Supélec d'une EPC avec Inria incluant des membres de Réseaux, qui n'a pas abouti. Mais cette volonté de l'équipe, appuyée par la direction, de jouer pleinement un rôle actif dans la structuration d'un tel axe, étendu aux écoles telles que Télécom ParisTech et Télécom SudParis qui vont bientôt arriver sur le plateau, reste on ne peut plus d'actualité dans le cadre de l'Idex Paris-Saclay comme on le verra. L'équipe a réussi à se renforcer de manière importante en interne durant la période 2008-2013 grâce au recrutement de deux MCF en 2009 et d'un PR en 2011 (qui était aussi classé premier la même année sur un poste de CR1 CNRS pour intégration au LRI et est nommé membre junior

de l'IUF à compter du 1er octobre 2013). Mais, lors de la restructuration conduite en 2013, ce professeur, ainsi qu'un des deux MCF, qui mènent des travaux essentiellement théoriques sur l'algorithmique des systèmes en réseau et la théorie des jeux, se sont trouvés plus d'affinités thématiques avec des collègues de GaLAC et ont intégré cette équipe. Comme de plus le responsable de l'équipe "Réseaux" a quitté le LRI en cette rentrée 2013 pour être détaché dans la start-up Green Communications qu'il avait créée avec un collègue de l'UPMC, l'équipe s'est trouvée soudain réduite de six (2 PR et 4 MCF) à trois (3 MCF dont 2 HDR et 1 très prochainement HDR) en cette rentrée 2013. Une action prioritaire pour le futur proche sera donc de renforcer cet axe par des opérations de recrutement et/ou de collaborations externes.

Ces deux équipes Optimisation et Réseaux, de trois enseignants-chercheurs chacune en cette rentrée, après concertation lors de la restructuration de 2013 ont d'un commun accord décidé d'unir leurs forces au sein de la nouvelle équipe "Réseaux et Optimisation Combinatoire Stochastique" (ROCS). Les nombreux problèmes d'optimisation qui se posent dans les réseaux, sur lesquels les membres de l'équipe "Réseaux" ont une expertise, notamment pour étudier les performances de leurs solutions par rapport à l'optimal, et la très bonne connaissance de ces problèmes par le responsable du groupe Optimisation, qui a travaillé plusieurs années à France Télécom, garantissent la pertinence scientifique de cette fusion et laissent augurer qu'une synergie fructueuse entre les deux groupes s'opèrera. Il reste néanmoins que cette nouvelle équipe, dont la constitution a relevé en partie d'événements distincts et concomitants non prévus et difficiles à anticiper et est en ce sens moins immédiatement "naturelle" que les regroupements qui ont présidé à la formation des autres équipes, doit être considérée comme en incubation et un bilan sera tiré dans un an.

Le LRI dans son environnement

Le LRI participe largement aux différents conseils de l'université Paris-Sud et de ses composantes et joue un rôle moteur dans la structuration des STIC à Saclay, à travers le RTRA Digiteo depuis sa fondation et via son implication depuis 2010 dans les programmes des investissements d'avenir et le montage de la future Université Paris-Saclay.

- Durant toute la période considérée, la présidence du département d'informatique de la Faculté des Sciences a été assurée par un professeur du LRI (et la vice-présidence par un professeur du LIMSI) ainsi que les vice-présidences recherche et formation. Tant au titre de la recherche que de la formation, le LRI représente les STIC par ses élus dans les différentes instances de l'université Paris-Sud, tant au niveau de ses composantes, à la Faculté des Sciences (deux au conseil de l'UFR et deux au conseil de division de la recherche), à l'école d'ingénieurs Polytech Paris-Sud (trois au conseil de perfectionnement, un au conseil de gouvernance, un au conseil de direction), à l'IUT d'Orsay (un au conseil), à l'IUT de Sceaux (un au conseil), qu'à celui de l'université même (deux au conseil scientifique ainsi que deux au comité technique et deux au Comité d'Hygiène, de Sécurité et des Conditions de Travail).
- Le LRI est actif dans le RTRA Digiteo, le premier parc français de recherche en STIC, depuis son organisation en 2007 : c'est un professeur du LRI qui a dirigé le comité des programmes depuis l'origine jusqu'à mi 2013 (un autre membre du LRI vient de lui succéder), le LRI est représenté par un membre à ce comité et son directeur est le représentant de Paris-Sud au comité de pilotage. Les membres du LRI ont largement répondu avec succès aux appels à projets de Digiteo : chaires internationales (une senior en 2008 avec le LIX, une junior en 2009, une senior en 2013), projets scientifiques avec financement de matériel, bourses de thèses ou postdocs (en commun jusqu'à 2011 avec le DIM (domaine d'intérêt majeur) "Logiciels et systèmes complexes" de la région Île-de-France), invités, manifestations scientifiques, opérations de maturation technico-économiques. Citons en particulier le projet WILD obtenu en 2008 par l'EPC In Situ en coopération avec l'EPI Aviz et le LIMSI : ce mur d'image, installé en février 2009 et inauguré en juin 2009, est constitué de 32 écrans de 30 pouces (plus de 130 millions de pixels sur une surface de 5m50 x 1m80), d'une table interactive "multitouch", d'un système de capture et de suivi de gestes et de mouvements et d'un cluster de visualisation de 18 machines. Est privilégiée dans ce projet l'interaction avec de grandes masses de données complexes et hétérogènes, avec pour applications l'aide à la découverte scientifique : c'est ainsi que huit laboratoires du plateau de Saclay sont associés au projet, représentant des disciplines aussi diverses que l'astrophysique (IAS), la physique (LAL), la chimie (ICMMO), la biochimie (IMMBC), la génétique (IGM), la mécanique (LIMSI), les mathématiques appliquées (MAS) et les neurosciences (LNAO).
- Comme mentionné en introduction, le LRI s'est fortement mobilisé dans les programmes des investissements d'avenir. C'est un professeur de l'équipe In Situ, déjà à l'origine du projet WILD, qui a coordonné la proposition d'Equipex Digiscope, acceptée et lancée en 2011, qui affirme la place éminente

au niveau international que tiennent les équipes de Saclay en visualisation haute performance pour l'interaction collaborative avec des données massives et des plateformes de calcul. Digiscope a intégré le mur WILD et un autre mur d'image, WILDER, sera installé début 2014 par Inria dans Digiteo Moulon. Il comprend aussi un "fab lab" (laboratoire de fabrication) d'abord installé au PCRI puis déplacé dans Digiteo Moulon début 2013 près du futur mur WILDER et qui est en activité avec des équipements financés par Paris-Sud. C'est aussi un professeur du LRI, le responsable du département d'informatique, qui a coordonné la proposition de Labex DigiCosme et en est le directeur depuis son lancement en mars 2012 (un colloque inaugural s'est tenu en septembre 2012 qui a regroupé 150 participants). L'axe DataSense de DigiCosme est dirigé par un chercheur du LRI et trois de ses cinq tâches ont pour responsables ou co-responsables des membres du LRI. Il en est de même pour une des trois tâches de l'axe SciLex et une des trois tâches de l'axe ComEx. Trois membres sur dix du comité exécutif sont des membres du LRI. Le LRI a participé avec succès aux appels à bourses de thèses et bourses de master en 2012 et en 2013. Le LRI s'est de même beaucoup impliqué dans la création de l'IRT SystemX et deux membres de l'équipe ForTesSE de test formel participent depuis début 2013 à un projet dans ce cadre avec un financement doctoral. Enfin plusieurs membres du LRI ont joué un rôle très actif dans l'élaboration du projet d'Idex Paris-Saclay par leur participation au Comité académique consultatif (CAC) puis au sénat académique, qui a pris sa suite en 2013 et auquel deux membres du LRI ont été élus, et aux nombreux groupes de travail tant en recherche au niveau de la définition des départements qu'en formation au niveau de la définition des collèges ("Schools"). Cette implication ne fait que s'accroître dans la structuration de la future université Paris-Saclay qui sera créée en 2014 : le LRI est un des acteurs importants de l'organisation du futur département Sciences et Technologies de l'Information de cette université, qui sera en grande partie l'émanation de Digiteo, et dont le périmètre et les missions sont en voie de finalisation ; ce sont deux professeurs du LRI qui coordonnent l'élaboration actuelle dans le cadre du prochain contrat quinquennal des maquettes du futur master mention Informatique et de la future Ecole Doctorale STIC de l'université Paris-Saclay. Le LRI est aussi présent dans certains des projets Idex lancés en 2013, notamment l'Institut de la Société Numérique ainsi que l'Institut de Modélisation des Systèmes Vivants via son équipe BioInfo et il est impliqué dans les réponses à l'appel à projets 2013 pour 2014. Il faut aussi noter la participation du groupe d'Optimisation Combinatoire Stochastique du LRI à des projets du "Programme Gaspard Monge pour l'Optimisation et la recherche opérationnelle" (PGMO) lancé par EDF et la Fondation Mathématique Jacques Hadamard (FMJH).

Résumé de l'activité scientifique

Total cumulé des publications du 01/01/2008 au 30/06/2013

Sur les derniers cinq ans et demi, les membres du LRI ont produit plus de 2000 publications, en hausse par rapport à la période précédente (un peu plus de 1400 durant le quadriennal précédent), dont 309 articles dans des revues internationales majeures, 394 dans des conférences internationales majeures et 78 livres et chapitres de livres. En se limitant aux deux premières catégories, ceci représente 7,2 publications majeures par enseignant-chercheur ou chercheur permanent (10,9 par équivalent-chercheur, où un enseignant-chercheur est compté la moitié d'un chercheur). Si l'on compte toutes les formes de publication, on arrive à 8,6 par membre du laboratoire, y compris les doctorants et postdocs (10,1 en équivalent-chercheur). Dans les deux cas, ceci représente donc de l'ordre de deux publications par an par équivalent-chercheur en moyenne.

La mesure qualitative adoptée pour définir les publications "majeures" repose comme il y a cinq ans sur une classification créée à l'origine par l'association australienne CORE pour la recherche et la formation en informatique (qui a malheureusement arrêté sa diffusion il y a deux ans environ), qui comprend quatre catégories : A+, censé représenter les 5% meilleures, A, pour les 15% suivantes, B, pour les 30% suivantes, et C, pour les 50% restantes. On a formé les publications majeures en regroupant celles notées A+ ou A soit environ les 20% réputées les meilleures.

Type de publication	Nombre
Articles de revue	467
<i>dans des revues majeures</i>	309
<i>dans d'autres revues</i>	158
Conférences invitées	22
Articles de conférence et de workshop	1005
<i>dans les conférences internationales ma-</i>	394
<i>jeures</i>	
<i>dans les conférences nationales majeures</i>	72
<i>dans d'autres conférences et workshops</i>	539
Posters et autres communications	43
Livres et chapitres de livres	78
Coordination de livres	27
Information scientifique	14
Autres publications	242
Thèses et Habilitations	132
Total	2030

Les revues et conférences ne figurant pas dans CORE se sont vu attribuer une catégorie par les membres du LRI selon les critères définis par CORE. On a aussi dans quelques cas changé la catégorie CORE lorsqu'elle nous est apparue erronée et on a introduit deux nouvelles catégories N+ et N pour les publications nationales (la table CORE originale et sa version enrichie et modifiée par le LRI sont disponibles sur le site web du laboratoire).

Il s'ensuit de la classification CORE modifiée la distribution suivante des publications majeures et autres du LRI :

Classement des publications	Total	A+/A	N+	B/C/N
Revues	467	309	N/A	158
		66.16%	N/A	33.83%
Conférences	1005	394	72	539
		39.20%	7.16%	53.63%
Total	1472	703	72	697
		47.75%	4.89%	47.35%

Le pourcentage de publications majeures atteint 66,16% pour les revues (en progression de 7,16%) et 46,36% pour les conférences (en légère baisse de 1,64%).

Total cumulé des contrats du 01/01/2008 au 30/06/2013

En plus des très nombreuses collaborations qu'entretient le LRI aux niveaux national, européen et international, souvent informelles au niveau des chercheurs individuellement sous forme de courtes visites et de publications conjointes, le laboratoire développe des collaborations formelles sous forme d'une importante activité contractuelle.

Durant les cinq ans et demi passés, plus de 250 contrats et subventions, représentant près de 17 millions d'euros, ont été obtenus par les membres du LRI, en hausse par rapport à la période précédente (120 contrats pour un peu plus de 11 millions d'euros sur quatre ans), même si le montant moyen par contrat a diminué pour toutes les catégories, notamment l'Europe.

Si le classement des montants par catégorie est resté le même, on observe une nette hausse des montants des contrats ANR, industriels, Digiteo et autres (financement par les tutelles de projets collaboratifs ou de réseaux aux plans local, national ou international) et une baisse significative du montant des contrats européens. Cette baisse des contrats européens, malgré l'apport très substantiel du KIC ICT Labs, reflète la situation générale en France : face à l'extrême sélectivité de la compétition et à la lourdeur de montage des projets et l'investissement énorme en temps que cela représente, les chercheurs préfèrent se tourner vers l'ANR et, pour ce qui est des STIC à Saclay, vers Digiteo (incluant aussi jusqu'en 2011 des financements de la région Ile-de-France via le DIM Logiciels et Systèmes Complexes) finançant principalement des projets collaboratifs entre membres de Digiteo. La croissance de cette dernière catégorie démontre le rôle majeur que le LRI joue dans ce réseau.

Contrats	Nombre	(LRI+Inria)	Montant total (€)	Moyenne par contrat (€)
ANR	81	(52+29)	7.553.392	93.252
Europe	39	(28+11)	2.626.486	67.346
Industrie	36	(17+19)	2.578.055	71.613
Digiteo	41	(30+11)	2.541.737	61.994
Autres	59	(42+17)	1.689.873	28.642
Total	256	(169+87)	16.989.543	66.365

Note: Les nombres entre parenthèses sont ceux des contrats gérés par le LRI et par Inria respectivement.

Résumé du bilan financier

Il faut avoir à l'esprit, dans la lecture des tableaux qui suivent, que seule une petite partie du budget total du laboratoire est sous son contrôle. En effet la plus grosse partie du budget est constituée des salaires des permanents directement versés par le ministère de la recherche, le CNRS ou Inria. Les doctorants titulaires d'une allocation de recherche sont aussi directement financés par l'université. De même, une part importante des coûts d'infrastructure (fluides : chauffage, électricité) sont directement pris en charge par l'université ou Inria. Enfin, les EPC reçoivent un financement d'Inria.

Budget du LRI hors Inria par année du 01/01/2008 au 30/06/2013

On constate, dans les deux tableaux ci-dessous, que, pour la part restante du budget sous le contrôle du laboratoire, les ressources propres (contrats) en représentent environ 75% et les subventions des deux tutelles environ 25%, soit une stabilisation au niveau atteint à la fin du quadriennal précédent.

	2008	2009	2010	2011	2012	2013
<i>Subvention d'état</i>						
Université Paris-Sud	336.416 €	339.257 €	312.200 €	300.497 €	355.874 €	265.455 €
CNRS	188.301 €	207.727 €	239.500 €	190.000 €	159.000 €	190.450 €
Total subvention d'état	524.717 €	546.984 €	551.700 €	490.497 €	514.874 €	455.905 €
<i>Ressources propres</i>						
Progr. internationaux	66.875 €	77.775 €	48.438 €	4.375 €	1.875 €	30.500 €
Union européenne	31.040 €	39.406 €	44.945 €	304.790 €	307.459 €	184.533 €
ANR	903.497 €	841.939 €	544.591 €	588.784 €	684.924 €	265.524 €
Pôles de compétitivité	127.139 €	72.811 €	66.743 €	18.214 €	42.531 €	18.214 €
RTRA Digiteo	194.598 €	392.352 €	395.549 €	334.557 €	322.723 €	126.402 €
Industrie	9.491 €	67.151 €	137.540 €	160.278 €	196.547 €	91.802 €
Autres	150.528 €	156.533 €	116.000 €	58.660 €	89.000 €	23.776 €
Total res. propres	1.483.168 €	1.647.967 €	1.353.806 €	1.469.658 €	1.645.059 €	740.751 €
Total	2.007.885 €	2.194.951 €	1.905.506 €	1.960.155 €	2.159.933 €	1.196.656 €

Pourcentage des ressources propres hors Inria sur les dix dernières années

Ressources (k€)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Univ. Paris-Sud	257	203	250	308	305	336	339	312	300	356	265
CNRS	138	138	211	257	234	188	208	239	190	159	190
Ressources propres	1.315	1.184	983	1.682	1.453	1.483	1.648	1.354	1.470	1.645	741
Total	1.710	1.525	1.444	2.247	1.992	2.008	2.195	1.906	1.960	2.160	1.197
% Ressources propres	77%	78%	68%	75%	73%	74%	75%	71%	75%	76%	62%

Comparaison des ressources LRI et des ressources Inria des EPC du 01/01/2008 au 30/06/2013

On a vu que durant la période considérée il y a avait entre six et huit EPC avec Inria (sur un total de douze équipes de recherche). Outre qu'Inria gère une partie des contrats et subventions de ces EPC, il les finance aussi directement avec ses propres ressources internes, ce qui n'apparaissait pas dans les deux tableaux ci-dessus. Le tableau ci-dessous montre la part respective des ressources LRI et des ressources Inria des EPC (toujours hors salaires des permanents et hors certains coûts d'infrastructure).

Ressources	2008	2009	2010	2011	2012	2013
Subvention d'état	524.717 €	546.984 €	551.700 €	490.497 €	514.874 €	455.905 €
Ressources propres	1.483.168 €	1.647.967 €	1.353.806 €	1.469.658 €	1.645.059 €	740.751 €
Total LRI	2.007.885 €	2.194.951 €	1.905.506 €	1.960.155 €	2.159.933 €	1.196.656 €
Financement Inria	3.033.358 €	2.434.763 €	1.340.480 €	1.028.318 €	645.368 €	166.850 €
Total général	5.041.243 €	4.629.714 €	3.245.986 €	2.988.473 €	2.805.301 €	1.363.506 €
% Inria	60%	53%	41%	34%	23%	12%

On remarque que la part de financement d'Inria, qui avait crû de façon spectaculaire au démarrage, passant de 35% en 2006 à 60% en 2008 est progressivement redescendu durant le présent quinquennal à environ 20%, ce qui est plus conforme au pourcentage Inria en effectifs (environ 15% parmi les chercheurs et enseignants-chercheurs permanents ; de l'ordre de 25% sur le total du personnel du LRI).

Dépenses

Outre les principales sources habituelles de dépenses que sont l'équipement, notamment informatique, les missions et les salaires des personnels temporaires sur contrats, le LRI a connu durant la période un poste de dépenses exceptionnelles majeur, celui des dépenses d'infrastructure des nouveaux bâtiments PCRI et Digiteo Moulon : coûts des déménagements depuis la vallée et le parc Club, des travaux, de l'aménagement des bureaux, des espaces-projets, des salles de réunion, des espaces détente, etc., ainsi que les salaires de personnels temporaires indispensables dans ce contexte (gardiennage nuit et week-end de PCRI de mi-2011 à fin 2012 ; ingénieur en maintenance immobilière en CDD depuis novembre 2012). S'y est ajoutée durant la quasi-totalité de la période l'embauche en CDD de personnels administratifs pour la gestion des contrats, notre personnel administratif permanent n'étant pas en nombre suffisant pour faire face à l'accroissement très significatif des tâches de gestion.

Le LRI a continué durant la période à pratiquer une forme de solidarité financière, instituée en 2002 sous la forme d'un fonds de soutien à la recherche, alimenté par un prélèvement de 10% sur ses ressources propres (hors salaires des personnels temporaires), utilisé principalement pour financer des missions, notamment de jeunes chercheurs, des ordinateurs pour les nouveaux arrivants, notamment les doctorants, la participation à des écoles d'été ou pour sponsoriser des conférences organisées par des membres du laboratoire.

1/ Présentation de l'unité

Profil d'activités

Le profil d'activités est sensiblement homogène parmi les équipes de recherche. On peut l'estimer en moyenne comme suit : environ 75% des activités sont dédiées à la recherche académique, environ 10% à l'appui à la recherche ainsi que 10% à la formation par la recherche et enfin de l'ordre de 5% aux interactions avec l'environnement. Ce dernier pourcentage peut augmenter pour certaines équipes plus impliquées dans la valorisation et le transfert, par exemple l'équipe Réseaux dont un membre a co-fondé la start-up Green Communications et l'équipe Archi dont un membre a fondé la start-up Metascale. Evidemment cette répartition ne concerne que l'ensemble des activités consacrées à la recherche et ne reflète donc pas celle de l'ensemble des activités de l'unité et de chacun de ses membres : la plupart

des membres des équipes de recherche sont des enseignants-chercheurs qui consacrent la moitié de leur temps à l'enseignement et aux tâches administratives afférentes et beaucoup de membres du laboratoire exerçant des responsabilités consacrent la majeure partie de leur temps à des tâches de nature administrative.

1/ Présentation de l'unité

Organisation et vie de l'unité

Personnel

Les effectifs par catégorie de personnel au 1er janvier des six années passées sont donnés par le tableau suivant :

Personnel CNRS						
	2008	2009	2010	2011	2012	2013
<i>Chercheurs permanents et en délégation</i>						
Directeurs de recherche	5	5	6	2	3	3
Chargés de recherche	10	11	8	9	9	9
Total chercheurs	15	16	14	11	12	12
<i>Personnel technique et administratif (ITA)</i>						
Total ITA	12	12	11	10	12	11
Personnel universitaire						
<i>Enseignants-chercheurs permanents</i>						
Professeurs	25	24	25	24	26	23
Maîtres de conférences	40	40	43	44	46	41
Total EC permanents	65	64	68	68	72	64
<i>Personnel technique et administratif (BIATSS)</i>						
Total BIATSS	3	3	4	5	4	5
<i>Personnel temporaire</i>						
Doctorants	82	92	83	75	65	72
Post-docs	14	7	17	10	10	11
Ingénieurs, ITA ou BIATSS en CDD	2	4	5	5	6	5
Total personnel temporaire	98	103	105	90	81	88
Personnel Inria						
<i>Chercheurs permanents et en délégation</i>						
Directeurs de recherche	8	8	8	9	7	7
Chargés de recherche	9	10	10	10	9	10
Total chercheurs	17	18	18	19	16	17
<i>Personnel temporaire</i>						
Doctorants	43	37	45	32	28	16
Post-docs	13	8	8	10	19	11
Ingénieurs en CDD	14	11	9	5	7	8
Total personnel temporaire	70	56	62	47	54	35
Total Personnel	280	272	282	250	251	232

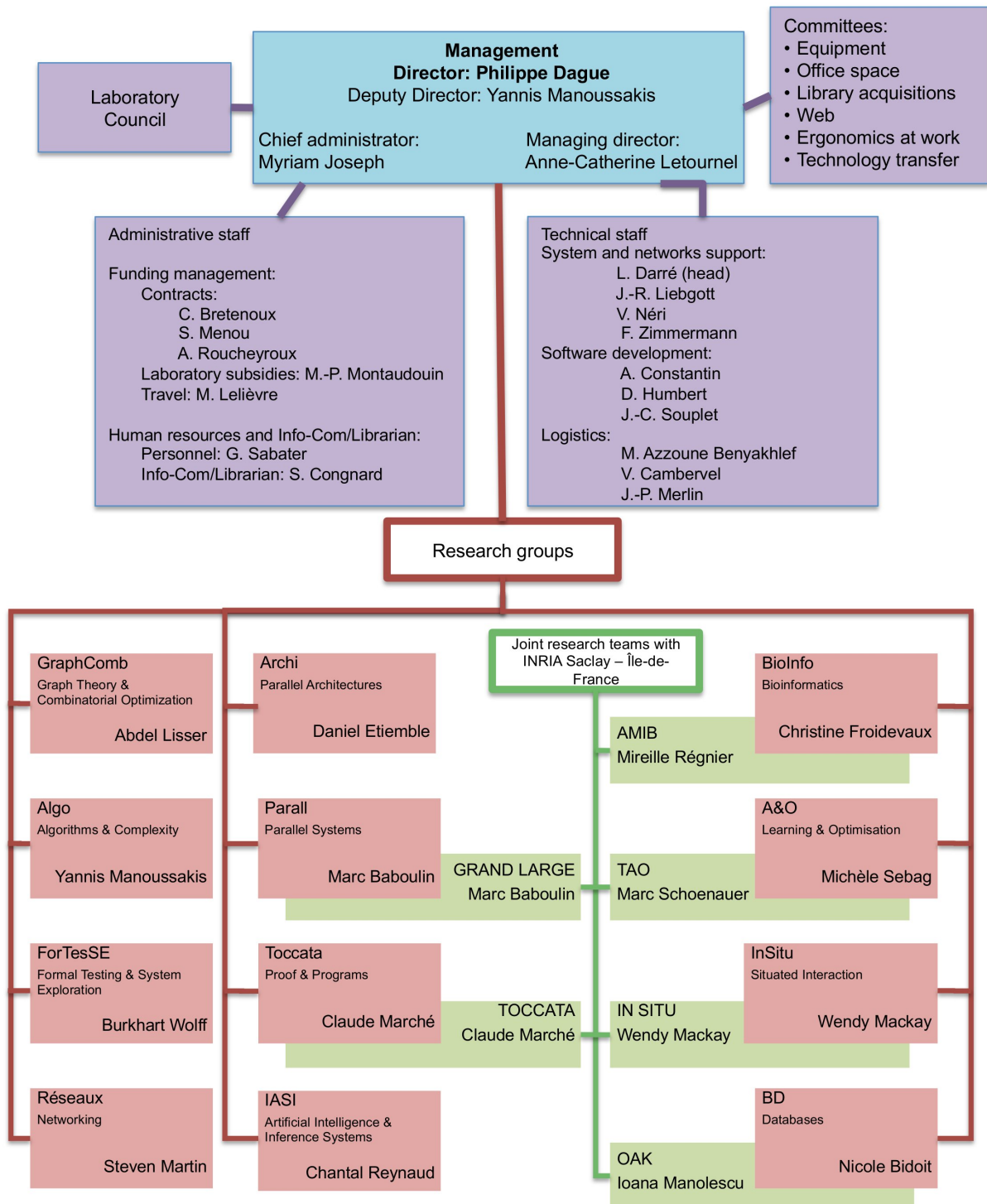
Comme souligné en introduction, on remarque la stabilité sur la période des effectifs d'enseignants-chercheurs permanents, les départs (mutations, promotions externes, départs à la retraite) étant compensés ; la chute brutale entre 2009 et 2011 des effectifs de chercheurs CNRS, due essentiellement à la mutation groupée pour le LIAFA du groupe d'Algorithmique quantique, et la remontée progressive de ces effectifs depuis (ils passeront à 15 en 2014, donc auront presque retrouvé le niveau de 2009) ; la stabilité des effectifs des chercheurs Inria (représentant 53% du total des effectifs chercheurs au début de la période et 58% à sa fin après avoir culminé à 63% en 2011 à cause de la chute des effectifs de chercheurs CNRS). Au long de la période, le pourcentage de chercheurs parmi les enseignants-chercheurs et chercheurs a varié entre 28% et 35%. Il y a donc en moyenne un chercheur pour deux enseignants-chercheurs, soit une parité d'un chercheur pour un équivalent-chercheur parmi les enseignants-chercheurs. On note la tension sur les postes ITA et surtout l'insuffisance de postes BIATSS (ne représentant que 20% à 33% du total). Après une forte hausse en fin de quadriennal précédent et début de ce quinquennal, on observe une baisse très nette des effectifs de personnel temporaire depuis 2011 (de 60% à 53% des effectifs totaux du LRI), due principalement à la baisse du nombre des doctorants (de presque un tiers entre 2010 et 2013).

Structuration

Durant la période considérée, le LRI était structurée en douze équipes de recherche (dont six à huit EPC selon l'évolution des équipes-projets Inria), une équipe administrative et une équipe technique, comme suit (les effectifs sont en enseignants-chercheurs et chercheurs permanents en juin 2013 ; les mots-clés sont volontairement empruntés exclusivement à ceux des sections 06 et 07 du CoNRS, rappelons que globalement seule l'équipe InSitu est rattachée à la section 07, les onze autres à la section 06 et que toutes se rattachent à la section 27 du CNU) :

1. **Algo** : Algorithmique et Complexité (Resp. Miklos Santha puis Yannis Manoussakis ; 5EC, 1C)
Algorithmique, combinatoire
2. **GraphComb** : Théorie des Graphes et Optimisation Combinatoire (Resp. Abdel Lisser ; 4 EC, 1 PR émérite, 2 C)
Graphes, recherche opérationnelle, optimisation discrète
3. **Réseaux** (précédemment EPC Hipercom) : Réseaux (Resp. Khaldoun Al Agha ; 6 EC)
Réseaux
4. **Toccata** (EPC, auparavant EPC Proval) : Preuve de programmes (Resp. Christine Paulin puis Claude Marché ; 6 EC, 6 C)
Programmation, calcul certifié, vérification et preuves
5. **ForTesSE** : Test Formel et Exploration de Systèmes (Resp. Marie-Claude Gaudel puis Burkhart Wolff ; 4 EC, 1 PR émérite)
Génie logiciel
6. **Parall** (EPC Grand Large) : Parallélisme (Resp. Brigitte Rozoy puis Marc Baboulin ; 5 EC)
Parallélisme, réseaux de capteurs, calcul distribué, calcul à haute performance
7. **Archi** (précédemment EPC Alchemy) : Architectures parallèles (Resp. Daniel Etiemble puis Olivier Temam puis Christine Eisenbeis puis Cédric Bastoul puis Daniel Etiemble ; 5 EC, 2 C)
Architecture et compilation
8. **IASI** (précédemment EPC Gemo puis LEO) : Intelligence Artificielle et Systèmes d'Inférence (Resp. Chantal Reynaud ; 9 EC, 1 C)
Intelligence artificielle, web sémantique, ingénierie / représentation et traitement des connaissances, formalisation des raisonnements, logique, SAT, diagnostic
9. **BD** (EPC OAK, ex LEO) : Bases de Données (Resp. Nicolas Spyratos puis Nicole Bidoit ; 4 EC, 1 C)
Base de données, gestion de données, masses de données
10. **A&O** (EPC TAO) : Apprentissage et Optimisation (Resp. Michèle Sebag ; 3 EC, 1 PR émérite, 8 C)
Apprentissage, optimisation continue, fouille de données, grilles, robotique
11. **BioInfo** (devenue l'une des deux EPC composant l'EPI AMIB) : Bioinformatique (Resp. Christine Froidevaux ; 6 EC, 1 DR émérite)
Bioinformatique
12. **InSitu** (EPC) : Interaction Située (Resp. Wendy Mackay avec un intérim d'Olivier Chapuis ; 3 EC, 4 C)
Interaction homme-machine
13. **Admin** : Administration (Resp. Nicole Lefèvre puis Myriam Joseph ; 7)
14. **Technique** : Equipe technique (Resp. Anne-Catherine Letournel ; 9)

Laboratoire de Recherche en Informatique – UMR 8623



May 2013

Comme dit en introduction, le LRI vient de se restructurer : l'opération, lancée en novembre 2012, a donné lieu à une très large concertation et de nombreuses réunions et discussions au sein des équipes et lors de conseils de laboratoire élargis aux responsables d'équipes et s'est achevée cet été 2013.

- Trois équipes ont souhaité, en s'appuyant sur des arguments scientifiques et structurels tout à fait pertinents, demeurer inchangées : l'équipe InSitu (qui a juste changé son nom en HCC : "Human-Centered Computing"), unique équipe rattachée à la section 07 du CoNRS, dédiée à l'IHM, dont les protocoles

d'évaluation de la recherche diffèrent sensiblement de ceux des autres équipes et relèvent en partie des Sciences Humaines et dont les thèmes de recherche (interaction-visualisation pour des données massives hétérogènes) sont par nature transversaux et ont vocation à être utilisés par plusieurs équipes du LRI et au delà, comme mentionné à propos de Digiscope ; l'équipe interdisciplinaire BioInfo, qui s'est constituée, fédérée et développée autour de son objet d'étude, la Biologie, et dont les méthodes informatiques complémentaires qu'elle utilise à cette fin (modélisation, ontologies, intégration d'informations et workflows, apprentissage et fouille de données, algorithmique et combinatoire) sont transverses à plusieurs autres équipes du LRI et l'amènent naturellement à collaborer avec elles, alors que son objet d'étude l'amène à collaborer avec des équipes de biologistes comme à l'IGM ou l'INRA ; enfin l'équipe A&O qui a la spécificité de s'attaquer à des problèmes modélisés de façon inhérente en nombres réels et d'utiliser pour ce faire des techniques numériques d'apprentissage statistique et d'optimisation continue peu présentes dans les autres équipes et qui est une équipe aux effectifs importants s'étant déjà structurée en interne en plusieurs activités scientifiques.

- Très naturellement, trois paires d'équipes aux thématiques proches, qui collaboraient déjà effectivement et pour deux d'entre elles s'étaient déjà trouvées en partie réunies au sein d'équipes-projets Inria, ont décidé de fusionner : les équipes Toccata et ForTese ont ainsi fusionné en l'équipe VALS de vérification, mêlant test et preuve ; les équipes Parall et Archi (au cours de la période considérée, des membres d'Archi avaient rejoint Parall à la fin de l'EPI Alchemy, puis ont reconstitué une équipe Archi) en l'équipe ParSys qui réunit l'algorithmique distribuée, le HPC et la compilation et optimisation de programmes sur architectures parallèles (à l'exception d'un enseignant-chercheur en algorithmique distribuée qui a préféré rejoindre l'équipe GALaC) ; les équipes IAS et BD (qui avaient un temps été réunies dans le projet avorté d'équipe Inria LEO) en l'équipe LaHDAK ("Large-scale Heterogeneous Data and Knowledge") réunissant données et connaissances.
- Restaient les trois équipes Algo, GraphComb et Réseaux. Il était impératif de réunir la partie Théorie des Graphes de GraphComb avec Algo comme déjà expliqué : les liens entre Graphes et Optimisation Combinatoire n'étaient plus vraiment effectifs et lors des deux derniers recrutements de chercheurs CNRS en théorie des graphes, l'un avait intégré GraphComb et l'autre Algo, ce qui n'avait pas de cohérence scientifique. Algo, réunissant l'Algorithmique et la Combinatoire, et cette partie Graphes de GraphComb ont donc fusionné en l'équipe GALaC. Outre l'enseignant-chercheur de Parall déjà cité, deux enseignants-chercheurs de l'équipe Réseaux, qui y menaient des travaux essentiellement théoriques sur l'algorithmique des systèmes en réseau et la théorie des jeux, ont décidé de rejoindre GALaC. Le groupe d'Optimisation Combinatoire n'a pas de son côté souhaité intégrer cette équipe, ce qui aurait été une possibilité, estimant les interactions avec les autres axes trop réduites. Une concertation s'est alors engagée entre ce groupe de deux enseignants-chercheurs (heureusement renforcé en cette rentrée 2013 par le recrutement d'un MCF) et l'équipe Réseaux, réduite à quatre enseignants-chercheurs (et à trois en cette rentrée 2013, le professeur responsable de l'équipe ayant demandé un détachement dans la start-up qu'il avait co-créée), qui a abouti à leur fusion pour constituer l'équipe ROCS, qui devra développer les synergies entre les deux axes, ce qui devrait ne pas être trop difficile compte tenu des nombreux problèmes qui se posent sur les réseaux qui font appel à des techniques d'optimisation combinatoire (qualité de service, gestion de la consommation d'énergie, etc.) et de l'expertise conjointe dans ce domaine des membres de l'équipe Réseaux et de l'ex-responsable de GraphComb qui a longtemps travaillé à France Télécom.

La nouvelle structure comporte donc huit équipes de recherche (dont six EPC), une équipe administrative et une équipe technique. Chaque équipe de recherche s'est structurée en interne en un certain nombre d'activités représentant les axes scientifiques de l'équipe : un même membre de l'équipe peut participer à plusieurs activités et le responsable d'une activité n'a en charge que des tâches scientifiques, comme l'organisation d'un séminaire ou de manifestations scientifiques. Chacune de ces équipes a procédé cet été à l'élection d'un responsable et d'un responsable adjoint. La liste des équipes est donc la suivante (avec pour chacune ses responsables, ses effectifs permanents au 30 juin, l'évolution éventuelle de ces effectifs à la rentrée 2013, ses mots clés empruntés à l'INS2I comme ci-dessus et la liste de ses activités) :

1. **GALaC** : Graphes, Algorithmes et Combinatoire (Resp. Florent Hivert, Resp. adjoint Hao Li ; 10 EC, 1 PR émérite, 3 C ; +2C)
Algorithmique, combinatoire, graphes, (systèmes en) réseaux
 - Combinatoire
 - Théorie des graphes
 - Algorithmique des systèmes en réseau
2. **ROCS** : Réseaux et Optimisation Combinatoire Stochastique (Resp. Steven Martin, Resp. adjoint Dominique Quadri ; 6 EC)

Réseaux, recherche opérationnelle, optimisation discrète

- Réseaux
 - Optimisation combinatoire stochastique
3. **VALS** (contient l'EPC Toccata) : Vérification d'Algorithmes, Langages et Systèmes (Resp. Burkhart Wolff, Resp. adjoint Claude Marché ; 10 EC, 1 PR émérite, 6 C)
Programmation, génie logiciel, logique, vérification et preuves, calcul certifié
- Démonstration automatique, SMT et applications
 - Formalisation et preuves de programmes numériques
 - Formalisation de langages (de spécification et de programmation) dans les assistants de preuve
 - Langages et systèmes centrés données
 - Test formel basé sur les modèles
 - Vérification déductive de programmes
4. **ParSys** (contient l'EPC Grand Large qui prend fin, EPC Postale en préparation) : Systèmes Parallèles (Resp. Marc Baboulin, Resp. adjoint Joël Falcou ; 9 EC, 2 C)
Parallélisme, réseaux de capteurs, calcul distribué, calcul à haute performance, architecture et compilation
- Algorithmique distribuée
 - Calcul à haute performance
 - Architectures parallèles
 - Compilation et optimisation des programmes
5. **LaHDAK** (contient l'EPC OAK) : Données et Connaissances Massives et Hétérogènes (Resp. Chantal Reynaud, Resp. adjoint Nicole Bidoit ; 13 EC, 2 C ; -2EC)
Base de données, gestion de données, masses de données, intelligence artificielle, web sémantique, ingénierie / représentation et traitement des connaissances, formalisation des raisonnements, logique, diagnostic
- Intégration de données et de connaissances
 - Raisonnement automatique
 - Gestion de données du Web
 - Algorithmes pour les grands volumes de données distribuées
 - Transformations complexes et évolutives
6. **A&O** (contient l'EPC TAO) : Apprentissage et Optimisation (Resp. Michèle Sebag, Resp. adjoint Jamal Atif ; 3 EC, 1 PR émérite, 8 C)
Apprentissage, optimisation continue, fouille de données, grilles, robotique
- Optimisation stochastique numérique
 - Décision optimale en contexte incertain
 - Modélisation et systèmes à grande échelle
 - Critères
 - Calibration d'algorithmes (sélection, ajustement d'hyperparamètres)
7. **BioInfo** (EPC partie de l'EPI AMIB) : Bioinformatique (Resp. Christine Froidevaux, Resp. adjoint Alain Denise ; 6 EC, 1 DR émérite ; -1EC, +1C)
Bioinformatique
- Biologie des systèmes
 - Biologie structurale
8. **HCC** (EPC InSitu) : Informatique Centrée sur l'Humain (Resp. Michel Beaudouin-Lafon, Resp. adjoint Olivier Chapuis ; 3 EC, 4 C ; +1EC)
Interaction homme-machine
- Paradigmes d'interaction et de visualisation
 - Méthodes de conception générative
 - Ingénierie des systèmes interactifs
 - Collaboration médiatisée
9. **Admin** : Administration (Resp. Myriam Joseph ; 7)

- Pôle Gestion
- Pôle Ressources Humaines et Info-Com/Documentation

10. **Technique** : Equipe technique (Resp. Anne-Catherine Letournel ; 9 ; +1)

- Pôle Système et réseaux
- Pôle Développement logiciel
- Pôle Logistique

Rapports avec les tutelles et partenaires

L'organisation des relations avec le CNRS est, surtout depuis la création de l'INS2I, parfaitement institutionnalisée sous la forme d'un suivi très proche et de contacts réguliers. La relation du LRI avec l'INS2I se fait essentiellement point à point entre son directeur et le Directeur Adjoint Scientifique de l'institut ayant en charge le LRI dans son portefeuille de laboratoires (Michel Bidoit jusqu'en mai 2013, Brigitte Vallée depuis). Le DAS organise environ trois réunions par an au siège avec les directeurs des unités dont il est en charge (en présentiel pour ceux qui le peuvent, en visio-conférence pour les autres) pour les tenir informés de décisions prises ou d'actions lancées par l'institut et leur faire passer des messages. Le directeur de l'INS2I organise une fois par an une journée d'information et discussion à l'intention de tous les directeurs d'unités relevant de l'institut. Le LRI a été un des laboratoires pilotes fin 2010 pour la mise en place du dialogue de gestion, qu'il a expérimenté cette année là sous forme approfondie (en présentiel) et qui a été généralisé à toutes les unités fin 2011. Il a de nouveau mené ce dialogue approfondi en 2011 et 2012 (en présence du DAS et de la directrice adjointe administrative de l'INS2I, de la déléguée régionale de la DR04, du représentant de Paris-Sud, président ou vice-président du conseil scientifique, et, pour le LRI, du directeur, de l'administratrice et de la sous-directrice). Lors de ce dialogue de fin d'année, un échange a lieu tant sur la politique scientifique que le fonctionnement et les besoins du laboratoire, en appui à la demande de ressources financières (crédits FEI de fonctionnement, équipement, investissement) et humaines (postes d'ITA) que ce dernier a transmise deux mois auparavant en septembre pour l'année à venir (avec une prévision pour les trois années suivantes) et l'INS2I fait connaître sa réponse à cette demande (subvention et postes éventuels accordés). Le LRI étant un des laboratoires stratégiques de l'INS2I sur le campus de Saclay et ayant dû faire face à deux lourdes opérations immobilières durant la période avec PCRI et Digiteo Moulon, il a été suivi très attentivement et a reçu un soutien marqué de l'INS2I tant en financements exceptionnels qu'en remplacement sur NOEMI des postes d'ITA dans les équipes administrative et technique suite à des départs en mutation ou à la retraite (anticipés dans ce dernier cas pour former un "biseau" pour la transmission d'informations) ou au financement de CCD ou CLD. Un DAS (Michel Bidoit jusqu'en mai 2013, Mokrane Bouzeghoub depuis) est membre du comité de pilotage de Digiteo, ce qui donne lieu à des rencontres et discussion supplémentaires une fois par mois et Michel Bidoit a été membre du Conseil Scientifique de Paris-Sud. En plus de toutes ces réunions programmées, de très nombreux échanges directs ont eu lieu pour information, demande, conseil entre le directeur du LRI et le DAS de l'INS2I, accessible à tout moment. Ajoutons que deux membres du LRI font partie actuellement du conseil scientifique de l'INS2I : un chercheur et un ITA. Le second contact avec le CNRS se fait via la DR04. Là encore, les échanges avec la déléguée régionale (Michèle Saumon puis Véronique Debisschop) sont suivis, que ce soit lors d'invitations de DU ou directs, ceux avec le délégué adjoint concernant le bâtiment Digiteo Moulon, dont le CNRS est propriétaire et a été le maître d'ouvrage, ont été extrêmement fréquents, enfin ceux concernant la gestion des contrats avec l'administratrice du LRI et la gestion du personnel avec la responsable RH du LRI ou le directeur (en particulier les procédures de NOEMI, les embauches en CDD) sont permanents tout au long de l'année. Au total, tant l'organisation que la teneur des rapports entre le LRI et le CNRS sont extrêmement satisfaisants.

Les relations avec Paris-Sud se font, pour ce qui est de la réponse aux appels à projets organisés par l'université (tels que les projets "Attractivité"), pour les demandes de poste d'enseignants-chercheurs (remplacement des départs par promotion externe, en mutation, à la retraite ; postes BQR ; ATER) et de BI-ATSS (permanents ou en CDD), pour les promotions en interne, pour les allocations de thèses, les mois de chercheurs invités, etc., avec le département d'informatique (représentant, outre le LRI, la partie CHM du LIMSI) et pas directement avec les DU. Et cette communication a lieu principalement, suivant l'organisation de l'université en composantes, avec la Faculté des Sciences, dont fait partie le département d'informatique. La communication au niveau des DU s'est améliorée depuis trois ans, notamment avec le montage des projets d'investissement d'avenir puis de la future université Paris-Saclay. C'est ainsi

que le vice-doyen recherche de la Faculté des Sciences, Eric Simoni, a réuni périodiquement pendant le montage de l'Idex quelques directeurs d'unité représentant les différents départements (dont celui du LRI) afin de se tenir informés et que le président Jacques Bittoun, en continuation de Guy Couarraze, organise des réunions d'information à destination des DU sur la politique de l'université et sur Paris-Saclay. Ajoutons que plusieurs membres du LRI ont été élus dans différentes instances de Paris-Sud comme signalé plus haut (dont le directeur au conseil de division de la recherche de la Faculté des Sciences). Plusieurs réunions, sollicitées par le directeur du LRI en ce qui concerne l'opération immobilière de Digiteo Moulon dont le CNRS a confié l'exploitation à Paris-Sud, ont été organisées par la doyenne de la Faculté des Sciences, Sylvie Retailleau, en présence du vice-doyen chargé des infrastructures, avec qui les contacts directs sont par ailleurs fréquents notamment en comité de suivi Digiteo Moulon, et souvent de la directrice générale des services et du vice-président du conseil scientifique de Paris-Sud, Etienne Augé. Les contacts sont par ailleurs réguliers entre la sous-directrice du LRI et la direction du patrimoine pour ce qui est des travaux immobiliers, entre l'administratrice du LRI et les services financiers pour ce qui est du budget et contrats, entre le responsable du pôle système et réseaux du LRI et la direction informatique pour ce qui est de l'équipement informatique, entre le responsable logiciels scientifiques et le SAIC pour ce qui est de la propriété intellectuelle, des dépôts APP et des brevets. La direction du LRI peut faire appel chaque fois que nécessaire directement à la direction de la Faculté des Sciences ou à celle de l'Université.

Bien qu'Inria ne soit pas, du moins pour l'instant, tutelle du LRI, les relations entre le laboratoire et cet institut sont très étroites du fait des équipes-projets communes qu'ils ont ensemble. Depuis que des accords entre Inria et Paris-Sud (puis la CPU) et ensuite entre Inria et le CNRS ont été signés, les rapports entre le LRI et le centre Inria Saclay — Ile-de-France se font dans un cadre en grande partie institutionnalisé et l'information circule mieux dans les deux sens, d'où une transparence accrue. Tout projet de création d'EPC doit être transmis au directeur du LRI en même temps qu'à la direction du centre Inria et celui-ci en avertit immédiatement les tutelles, CNRS et Paris-Sud, qui donnent un avis d'opportunité. L'instruction se poursuit à Inria uniquement en cas d'avis favorables. Le directeur du LRI est invité au comité des projets du centre Inria chaque fois que des questions ayant trait à l'une de ses EPC est à l'ordre du jour, notamment la création ou l'évaluation. Des réunions entre direction du LRI et direction du centre Inria Saclay ont eu lieu concernant la répartition des surfaces Inria dans PCRI (Inria possède un tiers des surfaces de l'aile sud où se trouvent les bureaux des chercheurs et enseignants-chercheurs) ainsi que la convention de reversement par Inria du tiers des dépenses d'exploitation de PCRI. L'application de cette convention donne lieu à des échanges réguliers entre l'administratrice du LRI et son homologue du centre Inria pour information et accord sur les postes de dépenses. Il en est de même pour les questions de propriété intellectuelle ou de brevets au sein des EPC, qui doivent être transmises au SAIC pour traitement ou information.

Instances de pilotage

L'instance de consultation représentative du laboratoire, en charge d'émettre des suggestions et des avis et de discuter, amender et entériner par vote les propositions de la direction, est le conseil de laboratoire qui constitue donc de facto, conjointement à la direction, l'instance décisionnelle du laboratoire. Il est convoqué par le directeur environ toutes les six semaines en moyenne (plus selon les échéances du calendrier) et les comptes-rendus de ses sessions et décisions sont disponibles sur le site web du laboratoire. Il est saisi de toutes les questions concernant la vie de l'unité : politique scientifique, budget, gestion des ressources humaines, etc. Les questions de politique scientifique, telles que détermination des profils de postes d'enseignants-chercheurs mis au concours, sont le plus souvent discutées au préalable en réunion de responsables d'équipe. L'équilibre des prérogatives entre ces deux instances n'est pas toujours facile à réaliser. En début de période, le fait de saisir les responsables d'équipe juste avant le conseil de laboratoire pour toute question de politique scientifique a pu faire ressentir à certains membres du conseil de laboratoire que celui-ci n'était qu'une simple chambre d'enregistrement de décisions déjà prises en amont. Or le conseil étant la seule instance comportant des élus (plus de 50%) ainsi que des membres du collège B, il est apparu important au directeur que la décision finale lui revienne. C'est pourquoi il a beaucoup eu recours en seconde partie de mandat à des réunions du conseil de laboratoire élargi aux responsables d'équipe et bureau du département. Ce fut le cas en particulier de novembre 2012 à juin 2013 pour mener la restructuration du laboratoire. Des responsables d'équipe ont néanmoins trouvé que le balancier était allé trop loin dans l'autre sens avec un nombre insuffisant de réunions entre eux et la direction. C'est pourquoi il a proposé lors de la restructuration des équipes de recherche que chacune de ces équipes procède à l'élection d'un responsable et d'un responsable adjoint parmi les permanents

(A ou B) de l'équipe (ce qui fut fait avant l'été) et que les responsables d'équipe (représentés éventuellement par leurs responsables adjoints) constituent, avec le directeur et le(s) directeur(s) adjoint(s), un conseil scientifique en charge de faire des recommandations sur tout ce qui a trait à la politique scientifique, avec cette fois la légitimité d'être composé de membres élus. Cette nouvelle gouvernance, qui a été entérinée en septembre 2013 dans le règlement intérieur par le conseil de laboratoire et est désormais opérationnelle, clarifie ainsi les rôles respectifs de ce conseil et du nouveau conseil scientifique.

Le directeur réunit une fois par an en octobre ou novembre l'assemblée générale du laboratoire, au cours de laquelle il fait le bilan de l'année écoulée, présente les orientations de l'année à venir et répond aux questions. Le laboratoire est par ailleurs doté de sept commissions qui peuvent être saisies d'une question par la direction ou le conseil de laboratoire ou encore par son responsable : "Web et Communication", "Logiciel", "Locaux", "Matériel", "Bibliothèque", "Hygiène du travail et Sécurité", "Election". Leur rôle figure dans le règlement intérieur.

Le directeur a des contacts quasi-journaliers avec l'administratrice sur les questions budgétaires (par exemple réponse aux demandes de financement sur le fonds de soutien à la recherche) et avec la sous-directrice sur les questions de logistique et infrastructure, du site web du laboratoire et de montée en puissance de l'activité de soutien aux logiciels scientifiques. Il organise des réunions très régulières à trois toutes les trois semaines environ. Il a aussi des contacts plusieurs fois par semaine avec la gestionnaire RH, notamment pour valider l'accueil du personnel temporaire (doctorants, post-doctorants, chercheurs en délégation, ATER, stagiaires, invités, visiteurs, etc.) et intervenir en cas de problème. Faisant partie de la CCSU, le directeur participe chaque année à la sélection des doctorants allocataires et des ATER ; il participe aussi à chaque rentrée aux entretiens de réinscription à partir de la troisième année de thèse avec tous les doctorants du LRI. Il est en liaison régulière avec la documentaliste du LRI en charge de la communication pour les questions de communication interne et avec les responsables communication de Paris-Sud et de Digiteo pour la communication externe (par exemple lors de l'inauguration par les ministres de la recherche des bâtiments PCRI puis Digiteo Moulon).

Le LRI est très actif chaque année dans sa participation à la "Fête de la Science" en octobre (accueil des industriels, des scolaires, du public avec de nombreuses démonstrations) et aux "Journées Portes Ouvertes" à destination des élèves et de leurs familles. Au niveau interne, le laboratoire organise chaque année en juin dans un lieu réservé à l'extérieur la "Journée du LRI" à laquelle tous les membres du LRI sont invités et au cours de laquelle tous les nouveaux enseignants-chercheurs et chercheurs recrutés à la rentrée précédente font un exposé de vulgarisation de leurs travaux, avant un après midi de détente (visite, jeux sportifs, etc.). Le laboratoire sponsorise également certaines manifestations scientifiques ou conférences organisées par ses membres.

Hygiène du travail et sécurité

Depuis février 2013, les activités du laboratoire sont rassemblées dans deux bâtiments voisins, communiquant par une passerelle contrôlée par badge électronique. L'ensemble du personnel représente environ 230 personnes qui sont presque pour moitié des permanents qui connaissent bien l'environnement du laboratoire et les règles de sécurité. Pour les 120 autres (doctorants et contractuels), la répétition des consignes et l'information régulière sont importantes, parfois aussi en langue anglaise. En effet, cette catégorie de personnel non-permanent est plus difficile à sensibiliser aux aspects de sécurité.

Enfin, le laboratoire accueille également des stagiaires, des visiteurs ou des associés sur de très courtes durées (quelques semaines seulement) ou avec un taux de présence faible (un jour par semaine ou quelques jours par mois). Pour ces personnes, l'affichage clair et concis de consignes est important ainsi que la sensibilisation des membres permanents qui les accueillent. La nature des activités de recherche et d'enseignement est essentiellement constituée de travail sur ordinateur en bureau, ainsi que d'enseignement sur le campus et de missions scientifiques sur l'ensemble du territoire et à l'étranger.

Concernant les acteurs de la prévention, 3 établissements sont impliqués : l'université Paris-Sud en premier chef puisque le LRI est hébergé sur le campus de Paris-Sud, dans l'UFR des Sciences. La DR4 du CNRS est également partenaire via le contrat quadriennal. Dans la pratique, c'est au niveau de l'organisation d'actions de formation renforçant celles de PSud et de communication vers le réseau des assistants de prévention que le CNRS intervient. Finalement, Inria est aussi partie prenante puisque les nouveaux bâtiments sont co-gérés par lui aussi selon les conventions respectives.

Un assistant de prévention est nommé au conseil de laboratoire pour mettre en œuvre les règles de sécurité : tenue du registre de sécurité à la disposition du personnel, vérification des trousseaux de secours et de la maintenance du défibrillateur, organisation d'exercices d'évacuation avec les services de l'université.

Le document unique d'évaluation des risques (DUER) du laboratoire est également rédigé. Régulièrement mis à jour, il est transmis aux tutelles selon un format réglementé. Il recense notamment les sauveteurs et secouristes du travail, les personnels formés (protection incendie, chargés d'évacuation, ...) et surtout, il identifie les risques professionnels et met en place le programme annuel d'actions de préventions.

Avant début 2013, une dernière équipe scientifique du LRI était encore hébergée sur le campus "vallée" de Paris-Sud, au bâtiment 490, dans les anciens locaux occupés par l'ensemble du laboratoire jusqu'en juin 2011.

Avant juin 2011, quatre des douze équipes étaient hébergées au Parc Club, sur des surfaces du site Inria Saclay — Ile-de-France.

Les deux déménagements de ces trois dernières années ont donc été bénéfiques au rapprochement du personnel, ainsi qu'à la gestion des questions d'hygiène et sécurité. La gestion en soi des déménagements ainsi que les adaptations des nouveaux bâtiments ont représenté une charge de travail très conséquente (organisation et pilotage des prestations, coordination avec les services de Paris-Sud) ainsi que des frais importants (plus de 50k€ pour des travaux d'insonorisation, de remplacement d'équipements défectueux, acquisition de matériel, etc.). Un budget récurrent reste affecté au programme annuel d'actions de prévention.

1/ Présentation de l'unité

Équipe Administrative



L'équipe gère et suit le budget de l'unité : Crédit récurrent État, contrat de recherche (contrats industriels, région, ANR, Europe, Digiteo, programme international, etc...) et subvention.

Elle assure l'ensemble des activités de gestion de proximité au quotidien et aide les équipes de recherche dans toutes les phases de la réalisation des contrats de recherche en interagissant étroitement avec les services des tutelles (ressources humaines, partenariat et valorisation, achats/marchés, financier/comptable, formation permanente). Elle est un appui aux chercheurs dans le processus documentaire et dans la dif-

fusion d'informations. L'équipe est structurée en deux pôles : Pôle gestion et Pôle Ressources Humaines et Documentation et Info-Com.

Membres de l'équipe

Permanent Members (October 1st, 2013)			
Name	First name	Position	Institution
BRETENOUX	Claude	T	Paris Sud
CONGNARD	Sylvie	ASI	CNRS
GABRIEL	Gladys	T	CNRS
JOSEPH	Myriam	IE	CNRS
LELIEVRE	Martine	TCE	CNRS
MENOU	Sylvie	T	CNRS
ROUCHEYROUX	Agathe	AJT	Paris Sud
SABATER	Geneviève	ASI	CNRS

Non Permanent Members (October 1st, 2013)			
Name	First name	Position	Institution
MONTAUDOUIN	Marie-Pierre	AJT	CNRS

Evolution des effectifs

En 2008, l'équipe administrative était composée de 9 agents dont 5 statutaires CNRS (4 techniciens, 1 Ingénieur d'études), 3 statutaires Psud (1 technicien, 2 adjoints techniques de la recherche) et 1 CDD (niveau technicien).

En 2013, l'équipe compte 8 agents dont 6 agents CNRS (1 IE, 2 AI, 1 TCE, 2 TCN), 2 agents Psud (1 TCS, 1 AJTP) et 1 CDD (sur crédit Psud puis CNRS).

Au cours de cette période les personnes ayant quitté le LRI sont :

- Noëlle Kadi : Mobilité interne Psud (Gestionnaire RH - pôle personnel BIATOS)
- Sandrine Becuwe : Mobilité interne Psud (responsable (coordination budgétaire)
- Marine Alonso : Concours externe Psud (Ajointe technique en gestion administrative - Service Financier - Division de la Recherche)
- Cilem Dogan : Départ dans le secteur privé (secteur tertiaire)
- Nicole Lefèvre-Villain : Départ à la retraite
- Rachida Chabane : Mobilité interne CNRS (Gestionnaire RH - CNRS Paris B)
- Laurène Lorcy : Concours externe CNRS (Gestionnaire administratif et financier - Prodig)

Bien qu'elle ait vécu des départs (fin de CDD, réussite de concours, mobilité interne) l'effectif de l'équipe est resté constant car essentielle pour la vie administrative et financière des équipes de recherche et de la direction de l'unité. Pour maintenir cette constance de son effectif, l'équipe est contrainte de recruter sur crédit récurrent Etat de l'unité avec l'accord de sa direction, du personnel en contrat à durée déterminée pour renforcer son pôle gestion. C'est ainsi qu'elle fait face depuis 5 ans à l'accroissement des contrats des équipes de recherche qu'elle doit gérer ou apprendre à gérer compte-tenu de l'évolution de la typologie de certains contrats qui l'oblige à former, à mettre en place de nouvelles méthodes de travail, outils et procédures pour en assurer un suivi efficace, sans pour autant obtenir la création de fonction (statutaire Psud) en support à la recherche dans l'équipe. Il est indispensable que ce besoin soit pérennisé par la création d'un poste gestionnaire au sein de son pôle gestion. En disposant de ce poste, l'équipe continuera d'assurer en toute quiétude la gestion de ses ressources propres et crédit récurrent Etat, allant de la saisie des commandes via les outils de gestion mis à sa disposition en passant par le traitement des services faits, factures jusqu'à la liquidation des missions tout en privilégiant les échanges avec ses nombreux partenaires financiers internes et externes.

Le LRI a une fois de plus réitéré en 2013, sa demande de création de poste auprès des instances de Psud.

Événements majeurs

L'équipe participe et s'implique activement dans d'autres activités transversales tant à l'intérieur qu'à l'extérieur de l'unité :

Déménagement et réaménagement de la bibliothèque du LRI Depuis juillet 2011, la bibliothèque du LRI a déménagé avec le personnel de l'Unité dans une zone privilégiée de notre bâtiment PCRI. Ce déménagement dans ces nouveaux locaux (230 m²) a été l'occasion d'étudier le choix des rayonnages (dans le cadre d'une mise en concurrence rédigée et publiée par l'équipe) et d'un désherbage intensif pour laisser place à une documentation de qualité, nécessaire et indispensable.

Une nouvelle implantation a été élaborée pour faire de ce lieu un lieu de culture scientifique de renom. En effet, celle-ci est un outil précieux fréquenté par notre personnel ainsi que par un grand nombre de scientifiques de la région.

Rédaction et suivi de convention (Remboursement Inria/Paiement frais Digiteo) En 2011, l'équipe a rédigé en interaction avec le service juridique Inria les 2 avenants relatifs à la convention initiale de remboursement Psud/Inria pour prendre en compte toutes les dépenses engagées par le LRI depuis juin 2011 sur ses fonds propres et préciser les modalités de remboursement par Inria à hauteur de 1/3.

Validés par le conseil d'administration de Psud, ces avenants ont donné lieu à la création par l'équipe d'un fichier excel dans lequel elle suit précisément les dépenses engagées par le LRI en année N qu'elle présente à Inria pour remboursement en année N+1. A ce titre, elle se coordonne très étroitement avec la responsable de l'équipe technique pour toutes les dépenses de fonctionnement, équipement, réseau informatique, travaux et sécurité afférentes au bâtiment PCRI. Cette année, l'équipe a également mis en place un fichier excel pour suivre le montant des frais de gestion du bâtiment Digiteo Moulon incombant au LRI. A partir de ces fichiers, des indicateurs sont communiqués à la direction du LRI pour lui permettre d'établir entre autre un prévisionnel de ses demandes de moyens et ressources, voir prendre des décisions.

Signalétique intérieure du bâtiment PCRI Elle a ainsi porté dès 2011 le projet de la signalétique intérieure du bâtiment PCRI (5000 m²) qui a été finalisé et réalisé en 2012. Celui-ci a consisté en la création, la réalisation graphique et la fourniture et la pose de la signalétique.

Elle a établi en partenariat étroit avec les chargés de communication des tutelles et Inria un cahier des charges listant les différentes zones à baliser et les différents types de signalétiques nécessaires (totems, panneaux d'informations, plaques imprimées, pictogrammes, drapeaux, plan du site, codes couleur etc.).

Cette réalisation a été pensée pour que le personnel de l'unité ainsi que les visiteurs puissent circuler en toute aisance dans nos locaux. L'élégante création graphique extérieure a succédé à ce projet. La visibilité du bâtiment PCRI en est facilitée.

Réorganisation de l'équipe En 2012, pour afficher en interne et en externe une meilleure visibilité de ses missions et ses activités, l'équipe s'est structurée en deux pôles :

1. Pôle gestion (Crédit récurrent État, et contrat de recherche) composée de :
 - Claude Bretenoux (TCS Psud),
 - Martine Lelièvre (TCE CNRS),
 - Sylvie Menou (TCN CNRS),
 - Agathe Roucheyroux (AJTP Psud),
 - Marie-Pierre Montaudouin (CDD CNRS)
2. Pôle Ressources Humaines et Documentation et Info-Com. composé de :
 - Geneviève Sabater (AI CNRS) pour les RH
 - et Sylvie Congnard (AI CNRS) pour la Documentation Info-Com.

En 2012, le directeur de l'Unité a nommé la documentaliste de l'unité correspondant Information-Communication pour la délégation régionale (DR04), le département (INS2I), et l'Université Paris-Sud. Son intégration au sein du réseau des CoComs a permis à l'unité d'avoir un interlocuteur dédié vis à vis de nos organismes de rattachement (transfert d'informations, visite de locaux, organisation d'expositions, fête de la science etc.).

Accueil stagiaires En 2013, l'équipe en accueillant deux stagiaires (1 stage niveau lycée (mai à juin), 1 stage niveau université (juin à juillet) dans le cadre d'un stage professionnel qui constitue une étape importante dans leur formation) a souhaité d'une part, partager ses compétences et savoir-faire et d'autre part les aider à être plus performants dans la vie professionnelle qu'ils préparent et à développer des compétences.

Pour l'un, ce fût l'occasion de saisir les demandes d'ordre de mission, passer des commandes, liquider des factures via le logiciel comptable Sifac de Psud, double-saisir dans l'outil de gestion du CNRS Geslab des commandes et factures. Tenir à jour dans un fichier excel les salaires et les gratifications versés au personnel en CDD sur contrat de recherche. Réaliser des tâches de secrétariat. Pour l'autre, participer à la conception du rapport financier et budgétaire de l'unité de 2008 à 2013. Rassembler, trier et analyser des données financières, rédaction en anglais de la partie concernée. Contrôler toutes les lignes de finance de l'unité.

Missions de l'équipe

Pôle gestion

L'activité du pôle gestion s'articule autour de quatre axes en gestion et en suivi administratif et financier : dotation ministérielle, contrats de recherche, commandes et factures et missions.

De 2008 à 2013, outre la gestion des crédits récurrents Etat, l'équipe a géré et suivi près de 133 contrats de recherche (ANR, Europe, Industriel, Digiteo...) et subvention (PICS, PEPS, Grilles, IUF...) ce qui représente plus de 10 millions d'euros.

Pôle Ressources Humaines et Documentation et Info-Com

Le pôle RH gère le recrutement des personnels en CDD sur Crédit récurrent État et contrat de recherche. Il assure le suivi des dossiers des agents titulaires pour toute question relative à leur carrière. Il suit la gestion des crédits liés aux recrutements sur les Crédit récurrent État et contrats de recherche. Il gère également le domaine de la formation.

Le Pôle Documentation est responsable de la documentation et de la communication du LRI : 5700 monographies et 84 abonnements (papier et/ou électronique). Il assure l'indexation et le catalogage et gère les demandes d'articles et les prêts d'ouvrages.

Bibliothèque et communication

Le laboratoire bénéficie aujourd'hui d'une bibliothèque vaste et lumineuse (230 m2, 750 ml de documents) spécialisée en informatique. Celle-ci est située dans un emplacement stratégique de notre nouveau bâtiment PCRI pour être au plus près de notre personnel. Elle est très appréciée par les membres du laboratoire, visiteurs, stagiaires mais aussi par des chercheurs et professeurs provenant d'autres laboratoires ou institutions (plus de 100 personnes en 2012).

Le fonds documentaire comprend 5750 monographies, 70 titres de périodiques papier ainsi que de nombreux abonnements électroniques. Une documentaliste est responsable de la gestion de cette bibliothèque (achats, maintien du catalogue en ligne, réponse aux demandes d'articles et aide aux recherches documentaires). Le budget annuel nécessaire pour la gestion de la bibliothèque est de l'ordre de 85 k€.

La documentaliste entretient une collaboration et une coordination avec le Service Commun de la Documentation de l'Université de Paris-Sud, la bibliothèque Mathématiques Jacques Hadamard d'Orsay, les Centres de Documentation d'Inria, la bibliothèque du LIMSI, les réseaux régional, national et thématique.

Elle est en lien constant avec la Délégation Régionale 04, le Département INS2I et Psud pour tout ce qui concerne la Communication des informations les plus pertinentes pour le laboratoire.

Depuis 2012, la bibliothèque du LRI est Cadist (Centre d'Acquisition et de Diffusion de l'Information Scientifique et Technique) pour ce qui concerne les publications les plus prestigieuses publiées chez Elsevier et Springer.

Document majeur

Pour suivre l'évolution des procédures et règles applicables dans le domaine de la gestion administrative et budgétaire et des ressources humaines, une base documentaire ou veille administrative commune à l'équipe a été mise en place par la responsable.

Ce document interactif est accessible depuis un serveur et constitue pour l'équipe un vrai outil de travail. Il regroupe, notamment la liste des interlocuteurs de l'unité, les étapes à suivre ainsi que les référentiels nécessaires à la réalisation des actes de gestion (commande, facture, mission...).

En 2011, une réunion mensuelle a été mise en place au sein de l'équipe par la responsable. Objectif : suivre l'évolution des dossiers, informer et planifier les actions en définissant les priorités.

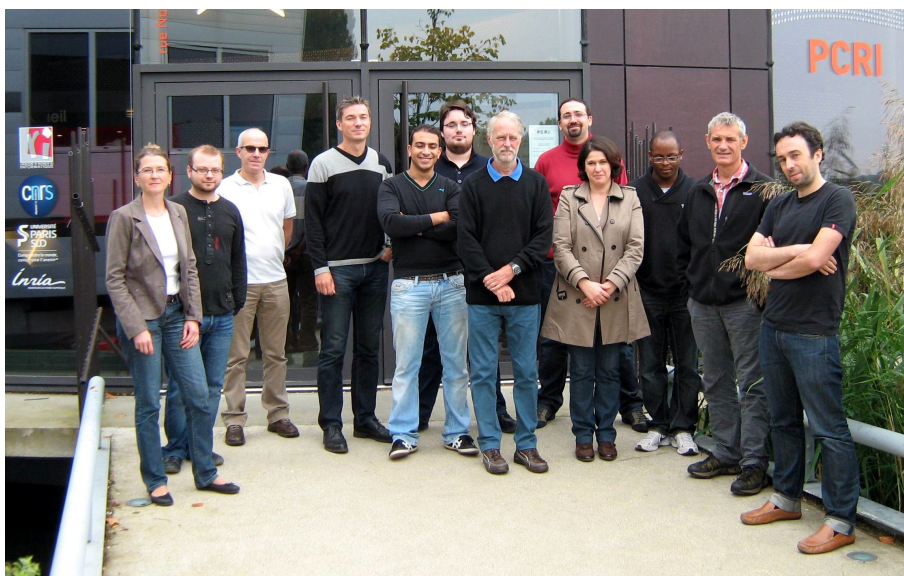
Intérêts collectifs

L'équipe se mobilise sur des projets communs et s'inscrit dans une dynamique positive en intégrant le "réseau des administrateurs de Gif sur Yvette", le "réseau des secrétaires-gestionnaires des unités" de Gif sur Yvette et les réseaux Go!Doc, St2i-Doc et Renatis et celui des correspondants Info.Com de Gif sur Yvette. Elle rencontre, partage ses expériences, échange de bonnes pratiques entre collègues, confronte ses idées.

Elle a ainsi accès à des informations privilégiées, qualifiantes et pertinentes qui lui ouvrent la possibilité d'enrichir ses connaissances par rapport à ses missions et activités au sein de l'unité.

1/ Présentation de l'unité

Équipe Technique



L'équipe technique assure 3 missions pour l'ensemble du personnel du LRI hébergé dans les bâtiments voisins 650 et 660 : La mission 'support et réseau' assure un rôle quotidien de service pour tous les utilisateurs des moyens informatiques du laboratoire. La mission 'développement logiciel' assure la production de logiciels administratifs et scientifiques et la gestion des problématiques associées. La mission 'Logis-

tique' assure un rôle quotidien au service de tous les membres du LRI au niveau de l'environnement de travail du site du laboratoire. L'équipe est donc structurée en 3 pôles correspondant à ces 3 missions.

Membres de l'équipe

Permanent Members (October 1st, 2013)			
Name	First name	Position	Institution
CAMBERVEL	Valéry	AJT	Paris Sud
DARRE	Laurent	IR	CNRS
HUMBERT	Denis	IE	Paris Sud
LETOURNEL	Anne-Catherine	IR	CNRS
LIEBGOTT	Jean-Roch	IE	CNRS
MERLIN	Jean-Pierre	AJT	Paris Sud
NERI	Vincent	IE	CNRS
PENSEL	Anthony	ASI	CNRS
SOUPLET	Jean-Christophe	IR	CNRS
ZIMMERMANN	François	IR	CNRS

Non Permanent Members (October 1st, 2013)			
Name	First name	Position	Institution
AZZOUNE BENYAKHLEF	Mounia	IE	Paris Sud
CONSTANTIN	Alexandre	IE	CNRS
SARHAN	Mohamed	apprenti	CNRS

Evolution des effectifs

Au cours de la période, 5 statutaires ont quitté le laboratoire: 2 concours affectés (Jean-Claude Barbet, CNRS, IR vers le LIMSI d'Orsay et Jérôme Bernier, UPS, IE vers le laboratoire Aimé Cotton d'Orsay), 2 mutations internes (Olivier Lebeltel CNRS, , vers le TIMC IMAG de Grenoble et Nicole Martin, UPS, vers le PUJO d'Orsay) et un départ à la retraite (Raymond Douet, CNRS). Ces départs ont été compensés par des arrivées: 3 concours externes (Jean-Roch Liebgott, CNRS, IE, Jean-Christophe Souplet, CNRS, IR et Jean-Pierre Merlin, UPS, AJT), 1 NOEMI CNRS (Antony PenseL, AI qui prendra ses fonctions en décembre 2013) et une ré-intégration suite à délégation externe (Denis Humbert, UPS, IE). Le recrutement sur concours externe de Valéry Cambervel, AJT est aussi intervenu sur la période (2008), pour occuper un poste UPS vacant depuis un an. Les effectifs de l'équipe et l'équilibre des compétences ont donc pu être préservés, malgré des difficultés conjoncturelles dans les ressources RH depuis plusieurs années et souvent au prix de vacance de poste de plusieurs mois entre les départs et leur remplacement.

Evénements majeurs

Structuration de l'activité en 3 pôles Au cours de ces cinq années, la structuration de l'équipe (11 personnes dont 9 permanents au 30 juin 2013) s'est mise en place autour de 3 pôles : support et réseaux (4 informaticiens), développement logiciel (3 informaticiens) et logistique (un chargé de mission et 2 agents). Une réorganisation profonde du poste d'agent d'accueil a été rendue nécessaire dans le cadre du nouveau bâtiment PCRI.

Déménagement de l'infrastructure informatique du laboratoire Depuis 2008, le pôle support et réseaux a préparé le déménagement vers PCRI. Il a été maître d'ouvrage pour l'aménagement complet de la salle serveur et de son couloir froid de 14 baies et a piloté le déménagement des machines et serveurs sans interruption de service. Les nouveaux systèmes de sécurité du bâtiment ont été la cause de multiples problèmes et demandent encore aujourd'hui des efforts particuliers dans leur exploitation.

Démarrage de l'exploitation du nouveau bâtiment PCRI Le passage en exploitation du bâtiment PCRI a été totalement confié au LRI, en accord avec les services du patrimoine de l'université et d'INRIA. Un volume de l'ordre de 200 keuros par an est consacré aux travaux et prestations pilotés par le laboratoire depuis 2011. Une convention de partenariat avec INRIA définit le remboursement du tiers des sommes engagées par le LRI. Ces tâches ont rendu nécessaire le recrutement en CDD d'un chargé de mission travaux depuis fin 2012. Le LRI a besoin que ce poste soit pérennisé en un poste permanent.

Promotion du laboratoire vers l'extérieur Un effort particulier a été porté sur la visibilité du laboratoire aussi bien via le site web qu'auprès des industriels (journées portes ouvertes), des scolaires (fêtes de la science), des collégiens et lycéens (accueil de trois stagiaires "découverte" niveau 3ème ou 2nde, visite du LRI pour des lycéens de Drancy et du club CNRS Jeunes Science et Citoyens), des étudiants en informatique (encadrement de stages de master ou de licence pro), du monde académique (participation aux journées Digiteo, présence active dans les réseaux métiers DevLOG ou Plume, sur les forums et manifestations publiques comme les rencontres Université-Entreprise).

Soutien aux logiciels scientifiques Finalement, l'activité logiciels scientifiques du pôle développement logiciel a vu en 2013 les premiers fruits d'un investissement commencé depuis 2007 avec le montage de cette activité : le recrutement depuis juin 2013 d'Alexandre Constantin, contractuel CNRS pour 30 mois, l'arrivée d'un apprenti Polytech, Mohamed Sahran, en septembre 2013 pour 3 ans et le recrutement d'un ingénieur maturation Digiteo, Cyril Dumont, pour 12 mois, portent à 4 personnes l'effectif actuel de l'activité. Deux missions doctorales "hors recherche" viennent renforcer l'activité. Elles sont financées par l'université et orientées vers le transfert technologique et le dépôt de logiciels à l'APP : renouvellement de Michele Mangili et arrivée de Sophie Felix. Le LRI souhaite vivement qu'un recrutement statutaire supplémentaire vienne pérenniser cette structure et consolider les résultats de ces efforts investis.

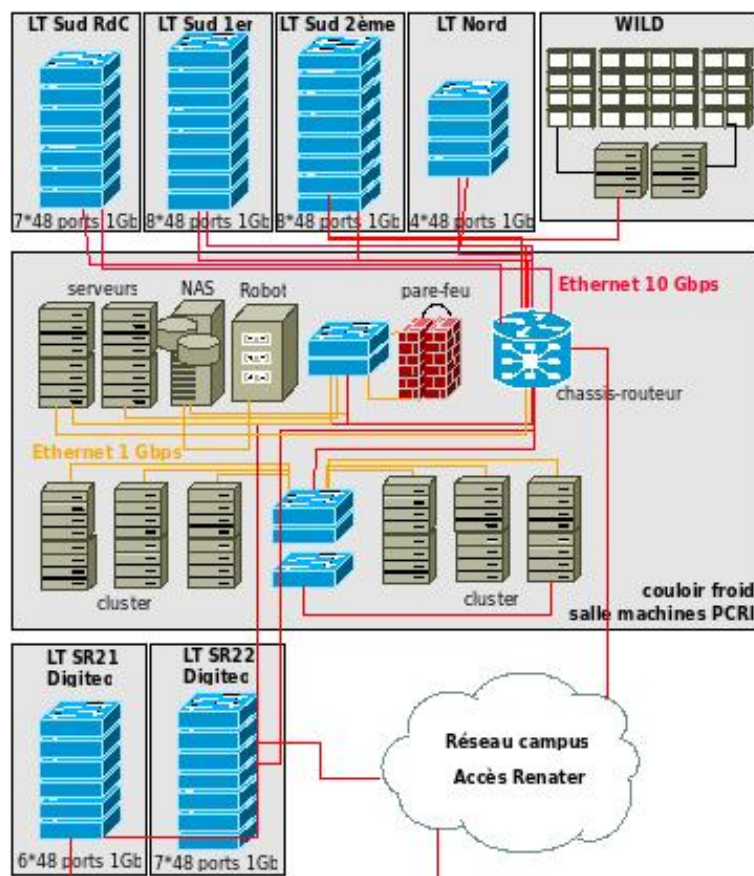
Missions de l'équipe

Environnement informatique

Le LRI possède un réseau informatique très performant, entièrement renouvelé à l'occasion du déménagement du laboratoire dans les bâtiments du PCRI et de Digiteo Moulon. Son cœur de réseau en 10 Gbps formé entre autre par deux châssis virtualisés est un des nœuds du réseau informatique du plateau du Moulon de l'Université Paris-Sud. Il est installé dans la salle machines du PCRI qui abrite aussi la plupart des ressources informatiques du laboratoire : serveurs, baies de stockage (plusieurs dizaines de To), robot de sauvegarde, pare-feu, clusters de calcul. Les locaux techniques des deux bâtiments abritent de nombreux switchs Ethernet connectés en 10 Gbps au cœur de réseau et qui comprennent au total plus de 1500 ports permettant de dédier des liens 1 Gbps à tous les équipements informatiques courants (postes de travail, téléphones, imprimantes, etc.). Certains de ces équipements, comme les clusters de calcul et le mur d'images WILD, sont utilisés directement pour les travaux de recherche.

Le cluster de calcul, installé en 2004 par l'équipe parallélisme dans le cadre du projet Grand Large, a par la suite été rendu accessible à l'ensemble des équipes et mis à niveau, sur les plans logiciel et matériel. Il est maintenant très largement utilisé par la plupart des équipes du laboratoire. Il se compose actuellement de 80 serveurs de calcul, pour un total de 448 cœurs. Le principe d'utilisation le rend accessible à toute personne disposant d'un compte informatique au LRI. Un ingénieur est chargé de suivre et de répondre aux besoins spécifiques de ces utilisateurs, en installant ou adaptant les logiciels et bibliothèques, ainsi qu'en répondant aux besoins éventuels de sécurité et de confidentialité. Des images système personnalisées peuvent ainsi être chargées en cas de besoin. En dehors de ces utilisations de type expérimental, le cluster fonctionne en mode soumission de tâches. Outre ce cluster, la salle machines abrite aussi un cluster acquis par Inria et ouvert à tous les membres des équipes communes. WILD, le mur d'images haute définition (130 millions de pixels) composé de 32 écrans pilotés par un cluster de 16 serveurs et de caméras infra-rouge sert d'outil de recherche pour l'équipe In Situ. Ce mur pourra bientôt interagir avec le mur WILDER prochainement installé dans Digiteo Moulon dans le cadre de l'Equipex Digiscope.

Le pôle Système et réseau du LRI, composé de 4 ingénieurs, gère ce réseau, les équipements qui y sont connectés (dont les nombreux postes de travail fonctionnant sur des systèmes d'exploitation très divers)



Architecture du réseau du LRI - juin 2013

et les services qui y tournent (web, mail, dns, dhcp, ldap, etc.). Il fournit les ressources matérielles et logicielles (machines virtuelles dédiées, bases de données, serveurs web virtuels, etc.) sollicitées par les chercheurs en s'attachant à maintenir un niveau de sécurité élevé. Il fait en sorte que cet environnement informatique soit opérationnel 7 jours sur 7 et 24 heures sur 24 pour tous les membres du laboratoire quelle que soit leur appartenance (Université, CNRS ou Inria). Pour cela, les ingénieurs du pôle ont mis en place et maintiennent une architecture réseau robuste, des serveurs virtualisés redondants et des services en haute disponibilité. Cela implique de travailler de concert avec la direction informatique de l'Université qui gère le réseau du campus et avec le staff technique d'Inria installé à Digiteo Palaiseau.

L'impact des déménagements sur cette activité a été substantiel, dès 2009. En effet, la partie courant faible des réunions de chantier du nouveau bâtiment a été suivie de très près par les "utilisateurs" représentés par les informaticiens système du LRI. Cela a permis de gérer certaines adaptations indispensables au projet, mais qui sont restées très contraintes par le cadre du projet architectural et contractuel. Ainsi, nous avons surtout pu intégrer l'ajout d'un tunnel froid dans la salle serveur, qui n'était pas inscrit au projet d'origine et qui aurait induit un retard important dans l'emménagement des locaux. Le choix du matériel actif et de l'infrastructure informatique a également été établi en accord avec la direction informatique de l'université en optant pour une architecture très robuste et redondante dont un des cœurs de réseau serait hébergé dans notre salle machine.

Soutien aux logiciels et Système d'Information

Depuis 2007, le LRI a obtenu du CNRS un poste permanent d'ingénieur de recherche dédié aux questions de soutien aux logiciels scientifiques produits au sein du laboratoire.

L'objectif est d'offrir un soutien en ingénierie informatique du génie logiciel auprès des équipes scientifiques du LRI. En maîtrisant le portefeuille des logiciels développés dans les équipes du laboratoire, l'offre de service se développe autour d'outils, de préconisations, de formations ou de conseils mais surtout en participant à des étapes de développement de logiciels en vue de la maturation de ceux-ci. Un travail important d'interface avec les équipes est nécessaire pour détecter les besoins puis arbitrer les deman-

des.

Afin d'atteindre ces objectifs ambitieux, tous les moyens ont été mis en œuvre pour trouver des ressources humaines : depuis 2011, 3 stages de master ou Polytech de plusieurs mois ont été encadrés sur ces projets, une mission doctorale "hors recherche" (deux en 2013-2014) est mise en place chaque année depuis 3 ans pour travailler sur les dépôts APP, l'appel à projet "Plateforme technologique 2013" de l'INS2I a été fructueux et a abouti au recrutement d'un ingénieur pour deux ans et demi, l'appel à projet Digiteo OMTE d'un projet d'équipe a également été couronné de succès et l'ingénieur sera co-encadré au sein de l'activité logiciels scientifiques du pôle. Finalement, un financement CNRS a été obtenu pour un apprenti Polytech qui sera au LRI à 50% de son temps pour 3 ans.

Activité développements et maturations de logiciels scientifiques

Cette activité vise à faire la promotion d'outils pour améliorer la qualité, la visibilité, la pérennisation et le transfert technologique du patrimoine logiciel du laboratoire. Elle se découpe en 4 axes majeurs :

- **Développement logiciel.** Cela concerne les logiciels scientifiques suite à la détection de besoins auprès des chercheurs puis l'organisation, la priorisation et la réalisation d'actions de développements de 1 à 4 mois. Des outils d'aide à la maturation de logiciels sont développés et utilisés pour notre activité, ainsi que du développement de pages web et de comportements sur une plateforme robotique visant à devenir un démonstrateur.
- **Mise en place et promotion d'outils de génie logiciel.** Cette partie de l'activité consiste en la comparaison, sélection et promotion d'outils existants (par exemple : Forges, outils d'audit de code source). Le pôle a un correspondant Sourcesup (Forge de Renater) pour le LRI, assure la mise en place et le maintien de serveurs comme SVN ou CDash, co-organise des journées de formation (comme les Journées chercheurs Digiteo ou les Journées LoOPS), anime la commission Logiciel composée d'un membre de chaque équipe, échange au quotidien avec les chercheurs et assure une veille technologique.
- **Augmentation de la visibilité et du transfert technologique du patrimoine logiciel du laboratoire.** Le rôle de correspondant valorisation du LRI pour les tutelles s'appuie sur les données du portefeuille logiciel du LRI : recensement des logiciels régulièrement mis à jour, référencement (plus de 130 fiches). Une aide à la pré-étude (audit de code, remplissage des formulaires) et un suivi des demandes de dépôt APP (environ 4 par an) est fourni aux chercheurs qui le souhaitent. Des conseils aux chercheurs dans le montage de divers dossiers d'appel à projets (OMTE Digiteo, prix de la valorisation, etc.) sont régulièrement proposés.
- **Echanges avec l'environnement social, économique et culturel, local ou national.** De nombreux liens sont créés et entretenus avec les réseaux métiers, le CNRS, l'université et le SAIC (Service des Activités Industrielles et Commerciales), Digiteo, le pôle de compétitivité System@tic, le Centre Francilien de l'Innovation. Des actions de vulgarisation ponctuelles agrémentées de démonstrations ont été organisées (visite de lycéens).

Activité de valorisation et de transfert

Un Correspondant Valorisation du LRI est désigné vis-à-vis du SAIC (et donc du CNRS via le mandat du contrat quinquennal en cours). Le service valorisation mandaté par les tutelles est le SAIC de l'université Paris-Sud et suit les dossiers du laboratoire. Des réunions d'échanges d'informations permettent une meilleure circulation et compréhension des dossiers entre les différentes parties. Les équipes-projets communes avec Inria peuvent aussi s'adresser au SRIV Inria Saclay — Ile-de-France pour leurs questions de valorisation. Des contacts réguliers existent également entre le SRIV et le LRI.

Par toutes ces actions, le LRI poursuit sa démarche d'améliorer la visibilité, la protection juridique, la mise en valeur et le transfert, lorsqu'il est possible et souhaitable, de ses travaux.

Quelques chiffres :

- Plus de 130 développements référencés sur le site web du LRI.
- 19 logiciels bénéficient déjà d'une protection par preuve de date auprès de l'agence de protection des programmes (APP).
- 3 brevets ont été délivrés à des chercheurs du LRI durant le dernier quinquennal (1 licence délivrée).

- 6 soutiens OMTE (Opération de Maturation Technico-Economique de Digiteo) ont été obtenus.
- 2 startups ont été créées : Green Communications (équipe Réseaux) et Metascale (équipe Archi).

Bilan : Les logiciels sont de mieux en mieux référencés. La protection juridique (par preuve de date ou de brevet) de ces travaux s'améliore. Les 130 développements référencés ne nécessitent pas pour autant, tous, une telle protection. Par exemple, des développements concernant la participation de chercheurs à des logiciels dits "libres" qui sont valorisés selon d'autres axes : au sein de la communauté, par l'obtention de contrats de recherche, etc.

Le soutien aux logiciels scientifiques constitue avec le suivi des projets web et l'exploitation du SI du LRI le périmètre du pôle développement de l'équipe technique. Aujourd'hui, deux permanents seulement appartiennent au pôle (un poste logiciel scientifique et un poste administrateur des systèmes d'information), mais le laboratoire cherche par tous les moyens à développer l'activité "logiciels scientifiques" qui a pris beaucoup d'ampleur depuis un an. Il est souhaitable que le poste contractuel obtenu cette année se pérennise par un recrutement statutaire.

Activités logistiques

Au sein du pôle logistique de l'équipe technique, trois personnes (dont deux permanents) jouent un rôle quotidien au service de tous les membres du LRI au niveau de l'environnement de travail du site du laboratoire :

- par l'entretien et la maintenance quotidienne du bâtiment en direct et en interface avec les services de l'université,
- par la gestion du contrôle d'accès et des badges de circulation,
- par l'accueil et la gestion des espaces communs et salles de réunion,
- par la distribution du courrier et des fournitures,
- par la mise en œuvre de projets d'améliorations du bâtiment (équipements complémentaires pour la convivialité et ergonomie des espaces communs).

Depuis 2009, les projets de nouveaux bâtiments ont généré une charge de travail qui a pris au fur et à mesure des mois une importance envahissante. Même si l'ampleur des efforts nécessaires avait été largement sous-estimée, les résultats aujourd'hui sont à la hauteur de l'investissement du laboratoire.

D'abord, en terme d'organisation et de planification des mouvements : la consultation et la communication vers les équipes, le pilotage de la prestation du déménageur, l'achat de mobilier pour tous les espaces communs ont demandé beaucoup d'énergie ; certaines tâches ont pu être effectuées en collaboration avec Inria qui était impliqué par un tiers du personnel provenant de leurs (anciens) locaux du Parc Club et par un tiers de propriété sur le site d'arrivée PCRI.

Ensuite, en terme de travaux supplémentaires (entièrement pilotés par le LRI et financés par le LRI et Inria) : le déplacement de la salle serveur, rendu nécessaire à cause d'une hauteur sous poutre béton mal placée, a eu des répercussions désastreuses en terme d'acoustique et d'importants travaux d'insonorisation ont dû être entrepris afin de rendre acceptable l'ambiance de travail de l'équipe technique hébergée à proximité de cette salle ; un travail important a été réalisé pour pallier les nombreux dysfonctionnements des systèmes de sécurité, des adaptations ont été nécessaires sur les ouvertures du bâtiment ; les règles de circulation ont été mises au point. Le bâtiment a bénéficié d'un gardiennage dédié pendant 18 mois, financé par le laboratoire et Inria. Il est prévu de mutualiser la prestation de gardiennage de Digiteo Moulon à partir de janvier 2014 pour faire bénéficier PCRI d'une surveillance rapprochée minimale.

Enfin, en terme de mise en place de l'exploitation : tous les locaux techniques ont dû être équipés selon leur usage (atelier, kitchenettes, stockage) ; les rôles et missions de chacun redéfinis dans un nouvel environnement (programmation des badges, gestion du courrier, affichage des consignes dans le bâtiment, etc.) ; les procédures du laboratoire ont gagné en robustesse, la mise en place d'une interface de remontée d'incidents y ayant contribué ; la qualité des services de proximité s'est beaucoup améliorée au quotidien et bénéficie à l'ensemble des membres du laboratoire.

Il est indispensable que le CDD en charge des travaux, maintenance et exploitation des bâtiments PCRI et surfaces LRI dans Digiteo Moulon, actuellement financé par le LRI sur son soutien de base, soit pérennisé en poste statutaire. Le LRI a demandé en 2013 une création de poste auprès des instances de PSud.

Faits marquants

Plusieurs membres du LRI ont été récipiendaires de prix ou d'honneurs :

- Serge Abiteboul, alors DR Inria dans l'équipe IASI / GEMO, a été élu à l'Académie des Sciences en décembre 2008.
- Yann Ollivier, CR1 CNRS HDR dans l'équipe A&O / TAO, est le lauréat de la médaille de bronze 2011 de l'institut national des sciences mathématiques et de leurs interactions (INSMI) du CNRS.
- Wendy Mackay, DR Inria dans l'équipe InSitu, est titulaire d'une chaire senior ("Advanced Grant") de l'ERC, qui a démarré le 1er juin 2013.
- Michel Beaudouin-Lafon, PR dans l'équipe InSitu, a été nommé membre senior à l'Institut Universitaire de France pour 5 ans à compter du 1er octobre 2011.
- Marc Pouzet, alors PR dans l'équipe Proval (devenue Toccata), a été nommé membre junior à l'Institut Universitaire de France pour 5 ans à compter du 1er octobre 2008.
- Fabio Martignon, PR dans l'équipe Réseaux, a été nommé membre junior à l'Institut Universitaire de France pour 5 ans à compter du 1er octobre 2013.
- Christine Paulin, PR dans l'équipe Toccata, a reçu le titre de docteur Honoris Causa de l'université de Göteborg (Suède) le 21 octobre 2011.
- Marie-Claude Gaudel, PR émérite dans l'équipe ForTesSE, a reçu le titre de docteur Honoris Causa de l'université de York (UK) le 11 Juillet 2013.
- Michèle Sebag, DR CNRS dans l'équipe A&O / TAO, est ECCAI Fellow depuis 2011.
- Wendy Mackay, DR Inria dans l'équipe InSitu, a été nommée membre de l'ACM SIGCHI Academy en 2009.
- Julia Kempe, alors CR1 CNRS dans l'équipe Algo, s'est vue décerner le 7 juin 2010 le Trophée Femme en Or 2010 dans la catégorie recherche.
- Caroline Appert, alors doctorante dans l'équipe InSitu, a reçu le premier prix de thèse Gilles Kahn 2008.
- André Chailloux, alors doctorant dans l'équipe Algo, a reçu le premier prix de thèse Gilles Kahn 2011.
- Sylvain Gelly, alors doctorant dans l'équipe A&O / TAO, a reçu le 2ème prix de thèse Gilles Kahn 2008.
- Xiangliang Zhang, alors doctorante dans l'équipe A&O / TAO, a reçu le Outstanding Award from National China Research Council for Abroad Students en 2010 (20 en France toutes disciplines confondues).
- Marie-Claude Gaudel, PR émérite dans l'équipe ForTesSE, a reçu le 20 septembre 2011 les insignes de Chevalier de la Légion d'Honneur.

Rappelons l'implication dans les investissements d'avenir et au niveau européen dans ICT Labs :

- Michel Beaudouin-Lafon a coordonné la proposition d'EquipEx Digiscope (infrastructure haute performance de visualisation pour la collaboration interactive avec des données massives), qui figure parmi les 51 lauréats de la première vague de l'appel à projet "Equipements d'Excellence" en janvier 2011, et en assure la direction scientifique et technique avec l'aide de ses collègues de l'équipe InSitu.
- Christine Paulin a coordonné la proposition de Labex DigiCosme, qui figure parmi les 71 lauréats de la seconde vague de l'appel à projets Laboratoires d'Excellence en janvier 2012 et rassemble 300 chercheurs et enseignants-chercheurs et autant de doctorants, appartenant à 11 établissements partenaires de l'Idex Université Paris-Saclay.
- Le projet ICT Labs, auquel participe le LRI, a été sélectionné le 16 décembre 2009 par l'EIT, l'institut européen d'innovation et de technologie à l'issue d'un processus européen très sélectif. Khaldoun Al Agha, de l'équipe Réseaux, a assuré la responsabilité européenne de la ligne d'action "Digital Cities of the Future".

Parmi les nombreuses contributions scientifiques faites par les membres du LRI, qu'on trouvera plus exhaustivement dans l'annexe 1 et les chapitres des réalisations de chaque équipe, telles que :

- Des membres de l'équipe InSitu ont reçu trois prix du meilleur article à la conférence ACM CHI en 2009, 2011 et 2012.
- Des membres de l'équipe A&O / TAO ont obtenu deux prix du meilleur article à ACM GECCO en 2010 et 2011.
- Sylvain Conchon, Evelyne Contejean et Mohamed Iguernelala, de l'équipe Toccata, ont obtenu le prix 2011 de l'EATCS (European Association for Theoretical Computer Science), pour le meilleur article théorique de l'ensemble des conférences ETAPS.

un grand nombre ont été incorporées dans des logiciels qui ont recueilli des prix ou suscité l'intérêt du public ou de l'industrie :

- Les versions successives du solveur SAT Glucose co-développé au sein de l'équipe IASI ont remporté le premier prix à la compétition internationale SAT dans la catégorie industrielle UNSAT en 2009, la catégorie application SAT+UNSAT en 2011, le challenge SAT en 2012 et la catégorie application certifiée UNSAT en 2013.
- Le logiciel MoGo de jeu de go développé dans l'équipe A&O / TAO a remporté le "ChessBase award" 2009 pour la contribution majeure à des jeux sur ordinateur.
- L'algorithme DAE (Divide and Evolve) développé par l'équipe A&O / TAO avec Thalès a remporté la compétition internationale en planification (catégorie "temporal satisficing") à ICAPS 2011, ainsi que le Silver Humies Award à GECCO 2010.
- L'équipe Algo coordonne le projet Sage-Combinat qui vise à "améliorer le système Sage comme boîte à outils extensible pour l'exploration informatique en combinatoire, en fédérant et mutualisant les efforts de développements des chercheurs dans ce domaine". Sage-Combinat regroupe une cinquantaine de contributeurs internationaux (Europe, Amérique du Nord, Australie, Japon, Corée, etc.) et l'équipe a contribué à plus de 30000 lignes de code dans Sage.
- L'équipe Toccata a développé l'outil de preuve de programmes Why3, utilisé dans l'environnement Frama-C pour l'analyse statique de codes C critiques et dans le futur environnement Spark2014 (projet Hi-Lite) pour la vérification de codes Ada, et le prouveur Alt-Ergo, qui a été qualifié par Airbus France pour utilisation dans le développement de code critiques.
- L'équipe ForTesSE a développé la bibliothèque C++ en accès libre Rukia pour l'exploration de modèle par marche aléatoire uniforme, disponible sous LGPL, et le générateur de cas de test HOL-TestGen, construit au dessus d'Isabelle/HOL, également en accès libre sous licence de type BSD.
- Le générateur de code CLooG développé dans l'équipe Archi a été intégré à la version publique du compilateur GCC depuis la version 4.4.0 (bibliothèque externe), ainsi qu'au compilateur LLVM et aux compilateurs de haut niveau Pluto et PoCC.
- L'équipe BioInfo a procédé au dépôt APP de l'outil GeneValorization qui, du 15/12/2009 au 09/06/2013, a fait l'objet de 1800 visites et a été utilisé par une centaine d'utilisateurs réguliers.
- Le logiciel Varna, développé par l'équipe BioInfo en collaboration avec le LIX, l'IGM et l'EPI AMIB a été choisi par la banque de données Rfam, leader mondial pour les données ARN. L'article qui décrit Varna a été cité plus de 130 fois depuis 2009.

Deux startups ont été créées :

- Khaldoun Al Agha, de l'équipe Réseaux, a cofondé en 2010 l'entreprise Green Communications, spécialisée dans la qualité de service des réseaux mesh.
- Joël Falcou, de l'équipe Archi, a créé en mars 2012 l'entreprise Metascale, éditeur de logiciels d'aide au développement d'applications de calcul haute performance.

Citons pour finir l'organisation de conférences de renom et l'implication dans la formation par la recherche :

- Wendy Mackay et Michel Beaudouin-Lafon de l'équipe InSitu ont organisé en 2013 à Paris la conférence CHI, "ACM SIGCHI Conference on Human Factors in Computing Systems", la plus prestigieuse conférence internationale en IHM, qui a rassemblé près de 3500 participants de 54 pays durant 6 jours.
- Le master de Bioinformatique et Biostatistiques (BIBS), porté par des enseignants-chercheurs de l'équipe BioInfo du LRI, en collaboration avec des collègues d'autres départements de l'université Paris-Sud (biologie, mathématiques) et de l'Ecole Polytechnique, a été sélectionné parmi les "9 masters plébiscités par les étudiants et les entreprises" par le journal Le Monde en février 2011.

- L'équipe InSitu a coordonné la création du master HCID ("Human-Computer Interaction and Design") d'ICT Labs et lancé localement la spécialité M2R Interaction de ce master. Les étudiants de HCID ont remporté la championnat des Jeunes Entrepreneurs à la fois aux niveaux français et européen, une première pour la France.

1/ Présentation de l'unité

Implication du LRI dans la formation par la recherche

Le LRI est très impliqué dans la formation par la recherche, en assurant notamment la direction du master mention Informatique et de la plupart de ses spécialités et celle de l'Ecole Doctorale Informatique Paris-Sud (EDIPS, ED 427), en montant des spécialités de master ouvertes à l'international dans le cadre du KIC ICT Labs et en accueillant de nombreux étudiants en stage de master, d'ingénieur ou de licence ainsi que des missions doctorales. De plus, jusqu'en 2012, les cours de M2 avaient lieu au sein même du laboratoire pour faciliter la proximité entre étudiants et équipes de recherche.

Ecole doctorale

(voir plus de détails sur le site de l'ED : <https://edips.lri.fr>).

Les doctorants inscrits à l'EDIPS, école doctorale monothématique en STIC, effectuent leur recherche au LRI, au LIMSI, au Centre Inria Saclay ou au CEA-LIST. Durant chacune des cinq années passées, le LRI est le laboratoire qui a procédé à le plus de premières inscriptions en thèse (de 38% à 48% de l'ensemble des inscriptions à l'EDIPS).

L'EDIPS a continué comme par le passé à être dirigée depuis 2008 par des enseignants-chercheurs du LRI : Christine Paulin puis, lorsque celle-ci a remplacé Christine Froidevaux à la tête du département informatique, Nicole Bidoit. Le conseiller aux thèses et le responsable missions doctorats sont tous deux des enseignants-chercheurs du LRI. Sur les 26 membres, dont 8 extérieurs, du conseil de l'ED en 2012-2013, 11 étaient des membres du LRI : 4 sur 6 au titre de représentants des masters et du département informatique, 1 sur 2 (le directeur) au titre de représentants des laboratoires, 3 sur 5 au titre de représentants des doctorants, 3 sur 3 au titre de représentants de l'ED. Ce conseil se réunit au moins trois fois par an pour l'attribution des allocations de recherche, le suivi des doctorants et l'émission de recommandations sur tout ce qui touche l'organisation et le fonctionnement pédagogique de l'ED.

L'EDIPS a disposé de 18 à 20 allocations les deux premières années (2008-2010) puis de 14 à 15 les trois suivantes (2010-2013), dont 6 à 8 annuellement pour le LRI (excepté un pic de 11 en 2009-2010). L'attribution de ces allocations donne lieu tout début juillet à au moins deux journées d'audition des candidats suivies de la délibération du jury.

Le suivi des doctorants comprend entre autres des entretiens en septembre et octobre avec chaque doctorant au bout de deux ans de thèse, c'est-à-dire pour autoriser la réinscription à partir de la troisième année. Chaque doctorant fait un exposé d'une dizaine de minutes de l'état d'avancement de sa thèse, des résultats obtenus et du plan de travail pour la fin de thèse avec la date de soutenance prévue devant le directeur de l'ED, le conseiller aux thèses et le directeur de l'unité où il effectue sa recherche (c'est ainsi que le directeur du LRI participe à tous les entretiens avec les doctorants du LRI), en présence de son directeur de thèse et éventuels co-encadrants, suivi de questions. Ensuite le jury s'entretient avec le doctorant seul puis avec les encadrants seuls et décide de l'autorisation de réinscription assortie d'éventuelles recommandations, voire d'un suivi rapproché sous forme d'un prochain entretien. L'EDIPS est attentif à ce que la durée des thèses ne dérape pas, la recommandation forte étant de trois ans avec une tolérance de 40 mois ; malgré cela, des efforts restent à faire, la durée moyenne s'établissant aux alentours de 42 mois.

Excepté cas exceptionnels (deux doctorants salariés durant la période), toutes les thèses sont financées et tous les doctorants disposent d'un contrat doctoral. Le responsable missions suit chaque année les doctorants choisissant d'effectuer des missions hors recherche, que ce soit d'enseignement ou autre (conseil

et expertise, valorisation de la recherche, médiation scientifique). C'est ainsi que le pôle Développement logiciel de l'équipe technique du LRI a accueilli plusieurs missions doctorales de valorisation de la recherche. De plus, chaque doctorant doit suivre et valider durant ses deux premières années de thèse un module d'ouverture scientifique et un module d'ouverture professionnelle (représentant au moins une cinquantaine d'heures chacun).

La mobilité internationale est encouragée par le financement, sur présentation d'un projet et après sa validation, de frais de mission pour des stages à l'étranger, des écoles d'été ou des conférences, par l'ED ou par le laboratoire ou son équipe d'accueil.

Les actions principales pour préparer l'insertion des doctorants sont : les exposés lors des Journées de l'EDIPS présentant les différents organismes, la R&D en entreprise, la formation orientée insertion professionnelle, l'entretien de réinscription en 3ème année et l'ensemble des événements offerts par l'environnement de recherche de l'EDIPS (RTRA Digiteo, Labex Digicosme, pôle de compétitivité Systematic, etc.). L'insertion des docteurs est excellente avec un pourcentage de docteurs sans emploi quasi nul un an après la soutenance. Le pourcentage d'emplois stables quant à lui passe de 52% un ou deux ans après la soutenance à presque 88% (situations inconnues exclues) au delà de trois ans après la thèse, en adéquation notamment avec la tendance actuelle constatée lors des recrutements d'enseignants-chercheurs, i.e. la nécessité de plus en plus fréquente d'une période de deux ans de post-doc ou autre emploi temporaire avant d'obtenir un poste. Après leur thèse, les docteurs partent majoritairement en post-doc avec une tendance à l'équilibre entre France et étranger. L'insertion des docteurs en entreprise est plus que satisfaisante, de l'ordre de 65% (situations inconnues exclues) au delà de trois ans après la thèse.

Pour ce qui est du LRI proprement dit (hors doctorants Inria des EPC), le nombre moyen de doctorants par HDR s'établit en 2012-2013 à 1,6, soit exactement le même qu'au niveau de toute l'ED, en baisse à cause de la décroissance déjà notée des effectifs des doctorants depuis 2010. Un HDR du LRI ne peut diriger ou encadrer simultanément plus de l'équivalent de trois doctorants (300% d'encadrements cumulés).

Le LRI met à disposition de l'ED dans son bâtiment PCRI, dans la zone d'accueil non badgée afin d'être accessible à tous les doctorants, un bureau pour le secrétariat de l'EDIPS ainsi qu'un bureau annexe affecté à l'archivage. L'équipe technique du LRI apporte son soutien au secrétariat de l'EDIPS et héberge en particulier son site Web (application Tiki Wiki). Le LRI met aussi à disposition de l'ED les salles de réunion de la zone d'accueil du PCRI. Ces salles sont utilisées pour les réunions du conseil, les entretiens avec les doctorants et les soutenances de thèse. Les doctorants du LRI sont hébergés dans ses bureaux chercheurs et le laboratoire finance l'achat d'un poste de travail (le plus souvent un ordinateur portable) à tout nouveau doctorant.

A l'initiative de la direction du LRI et grâce aux contacts de l'un de ses directeurs de recherche chinois et avec l'appui de la DRI de Paris-Sud, un accord a été signé en 2012 entre Paris-Sud et le "China Scholarship Council" (CSC) prévoyant l'accueil de 40 doctorants par an à Paris-Sud avec un financement du CSC et l'EDIPS en a profité dès cette rentrée 2013. Le LRI et Inria Saclay participant au KIC ICT Labs de l'EIT, l'EDIPS en est également partie prenante, ce qui lui donne accès à des programmes doctoraux spécifiques dont la vocation est de développer l'innovation et l'entrepreneuriat.

Plus de détails figurent dans le rapport que l'EDIPS dépose à l'AERES en octobre 2013.

Evidemment le projet qui occupe actuellement tous les responsables d'ED et d'unités affiliées tout ou partie aux STIC dans le périmètre Paris-Saclay, et qui deviendra opérationnel pour le prochain quinquennal, est celui de l'ED STIC de la future université Paris-Saclay. Après concertation de tous les acteurs en STIC, il a en effet été décidé de créer une unique ED STIC qui délivrera les thèses sous le sceau de l'université Paris-Saclay. C'est précisément Nicole Bidoit, professeur au LRI et directrice de l'EDIPS, qui porte ce dossier. Cette ED est une création par restructuration de huit ED existantes dont l'EDIPS pour Paris-Sud (ainsi que l'ED STITS pour Paris-Sud et Supélec, les autres relevant de l'université de Versailles Saint-Quentin, de l'université d'Evry, de l'ENS Cachan, de l'Ecole Polytechnique, de l'Ecole Centrale et de Télécom ParisTech). Vingt-deux unités de recherche participent à cette ED, le LRI se situant au second rang pour le nombre d'HDR et aux environs du cinquième rang pour le nombre de doctorants.

Le champ disciplinaire de l'ED est l'ensemble des Sciences et Technologies de l'Information et de la Communication. Il s'agit sensiblement du périmètre des sections 27 (Informatique) et 61 (Génie informatique, automatique et traitement du signal) du CNU, qui correspond également aux sections 06 et 07 (Sciences de l'Information) du CoNRS. Les contours de l'ED STIC et ceux du futur département de recherche STIC de l'université Paris-Saclay sont très proches, à la fois l'ED et le département s'appuyant

largement sur le RTRA Digiteo. L'IRT SystemX sera aussi un laboratoire associé à l'ED et contribuera à la formation des doctorants.

L'ED STIC sera structurée en quatre grands pôles thématiques : Automatique, Traitement du Signal, Traitement des Images, Robotique ; Réseaux, Information et Communications ; Données, connaissances, apprentissage et interactions ; Programmation : modèles, algorithmes, langages, architecture. Le LRI est présent dans les trois derniers. Des interactions seront mises en place avec six autres ED sous forme de programmes inter-ED. Un projet de gouvernance a été élaboré avec un conseil des tutelles et quatre comités de pôle. Nous renvoyons au projet pour une description détaillée. L'important ici est de noter que le LRI est très impliqué dans la création de cette ED comme il l'est dans celui du futur département STIC et du futur master mention informatique de l'université Paris-Saclay. Outre que c'est un professeur du LRI qui porte ce projet de création d'ED, la directrice du Labex DigiCosme, également professeur au LRI, et le directeur du LRI sont membres du groupe de travail sur cette ED.

Masters

(voir plus de détails sur le site du département d'informatique : <https://dep-info.u-psud.fr>).

Le master mention Informatique de Paris-Sud, relevant du domaine des STIC, est lui aussi dirigé par un enseignant-chercheur du LRI, Daniel Etienne. Il comprend un parcours MIAGE (double compétence informatique et gestion), constitué d'un M1 et d'un M2P (spécialité MIAGE), qui se décline en une formation initiale et une formation par apprentissage, et un parcours général ("informatique"), constitué d'un M1 et de quatre spécialités de M2, trois recherche (créées en 2010, faisant suite aux trois parcours de l'unique spécialité recherche qui existait auparavant) et une pro. Certains cours d'informatique sont mutualisés entre les deux M1.

Le M1 du parcours informatique est dirigé par un enseignant-chercheur du LRI. Le M1 et le M2P du parcours MIAGE formation initiale sont co-dirigés par le responsable de la MIAGE et un enseignant-chercheur du LRI. La spécialité M2P IICI ("Ingénierie de l'Information, de la Communication et de l'Interaction") du parcours informatique est dirigée par deux enseignants-chercheurs du LRI. Quant aux trois spécialités M2R de ce parcours, la spécialité IAC ("Information, Apprentissage, Cognition") est co-dirigée par un enseignant-chercheur du LRI et un du LIMSI, la spécialité NSI ("Nouveaux Systèmes Informatiques") est dirigée par un enseignant-chercheur du LRI et la spécialité "Interaction" est dirigée par deux enseignants-chercheurs du LRI. On constate donc que le LRI est présent dans le pilotage du master et de toutes ses spécialités du parcours informatique. Il est également largement présent dans les équipes pédagogiques puisqu'on compte 35 enseignants-chercheurs du LRI intervenant en M1 ou dans les diverses spécialités de M2. Signalons pour être complet que des enseignants-chercheurs du LRI enseignent dans le M2P spécialité R&T ("Réseaux et Télécommunications"), rattaché à la fois au master mention Informatique et au master mention Information, Systèmes et Technologies (IST), et que c'est un enseignant-chercheur du LRI qui est responsable du M2P spécialité CCI ("Compétences Complémentaires en Informatique").

Chaque année, de nombreux étudiants des spécialités M2R effectuent leur stage de recherche au LRI et plusieurs y continuent en thèse. Les spécialités recherche ont des enseignements "formation à la recherche" et s'appuient sur les séminaires des équipes de recherche, dont celles du LRI. On renvoie pour plus de détails au rapport que le master mention Informatique dépose à l'AERES en octobre 2013. Mais le LRI est également présent dans d'autres masters. C'est le cas en particulier du master mention BIBS ("BioStatistiques et BioInformatique"), créé à l'initiative de membres de l'équipe BioInfo du LRI et de collègues biologistes de Paris-Sud et co-dirigé par Alain Denise puis Christine Froidevaux, professeurs dans l'équipe BioInfo, et un biologiste. Ce master, qui offre à la fois un parcours professionnalisant et un parcours recherche, assure la formation de spécialistes à l'interface de trois disciplines : Biologie, Informatique et Mathématiques. On peut affirmer que sa création est une grande réussite. Des enseignants-chercheurs du LRI enseignent aussi dans le master professionnel COMASIC ("Conception et Management des Systèmes Informatiques Complexes"), cohabilité par Paris-Sud, l'INSTN, Polytechnique, Centrale, Télécom ParisTech, l'ENSTA et l'Ecole supérieure d'Electronique, et un enseignant-chercheur du LRI est co-responsable à la fois du M1 et du M2P. Enfin quelques enseignants-chercheurs du LRI, principalement de l'équipe Toccata, enseignent dans le Master Parisien de Recherche en Informatique (MPRI), qui offre une spécialisation en informatique fondamentale.

Concernant les programmes internationaux, il faut signaler l'ouverture internationale durant ce quadriennal à la Master School du KIC ICT Labs de l'EIT (dont le LRI et Inria Saclay sont des acteurs) d'une

part pour la spécialité HCID ("Human-Computer Interaction and Design"), dirigée par deux enseignants-chercheurs de l'équipe InSitu du LRI, dont la première année a ouvert en 2012 et la seconde année, constituée de la spécialité M2R "Interaction" du master mention Informatique, a ouvert en 2013 pour les étudiants qui choisissent Paris-Sud comme point de sortie (les autres universités impliquées dans ce Master sont KTH (Suède), Aalto (Finlande), Berlin (Allemagne), Twente (Pays-Bas), UCL (Grande-Bretagne), Trento (Italie)) et d'autre part pour la spécialité DSS ("Distributive Systems and Design"). Cette Master School, qui inclut une mineure obligatoire en Innovation et Entrepreneuriat (I&E, 30 ECTS), conduit à la délivrance d'un diplôme de master double ou commun (des deux institutions où les étudiants auront étudié, la mobilité étant obligatoire) ainsi qu'un certificat de l'EIT. Depuis 2005, a été en outre mis en place par un enseignant-chercheur du LRI, qui en assure la responsabilité, le Master Franco-Hellénique en Informatique, issu d'une collaboration entre Paris-Sud, l'université Joseph Fourier de Grenoble et l'université de Crète. Enfin, à l'initiative du LIMSI, du LRI et du département d'informatique, Paris-Sud a signé en 2013 un accord de collaboration avec le National Institute of Informatics (NII) de Tokyo. Dans ce contexte, le NII finance l'accueil de trois étudiants en stage dans leurs locaux pour des séjours allant de 2 mois (stages de M1) à 6 mois (stages de M2).

Les stages au LRI des étudiants de master sont financés soit par des bourses (de pays étrangers, européennes, ministérielles, du Labex DigiCosme, etc.) soit par des contrats des équipes, soit sous forme de gratifications par le laboratoire.

Dans le cadre de l'Idex, avec en vue la création de l'université Paris-Saclay en 2014 et donc qu'à terme (en 2020) tous les masters seront des masters Paris-Saclay, une réflexion a eu lieu sur l'opportunité de proposer dès maintenant une unique mention Informatique commune aux douze établissements du campus qui proposent actuellement des formations en informatique (AgroParisTech, Centrale Paris, ENS Cachan, ENSIE, ENSTA, Polytechnique, Supélec, Télécom ParisTech, Télécom SudParis, université d'Evry Val d'Essonne, université Paris-Sud, université de Versailles St-Quentin en Yvelines). Suivant en cela la majorité des masters scientifiques qui ont demandé à être rattachés à Paris-Saclay pour le prochain quinquennal (durant lequel il y aura coexistence de masters Paris-Saclay et de masters d'établissements), les représentants informaticiens des établissements ont décidé en avril 2013 de créer un unique Master mention Informatique de Paris-Saclay dès 2015. Ce master sera rattaché à la "School" "Ingénierie et Sciences et Technologies de l'Information" de Paris-Saclay (les "Schools" constituant les portails formation de l'université) et adossé au département recherche STIC, unique lui aussi, et au Labex DigiCosme et débouchera, pour ce qui est de la formation doctorale, sur l'ED STIC. Les avantages attendus de cette unique structure sous l'emblème de Paris-Saclay sont : une masse critique d'étudiants, une meilleure visibilité et attractivité à terme, l'exploitation des convergences et complémentarités entre établissements en lieu et place de la concurrence.

Seize actuels masters ou projets de masters des douze établissements sont concernés. Soit, en ce qui concerne le LRI : les actuelles spécialités M2R "Interaction", NSI (qui sera intégrée à un parcours Réseau) et IAC (qui sera intégrée à un parcours plus large "DataSense" en liaison avec l'axe du même nom de DigiCosme) du master mention Informatique de Paris-Sud ; l'actuelle spécialité M2P R&T (qui sera intégrée à un parcours "Réseau") ; le projet de spécialité M2R MIFOSA ("Master d'Informatique Fondamentale de SAclay") rassemblant neuf établissements à l'initiative d'un enseignant-chercheur du LRI avec l'appui de la direction ; le projet de spécialité IHPS ("Informatique Haute Performance et Simulation").

Le LRI est à nouveau pilote de cette action puisque le porteur de ce projet de master Informatique Paris-Saclay est Alain Denise, enseignant-chercheur au LRI et vice-président formation du département d'informatique. Le descriptif des parcours thématiques en M2 est en cours pour soumission à la Fondation de Coopération Scientifique du Campus Paris-Saclay en octobre, les projets complets de mentions Paris-Saclay devant être déposés au ministère en avril 2014. Un socle commun de connaissances à la fin du M1 et de la 2ème année d'ingénieur (pour les étudiants qui se destinent à l'informatique) est aussi en cours de définition. Tout étudiant maîtrisant ce socle commun pourra potentiellement être admis en 2ème année de Master mention Informatique. Outre la mention Informatique, il y aura création d'une mention MIAGE (qui rassemblera les deux spécialités MIAGE actuelles, à Evry et à Paris-Sud). Les principes du travail de préparation de cette nouvelle offre de Master en Informatique de Paris-Saclay sont les suivants :

- Faire une offre globale, complète, lisible et cohérente (et donc non redondante) consistant en un ensemble de parcours thématiques.
- Encourager les équipes pédagogiques multi-établissements, cultiver des liens forts avec les laboratoires et les organismes de recherche.
- Prendre en compte toutes les origines des étudiants : universités, grandes écoles, étranger.

- Dans la mesure du possible, offrir une unité de lieu au sein d'un même parcours : déplacer les enseignants plutôt que les étudiants.

1/ Présentation de l'unité

Stratégie de l'unité

Avant la présentation détaillée qui suivra des stratégies scientifiques des huit équipes de recherche dans leurs chapitres de présentation, nous donnons ici quelques perspectives globales au niveau de l'unité pour le quinquennal 2015-2019, fondées en particulier sur l'auto-évaluation des actions du LRI durant le quinquennal qui s'achève et la mise en place de la future université Paris-Saclay.

Auto-évaluation

Comme il a été souligné dans la section sur le bilan de l'unité, la période qui s'achève a été particulièrement riche d'événements et aura vu le LRI connaître des mutations importantes en interne et un très profond changement du paysage académique dans son environnement.

Réunification enfin réalisée en un seul lieu géographique par son emménagement souhaité dans les nouveaux bâtiments PCRI et Digiteo Moulon. Mais, outre le retard pris par ces opérations, particulièrement important en ce qui concerne PCRI, le laboratoire a dû faire face, une fois dans les bâtiments, à de nombreux dysfonctionnements, le lot habituel d'essuyer les plâtres au sens propre, qui a mobilisé de nombreux membres du laboratoire au premier rang desquels l'équipe technique et son pôle Logistique, avec le souci de limiter au maximum les perturbations induites sur la vie des chercheurs. Plus de deux ans après l'emménagement dans PCRI, on peut dire par exemple qu'on entre à peine dans une situation enfin stabilisée.

Bouleversement subi malgré des efforts non ménagés pour les retenir que celui causé par le départ des membres du groupe d'algorithmique quantique, affaiblissant dramatiquement l'équipe Algo et créant une hémorragie parmi les chercheurs CNRS du laboratoire. Mais auquel le LRI a fait face par une politique volontariste de refondation d'un axe fort en informatique fondamentale qui a porté ses fruits.

Changement décidé en interne de restructurer les équipes de recherche et de réorganiser la gouvernance du laboratoire et mené à bien entre novembre 2012 et juillet 2013.

Bouleversement imposé mais assumé, accompagné, pris en charge avec lucidité mais aussi avec optimisme et passion et dans lequel le LRI a décidé de jouer un rôle moteur, ce qu'il réalise pleinement à tous les niveaux, que celui des investissements d'avenir et de la mise en place de la future université Paris-Saclay.

Pour ne s'en tenir qu'à cela, ce sont des centaines et centaines d'heures de travail, réunions, discussions qui ont mobilisé de nombreux membres du laboratoire. La crainte en faisant le bilan de ces cinq ans était d'en constater un impact négatif sur la production du laboratoire. Or, comme nous l'avons vu, notamment en ce qui concerne les publications et les contrats, le LRI améliore encore quantitativement et qualitativement sa production par rapport au dernier quadriennal, pourtant déjà de très haut niveau comme souligné alors par le rapport de la précédente évaluation de l'AERES.

Reprenons par contre les principaux points à améliorer et recommandations qui figuraient dans ce rapport de mars 2009 et examinons comment le LRI y a répondu.

- "Une organisation complexe :
la création de 7 équipes-projets INRIA au sein du LRI accentue la complexité organisationnelle du laboratoire ;
la participation à Digiteo est susceptible de modifier l'équilibre entre les recherches fondamentales et les recherches appliquées ;
des structures comme le PCRI ou Digiteo Labs, qui pourraient simplifier les opérations de valorisation et promouvoir les résultats du laboratoire, ne jouent pas toujours ce rôle-là ;
il faut vraiment veiller à ce que les structures additionnelles (INRIA, Digiteo) ne créent pas un laboratoire à plusieurs couleurs entre les équipes qui y participent, et celles qui ne le désirent pas."
S'il y a eu des craintes au début de la part de certaines équipes vis-à-vis de cette organisation en

effet quelque peu complexe, craintes qui ont sans doute joué un rôle dans la décision du groupe d'algorithmique quantique de muter au LIAFA, elles ne sont plus d'actualité.

Les relations avec Inria au niveau des chercheurs et enseignants-chercheurs au sein des EPC et plus largement les collaborations avec des équipes propres du LRI ou des EPI comme Aviz sont et ont toujours été excellentes. Tant le LRI qu'Inria sont bénéficiaires de ce partenariat gagnant-gagnant. Au niveau des structures, il a fallu que chaque partie apprenne à connaître et respecter le fonctionnement de l'autre : l'organisation d'une UMR diffère notablement de celle d'un centre Inria et il en est de même au niveau de leurs équipes respectives. Comme il a déjà été souligné, les accords-cadres Inria-PSud et surtout Inria-CNRS ont nettement amélioré en les institutionnalisant les procédures d'information du partenaire et de décision conjointe, notamment pour ce qui est de la création des EPC. Il reste néanmoins que l'imbrication des EPC parmi les équipes du LRI et leur durée de vie plus courte et reconfiguration plus fréquente ont posé des problèmes organisationnels, telle partie d'une équipe du LRI acquérant ou perdant son statut d'EPC au gré de ces mouvements. En ce qui concerne le premier point, il a été décidé d'un commun accord entre les directions du LRI et d'Inria Saclay qu'il ne serait plus procédé à la création d'EPC à cheval sur plusieurs équipes du LRI. Une EPC doit donc dans l'idéal coïncider avec, mais compte tenu de sa thématique en général plus focalisée au moins être incluse dans une unique équipe du LRI. Ce sera d'autant plus aisé à présent que la restructuration du LRI a abouti à moins d'équipes de taille plus importante. Il a aussi été acté que la composition d'une EPC ne doit relever que de son périmètre thématique et pas d'une sélection de ses membres à l'intérieur de ce périmètre selon des critères individuels. La direction du LRI veillera à ce que ces principes soient respectés lors des prochaines créations d'EPC. Enfin, le fait qu'environ la moitié des équipes aient été durant la période des EPC et l'autre moitié non n'a pas créé parmi les membres du LRI le sentiment d'un laboratoire à deux couleurs, encore moins à deux vitesses. L'égalité rigoureuse de traitement, de participation aux instances de gouvernance, celle des droits et devoirs sont assurées par le LRI quel que soit le statut des personnels, enseignant-chercheur, chercheur CNRS ou chercheur Inria. Bien entendu, les EPC bénéficient d'une plus grande souplesse par exemple pour la gestion des contrats ou l'embauche de personnel temporaire puisqu'elles disposent de deux "guichets" à cette fin, ainsi que de moyens humains (assistantes de projet, ingénieurs) et financiers (budget Inria pour l'équipe-projet) provenant d'Inria mais en contrepartie sollicitent moins le LRI. Les objectifs scientifiques, les méthodes de travail sont les mêmes, aucun déséquilibre ou tension interne n'est perceptible à ce niveau et chaque équipe ayant fait le choix d'être ou non une EPC est satisfaite de son statut. Il était d'ailleurs prévu il y a deux ans déjà qu'Inria devienne la troisième tutelle du LRI, ce qui serait assez naturel vu la proportion d'EPC et renforcerait encore sans doute les processus de concertation entre les différents acteurs, mais ce dossier qui devait être instruit rapidement semble ne plus être prioritaire.

De même, les préventions envers Digiteo, si elles ont existé pour certains au commencement, sans doute à cause d'une mauvaise communication, d'une confusion parfois avec le DIM "Logiciels et Systèmes complexes", laissant à penser que l'informatique fondamentale ne ferait pas partie de son périmètre ou que le soutien irait avant tout à la recherche finalisée, ont été depuis longtemps levées et toutes les équipes ont répondu aux appels à projets annuels et largement profité des actions de soutien sous toutes leurs formes (projets avec bourses de thèse ou de postdoc, chaires, opérations de maturation technico-économiques, mois d'invités, subventions pour l'organisation de colloque, etc.). Digiteo est ainsi devenu une source importante de financement de contrats comme il a été vu. Tous les membres du LRI sont conscients du bénéfice de la structuration de la communauté STIC sur Paris-Saclay qu'a réalisée Digiteo, des collaborations que cela a permis de nouer avec nos collègues d'autres établissements, de l'avantage que cela procure à cette communauté au moment de créer le département STIC de la future université Paris-Saclay qui sera en grande partie l'émanation de Digiteo.

Si néanmoins ces dernières trois années ont alimenté de nouveau des craintes d'organisation complexe et soulevé beaucoup d'interrogations et même d'oppositions, ce n'est pas vis-à-vis d'Inria ou de Digiteo, mais de l'accumulation des nouvelles structures apparues avec les investissements d'avenir : Labex, Equipex, IRT, SATT, Idex, etc. et du montage de la future université Paris-Saclay réunissant une vingtaine d'établissements de nature variée, donc d'un tout autre ordre de complexité que celui pointé par l'AERES il y a moins de cinq ans. Après une période d'incertitude alimentée de nombreux débats, le LRI a estimé que les opportunités d'un tel projet l'emportaient largement sur les risques et, tout en se montrant vigilant face aux évolutions, a décidé de s'approprier ces nouveaux outils et de se montrer acteur du changement, ce qu'il a fait en pilotant l'Equipex Digiscope et le Labex Digicosme, en participant à l'IRT SystemX, aux actions de l'Idex et continue de faire actuellement en pilotant le projet de la future ED STIC et celui du futur master Informatique, en étant un des acteurs majeurs de la réflexion sur le futur département STIC et en participant aux divers groupes de travail et structures de gouvernance de l'Idex en préparation de la création de l'université Paris-Saclay. Donc certes le paysage est complexe mais par son action de pilotage de nombre des nouvelles structures au niveau des STIC et de

leurs interfaces, le LRI se sent bien placé pour appréhender et maîtriser cette complexité, notamment par les gains apportés en mutualisation des structures et des moyens avec nos partenaires des autres établissements.

- "Le laboratoire doit chercher à saisir les opportunités de valorisation de ses recherches lorsqu'elles se présentent. Dans certains cas, des tentatives de valorisation ont été compliquées par la multiplicité des tutelles actuelles."

Comme présenté dans le bilan, une des actions prioritaires qu'a menée le LRI est la création au sein de l'équipe technique d'un véritable pôle Développement logiciel comprenant notamment deux nouvelles activités dédiées au développement et à la maturation de logiciels scientifiques et à la valorisation et au transfert. Grâce au recrutement d'un ingénieur de recherche CNRS en charge de ces activités sous la responsabilité directe de la responsable de l'équipe technique et en étroite concertation avec la direction, à son volontarisme et son dynamisme, notamment dans la mise en œuvre de tous les moyens pour trouver des ressources humaines (ingénieur en CLD de trente mois attribué par l'INS2I, apprenti à mi-temps pour trois ans financé par le CNRS, ingénieur Digiteo d'un an pour une OMTE, stages de niveau Bac+5, missions doctorales pour travailler sur les dépôts APP, etc.), ces missions connaissent un essor remarquable dont les résultats sont déjà manifestes (cf. le détail en première section de ce chapitre). Concernant plus précisément la valorisation, les circuits décisionnels avec les tutelles ont été clarifiés et simplifiés : c'est le SAIC de Paris-Sud qui est le service de valorisation mandaté par les tutelles pour suivre les dossiers du LRI. Les EPC peuvent de leur côté s'adresser également au SRIV Inria Saclay, mais le SAIC doit être informé et donner son accord.

- "Le nombre de postes de soutien administratif et technique est vraiment très faible. L'équipe administrative numériquement trop faible croule sous la tâche et n'est pas promue. Il faut que les tutelles, notamment les tutelles universitaires, prennent ce problème en compte et améliorent cette situation en répondant favorablement aux demandes de créations de postes du laboratoire et en ouvrant pour ce personnel de réelles possibilités de promotion."

Ce point à améliorer il y a près de cinq ans le reste hélas encore. Certes l'INS2I a apporté dans un contexte budgétaire tendu tout son soutien au laboratoire et aura durant la période réussi à remplacer les nombreux départs d'ITA, en promotion ou mutation externe ou à la retraite, dans les équipes administrative et technique, allant même jusqu'à accorder deux NOEMI au laboratoire la même année (mais un départ à la retraite a quand même mis 3 ans et demi à être remplacé). Ce soutien s'est manifesté aussi cette année comme on vient de le voir par le financement d'un CLD de trente mois et d'un apprenti de trois ans à 50% pour le pôle Développement logiciel. L'université a aussi procédé au remplacement des départs de BIATSS. Mais, dans un contexte local d'accroissement très notable des tâches auxquelles le LRI doit faire face, tant dans l'équipe administrative (gestion des contrats notamment) que dans l'équipe technique (essor du pôle Développement logiciel, missions considérablement élargies du pôle Logistique dues aux travaux et à la gestion d'exploitation de PCRI et Digiteo Moulon, périmètre d'action élargi pour le pôle Système et réseaux avec l'absence de support de proximité d'Inria à PCRI et Digiteo Moulon), ce simple maintien des effectifs est notoirement insuffisant. Le LRI a restructuré l'équipe technique et redistribué certaines missions au sein de son personnel pour la rendre plus efficace, mais il a dû financer aux deux-tiers (Inria remboursant un tiers) sur ses ressources un gardien nuit et week-end durant un an et demi pour le bâtiment PCRI et depuis un an un ingénieur responsable des travaux immobiliers pour PCRI et les surfaces LRI dans Digiteo Moulon. Il a aussi financé durant toute la période de un à deux adjoints administratifs en CDD pour la gestion des contrats par manque de personnel dans l'équipe administrative. Le LRI réclame depuis trois ans à Paris-Sud un poste permanent de gestionnaire pour l'équipe administrative et aussi depuis cette année un poste permanent d'ingénieur en charge de la maintenance immobilière pour pérenniser les postes actuels de CDD, car ces postes sont absolument nécessaires au soutien à la recherche et, avec une augmentation très importante des frais d'exploitation de ses bâtiments, le LRI ne pourra plus y faire face. Ce soutien doit venir de Paris-Sud, sachant que durant les six ans passés il n'y a eu qu'un BIATSS pour deux à quatre ITA en moyenne.

- "Une politique doctorale avec des faiblesses."

Le LRI avait répondu à l'époque à cette critique, notamment que ce qui apparaissait comme une faible proportion de publications co-signées par des doctorants provenait du comptage des seuls doctorants en cours de thèse et pas de l'ensemble des doctorants ayant soutenu pendant la période, alors même que les doctorants publient beaucoup plus en fin de thèse qu'au début. Quant au fait que la plupart des jeunes docteurs enchaînent par un post-doctorat, il ne s'agit que très rarement d'une position d'attente, mais d'un choix "forcé", car il est devenu dans les faits quasi-obligatoire pour candidater avec de sérieuses chances de succès à des postes de chercheurs ou d'enseignants-chercheurs d'avoir fait au moins un à deux ans de post-doc avec mobilité, si possible à l'étranger, et les directeurs et encadrants de thèses aident par leurs relations professionnelles les doctorants en fin de thèse à trouver

de tels postes. Comme il a été souligné dans la section consacrée à la formation par la recherche, le LRI travaille en très étroite concertation avec l'école doctorale à la fois pour le suivi et le devenir des doctorants.

Il reste néanmoins un sujet de forte préoccupation apparu durant cette période : la chute du nombre de doctorants depuis la rentrée 2010 (de presque un tiers entre 2010 et 2013), alors même que les effectifs restent faibles en master. Plusieurs membres du LRI sont comme on l'a vu très impliqués dans la structuration et la mise au point des maquettes des futurs master Informatique et ED STIC de l'université Paris-Saclay et on pense que les efforts de mutualisation et de rationalisation de l'offre ainsi que le vivier des grandes écoles partenaires de Paris-Saclay vont faire remonter les effectifs tant en master qu'en doctorat.

- "Il reste encore du chemin à faire pour que les convergences scientifiques et les possibles collaborations entre équipes décrites dans le rapport fonctionnent dans la réalité, car les collaborations effectives sont encore rares."

Même s'il reste cinq ans après encore du chemin à faire, la meilleure preuve que beaucoup a été accompli dans ce domaine est que la restructuration du laboratoire impulsée par la direction cette année mais laissée à l'initiative des équipes quant aux modalités a abouti très naturellement à des fusions d'équipes à leur initiative même : c'est ainsi en particulier que trois paires d'équipes ont fusionné précisément parce qu'elles avaient tissé des collaborations et qu'elles ont estimé que les convergences scientifiques justifiaient de tels regroupements et étaient garantes de leur viabilité. On pourrait ajouter que de telles collaborations et convergences sont aussi apparues nombreuses pendant la période non seulement en interne mais avec nos partenaires de Digiteo et que leur affirmation et leur développement va être tout l'enjeu du département STIC de l'université Paris-Saclay et au delà avec les autres départements au travers de nos collaborations interdisciplinaires.

Perspectives

On peut affirmer d'après ce qui précède que le LRI est en ordre de marche pour continuer en interne à progresser vers une recherche du plus haut niveau national et international et pour relever avec succès en local ce qui va constituer son principal défi pour le prochain quinquennal : la réussite de la mise en place de l'université Paris-Saclay, en étant un des acteurs principaux dans le domaine des STIC. Les opérations immobilières et de restructuration interne des équipes et de la gouvernance auxquelles le laboratoire a procédé durant ce quadriennal offrent en effet une stabilité et une organisation propre à répondre à ces deux objectifs : le LRI est pour la première fois depuis bien longtemps regroupé géographiquement dans un même ensemble de bâtiments, PCRI et Digiteo Moulon, lui assurant la place disponible pour son expansion prévisible durant la durée du prochain quinquennal, et la réorganisation en 2013 de ses équipes de recherche lui confère aussi la pérennité de son organisation scientifique pour ce quinquennal.

Avant de dresser quelques perspectives et plans d'action pour le prochain quinquennal, il faut d'abord redire que le LRI aura besoin du soutien de ses tutelles, avant tout en ce qui concerne les moyens humains de support à la recherche : la pérennisation en postes permanents par Paris-Sud des deux CDD de gestionnaire administratif et d'ingénieur en maintenance immobilière que le laboratoire finance sur ses propres ressources est prioritaire pour 2014 ; celle du CLD pour le pôle Développement logiciel sera demandée au CNRS fin 2015. Sans compter les frais d'exploitation en forte hausse des nouveaux bâtiments, notamment Digiteo Moulon, auxquels le laboratoire ne pourra pas faire face en cas de stagnation, voire de recul, du soutien de base des tutelles.

Le LRI qui a démontré notamment depuis 2010 son attractivité va poursuivre sa politique volontariste de recrutement de chercheurs CNRS (et Inria) en essayant en particulier de renforcer le potentiel de recherche de ses équipes ayant un faible ratio chercheurs / enseignants-chercheurs. Pour ce qui est des recrutements d'enseignants-chercheurs, il avait l'habitude jusqu'à présent de ne pas fléchir ses postes, hormis un coloriage interne par groupes d'équipes. Il a été décidé en 2013 de fonder une véritable politique scientifique de recrutement (dont sera en charge le conseil scientifique) en planifiant les profils des postes sur une base pluriannuelle et en procédant à un fléchage officiel chaque fois qu'un nombre suffisant de postes seront vacants, ce qui est généralement le cas pour les postes de maîtres de conférences à cause des nombreuses promotions externes comme professeurs. C'est ainsi que les priorités pour les trois prochaines années ont été établies, qui seront actualisées chaque année en fonction des postes réellement vacants, et que les sept postes de MCF mis au concours pour le LRI en 2014 ont été fléchés, en tenant compte des axes prioritaires à renforcer, à consolider ou à développer et en prenant garde

de veiller à l'équilibre entre recherche fondamentale, dont l'importance et la place au laboratoire sont réaffirmées, et recherche plus finalisée, les deux étant vues comme complémentaires et cohabitant dans la plupart des équipes (l'unique poste de professeur a quant à lui reçu des priorités thématiques sans être fléché).

C'est ainsi qu'une grande attention sera portée au développement de l'équipe ROCS et de la synergie entre ses deux activités Réseaux (pour laquelle un recrutement de PR est prévu) et Optimisation combinatoire stochastique. L'activité Calcul à haute performance de l'équipe ParSys, qui fait partie des activités les plus récentes du laboratoire, sera prioritairement renforcée par le recrutement d'un MCF et le responsable de l'équipe a déposé sur ce thème un projet d'EPC Postale, en cours d'instruction par Inria après avoir reçu le feu vert de l'INS2I. Sans être ici exhaustif, l'équipe GALaC sera aussi renforcé par un MCF, de même que l'équipe BioInfo, ainsi que les deux activités de LaHDAK concernant le raisonnement avec des ontologies et les données du Web.

Les recrutements sur des axes interdisciplinaires comme la bioinformatique, en liaison avec les initiatives au niveau de l'université Paris-Saclay, ou transverses à plusieurs équipes du LRI seront privilégiés. Dans cette dernière catégorie, un effort particulier sera porté sur le thème de la science des données ("Data Science", "Big Data") qui est un axe de recherches fondamentales au LRI qui concerne au moins les trois EPC A&O / TAO, HCC / InSitu et LaHDAK / OAK, dont on s'attachera à développer les synergies ainsi que celles avec les équipes partenaires au sein de l'axe DataSense du Labex DigiCosme. En ce sens, le LRI participe au projet ISD (Institut de la Science des Données) en réponse à l'appel à projets recherche 2014 de l'Idex. Une présentation détaillée du projet scientifique de chacune des huit équipes de recherche du LRI est fournie dans chacun des huit chapitres suivants.

Un des points à améliorer est une présence insuffisante en recherche au niveau européen. Hors l'important et remarquable investissement dans le KIC ICT Labs de l'EIT, tant en recherche qu'en innovation et formation, mobilisant plusieurs équipes et qui va se poursuivre, la participation du LRI aux projets du FP7 est faible. Sans doute précisément pour les équipes précitées à cause de leur investissement dans ICT Labs et aussi, comme déjà souligné, parce que, vu le très faible retour sur investissement en moyenne du montage très lourd de tels projets avec un taux d'acceptation extrêmement bas, les chercheurs préfèrent se tourner vers l'ANR ou Digiteo. Un des objectifs du prochain quinquennal sera néanmoins d'être plus présent sur la scène européenne à l'occasion du nouveau programme Horizon 2020. D'autant plus que des informations et des aides sont apportées tant par Paris-Sud, notamment au niveau du SAIC, que par le CNRS. Un des moyens pour atteindre cet objectif sera de disposer dans la future équipe de direction d'une personne en charge de la recherche à l'Europe et à l'international. A l'image de ce qui a été réalisé pour le volet formation à l'international au niveau du département d'informatique, dont est en charge un membre du LRI, en étroite concertation avec les directions du LRI et du LIMSI et avec la direction des relations internationales de l'université (DRI), et qui fonctionne très bien. C'est quelque chose que l'actuel directeur voulait mettre en place depuis deux ans mais qui ne s'est pas encore fait faute de temps et d'un accord sur une décharge d'enseignement. En attendant, le directeur gère directement avec la DRI les dossiers les plus importants qu'il a impulsés : voyage commun en Chine en octobre 2011 pour lancer un accord avec le CSC ("China Scholarship Council") en charge de l'attribution des bourses de thèse au niveau national en Chine, grâce à l'entremise d'un collègue chinois du LRI, accord signé par les deux parties en 2012, offrant une quarantaine de bourses de thèse pour Paris-Sud et dont a déjà profité le LRI cette année, qui recrute ainsi un doctorant ; entrée du LRI dans le JFLI ("Japanese-French Laboratory for Informatics") à l'occasion de sa transformation en UMI du CNRS, accord signé par Paris-Sud en avril 2012.

Pour revenir à l'Europe, une action prioritaire est de motiver parmi les membres du LRI des candidatures à l'ERC. Inria par exemple est beaucoup plus actif que nous sur ce plan : si durant ce quadriennal, tout comme durant le précédent, le LRI a bénéficié d'une ERC senior, il le doit à chaque fois à un DR Inria d'une EPC. Les enseignants-chercheurs et chercheurs CNRS s'autocensurent en quelque sorte et extrêmement rares sont ceux qui déposent un dossier (un senior durant le quadriennal). Alors que là aussi, Paris-Sud, avec entre autres le SAIC, et le CNRS apportent de l'aide au montage des dossiers. Aussi cette année la vice-présidente recherche du département d'informatique a décidé d'adopter une démarche pro-active et d'aller rencontrer en personne certains enseignants-chercheurs ou chercheurs pour les encourager à soumettre un dossier, avec l'aide en local de deux professeurs faisant partie de jurys ERC. Il faudra suivre attentivement les retombées de cette démarche et faire en sorte que le LRI s'implique beaucoup plus, au niveau de tous les types de bourses ERC, dans ce programme : s'il y a un nombre raisonnable de soumissions, les résultats devraient suivre en quelques années.

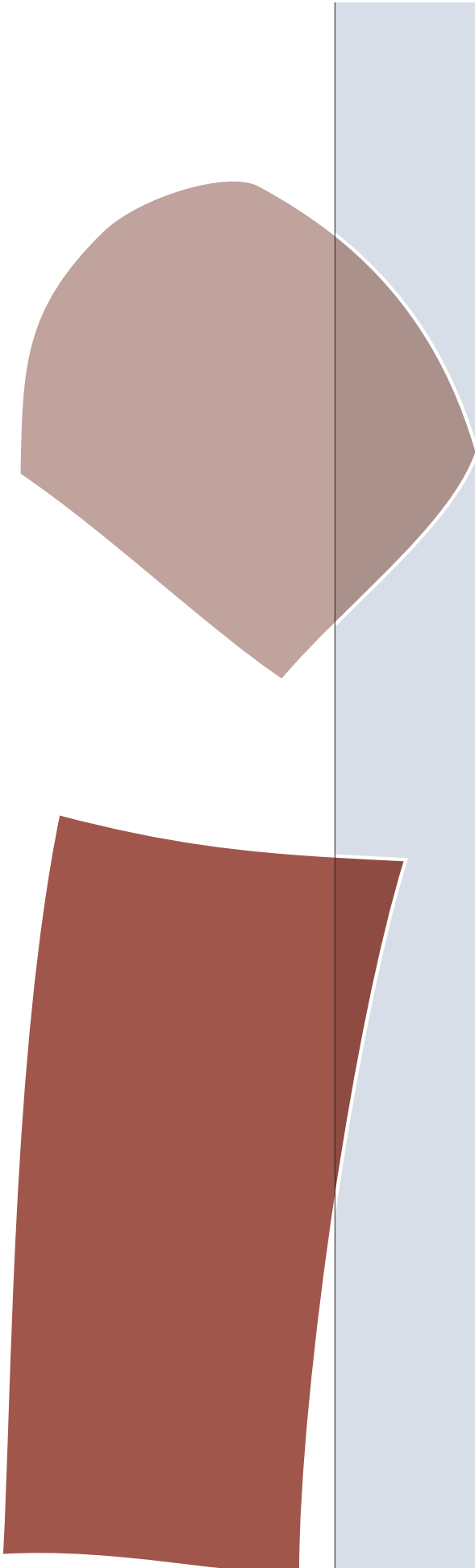
Comme mentionné ci-dessus, un sujet préoccupant est la baisse depuis trois ans du nombre de doctorants, sans doute corrélée entre autres à la baisse auparavant du nombre des étudiants en master

recherche. Une large concertation entre le bureau du département, les responsables de filières et les enseignants-chercheurs du LRI et du LIMSI et un travail important sur les maquettes des formations ont eu lieu cette année pour la préparation du quinquennal 2015-2019. Que ce soit au niveau de la licence d'informatique, dont le responsable est un enseignant-chercheur du LRI, en améliorant la progression des savoirs, en éliminant des redondances au long des trois années, en organisant avec nos collègues mathématiciens un parcours Mathématiques - Informatique théorique pour quelques étudiants, qu'au niveau des spécialités de master, avec une convergence professionnel-recherche et surtout l'intégration au sein d'un unique master mention Informatique au sein de la future université Paris-Saclay, piloté pour Paris-Sud par un enseignant-chercheur du LRI, vice-président formation du département d'informatique, qu'enfin au niveau de la formation doctorale par le projet d'une unique ED STIC de la future université Paris-Saclay, porté par un enseignant-chercheur du LRI, actuel directeur de l'Ecole Doctorale Informatique Paris-Sud. Nous espérons que l'ensemble de ces actions, dans lesquelles le LRI joue un rôle moteur, et la dynamique impulsée par la création de l'université Paris-Saclay à l'automne 2014 (il est significatif que la presque totalité des demandes d'accréditation de masters se font dans le cadre de l'université Paris-Saclay, un pourcentage bien supérieur à ce qui était originellement ciblé pour ce quinquennal à venir), en liaison avec le futur département STIC pour la recherche et la future "school" Ingénierie, Sciences et Technologies de l'Information pour le portail formation, vont avoir un effet d'entraînement qui va nous permettre en particulier d'enrayer la baisse des doctorants (qui n'est pas due à une insuffisance de financements, allocations ou contrats) et d'inverser la tendance durant le prochain quinquennal.

Il est certain que le défi principal qui va occuper le LRI durant le prochain quinquennal, en continuation de ses actions en ce sens depuis près de trois ans, est sa participation à la création et l'organisation de l'université Paris-Saclay et en particulier son rôle majeur dans l'affirmation de la place des STIC et leur structuration interne et aux interfaces et sa propre affirmation en tant qu'unité comme acteur principal de ce changement, tant en recherche qu'en formation, en étroite collaboration avec nos partenaires de Paris-Saclay. Le LRI, qui s'est impliqué dès le début dans tous les appels à projets des investissements d'avenir et dans les groupes de travail et structures de gouvernance de l'Idex Paris-Saclay, est de fait parfaitement bien armé pour relever avec succès ce défi. Il va tout d'abord poursuivre durant tout le quinquennal à venir les actions en cours qui sont bien lancées dans l'Equipex Digiscope (structurant la communauté IHM et visualisation de Paris-Saclay) et le Labex DigiCosme qu'il pilote tous deux, et dans l'IRT SystemX dans lequel sa participation aurait vocation à s'étendre. Il en est de même de sa participation via le groupe Optimisation Combinatoire Stochastique de l'équipe ROCS au "Programme Gaspard Monge pour l'Optimisation et la recherche opérationnelle" (PGMO) de la Fondation Mathématique Jacques Hadamard (FMJH) et d'EDF. Il est présent également dans les projets Idex aux interfaces ISN (Institut de la Société Numérique, impliquant les SHS) et IMSV (Institut de la Modélisation des Systèmes Vivants), via son équipe Bioinformatique, qui vont commencer leur travaux, et dans celui déposé dans le cadre de l'appel à projets recherche 2014, ISD (Institut de la Science des Données), porté au nom des deux laboratoires par un collègue chercheur au LAL (Laboratoire de l'Accélérateur Linéaire) et associé au LRI, impliquant les trois EPC A&O / TAO (avec laquelle le porteur collabore très étroitement depuis plusieurs années), BioInfo / AMIB et LaHDAK / OAK. Un autre projet structurant est la formation d'un axe "Réseaux-Télécoms" à Paris-Saclay. Un tel axe existe déjà à une moindre échelle au niveau du Labex (ComEx) et doit être élargi à toute la communauté. L'ex-équipe Réseaux du LRI est active depuis deux ans dans le montage d'un tel projet, d'abord avec Supélec puis étendu à l'institut Mines-Télécom et vient de participer à la soumission, dans le même cadre de l'appel à projets recherche 2014 de l'Idex, du projet "Wireless Ubiquity (Tools for 5G)" porté par le L2S. La refondation au laboratoire d'un axe visible et de haut niveau en informatique fondamentale s'est aussi accompagnée par l'organisation, à l'initiative de l'ex-équipe Algo, du "séminaire Algorithmique de Saclay" se tenant toutes les deux semaines alternativement au LRI et au LIX et réunissant les équipes d'algorithmique des différents partenaires. De même côté formation l'équipe a pris l'initiative avec l'appui de la direction de fédérer un partenariat pour bâtir un projet de spécialité de master en informatique fondamentale, MIFOSA ("Master d'Informatique FOndamentale de SAclay").

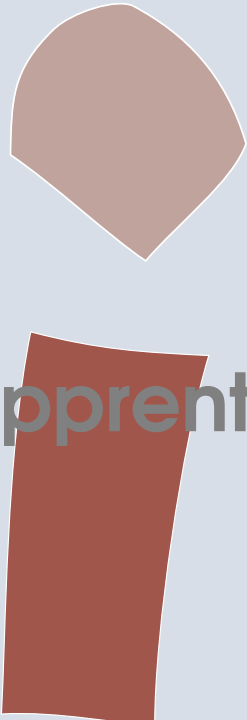
Plusieurs membres du LRI jouent on l'a vu un rôle actif dans l'Idex et la préparation des futures structures de l'université Paris-Saclay et vont continuer avec d'autres à s'y impliquer durant les prochaines années : en formation par la recherche, pilotages actuels du projet de master mention Informatique et du projet d'Ecole Doctorale STIC et, en recherche, participation de deux membres du LRI au sénat académique et forte implication dans la mise en place du département STIC, notamment via ses représentants aux comités des programmes et de pilotage du RTRA Digiteo qui va en être la matrice. Durant toute cette transformation profonde du paysage local, le LRI sera particulièrement attentif à la pleine représentation de ses personnels administratifs et techniques et à ce que sa production scientifique n'en ait pas à souffrir, c'est-à-dire à protéger au maximum le travail du chercheur "de base" pour qu'il soit le moins possible

affecté par les perturbations environnantes. Il sera aussi vigilant sur une possible évolution des contours des UMR impliquées. Celle-ci n'est pas à l'ordre du jour pour le prochain quinquennal mais, après l'arrivée à nos côtés d'établissements comme Centrale, l'ENS Cachan, Télécom ParisTech et Télécom SudParis, elle se posera sûrement. Le LRI veillera à ce que d'éventuels réorganisations et changements de périmètre se fassent dans la plus large concertation et transparence, avec l'assentiment de toutes les parties, sans dilution de son identité, pour le bénéfice de ses personnels, des étudiants, des STIC à Paris-Saclay et de la Science en général.



2/ A & O

Learning and Optimization



équipe Apprentissage & Optimisation

Responsable: Michèle Sebag, Jamal Atif

L'équipe Apprentissage & Optimisation est une équipe commune LRI, CNRS et INRIA-Saclay Île-de-France. L'objectif scientifique est de contribuer aux avancées de l'apprentissage statistique et de l'optimisation stochastique, en s'appuyant sur la complémentarité des deux domaines.

Cinq groupes de travail explorent en étroite collaboration des objectifs focalisés :

- *Optimisation stochastique continue (SCO)
- *Décision optimale en contexte incertain (MAB)
- *Sélection et paramétrisation optimale d'algorithmes (SELF-*)
- *Définition de nouveaux critères d'optimisation et d'apprentissage (CRIT)
- *Modélisation à grande échelle (BIG)



Learning and Optimization

Head: Michèle Sebag, Jamal Atif

A & O (Apprentissage & Optimisation) is a joint research group from LRI, CNRS and INRIA - Saclay Île-de-France. The scientific objective of A & O is to advance both fields of continuous optimization and machine learning, exploiting the now acknowledged synergy of both fields.

Our scientific objectives are investigated within five special interest groups (SIGs) focused on specific goals, and cooperating with each other:

- *Stochastic continuous optimization (SCO SIG)
- *Optimal decision making under uncertainty (MAB SIG)
- *Optimal algorithm tuning and portfolio selection (SELF-* SIG)
- *New ML & O criteria design (CRIT SIG)
- *Large scale modelling (BIG SIG)

Synthetic presentation

Nom du responsable de l'équipe : **Michèle SEBAG**

Effectifs de l'équipe

As of January, 2008, the group had 9 permanent members: 1 Pr, 2 DR, 4 CR, 2 MdC.

Personnels ayant quitté l'équipe pendant le contrat en cours: 1

Nicolas Bredèche, associate professor, was hired in 2012 as professor at Paris-6.

Nombre de recrutements réalisés au cours de la période considérée et origine des personnels: 4

Nikolaus Hansen (senior research engineer, Microsoft Cambridge); Yann Ollivier (CR1 CNRS Math, ENS-Lyon); Jamal Atif (MdC, U. Antilles et Guyane); Nicolas Spyrtatos (PR1, émérite, LRI).

Production scientifique au cours de la période écoulée

1. Information Geometric Optimization, a unifying perspective on distribution-based optimization algorithms.
By adapting the distribution on the search space using a time-dependent adaptive natural gradient descent, one yields: i) optimality guarantees in continuous time under no assumption on the objective function; ii) invariance under monotonous transformations of the objective (comparison-based); iii) invariance under transformations of the search space.
Y. Ollivier, L. Arnold, A. Auger, N. Hansen: Information-Geometric Optimization Algorithms: A Unifying Picture via Invariance Principles (archiv 1106.3708, 2011).
2. Partially observable games are undecidable even in the case of finite state spaces and deterministic transitions.
This major result contradicts former decidability results (focusing on the existence of a winning strategy against any opponent strategy, as opposed to, the selection of the move with optimal winning probability).
D. Auger, O. Teytaud: The Frontier of Decidability in Partially Observable Recursive Games. Int. J. Found. Comput. Sci. 23(7): 1439-1450 (2012)
3. Preference-based Reinforcement Learning: Addressing the limitations of reward-based reinforcement learning.
The learning agent demonstrates a few policies; the expert indicates the preferred agent demonstration; the agent learns a model of the expert preference (policy return estimate) and determines new policies which maximize the Expected Posterior Utility. Furthermore, the agent learns a model of the expert's inconsistencies.
R. Akrou, M. Schoenauer, and M. Sebag: APRIL: Active Preference Learning-Based Reinforcement Learning. In "ECML/PKDD", Springer LNCS 7524 1012; Preference-Based Policy Learning. In "ECML/PKDD", Springer LNCS 6911 2011.
4. Extensions of Multi-Armed Bandits and Monte-Carlo Tree Search
Risk avoidance. Exploration might exert a toll on the agent/system safety in real-world contexts (e.g. controlling a power system or a robot). Risk adverse criteria have been pioneered in MAB, together with multi-objective reinforcement learning. O. Teytaud et al., Strategic choices in optimization, JISE Special Issue on Emerging Technologies and Applications of Artificial Intelligence, 2013, accepted; Wang W. and Sebag M., Hypervolume indicator and dominance reward based multi-objective Monte-Carlo Tree Search. Machine Learning 92(2-3): 403-429 (2013)
Continuous options. The Rapid Action Value Estimate (RAVE) has been extended to continuous settings. D. Auger, A. Couëtoux, O. Teytaud: Continuous Upper Confidence Trees with Polynomial Exploration - Consistency. ECML/PKDD (1) 2013: 194-209.
Application to constraint programming. M. Loth, M. Sebag, Y. Hamadi, M. Schoenauer: Bandit-based Search for Constrained Optimization. In Constraint Programming 2013.

Bilan quantitatif des publications de l'équipe

• Journals : international major : 39, others : 7	• Books and books chapters : 24
• Conference papers : international major : 110, others : 188	

5 publications majeures

- Book: Anne Auger and Benjamin Doerr: Theory of Randomized Search Heuristics-Foundations and Recent Developments. In Theoretical Computer Science, World Scientific, to appear.
- Élteto, T. , Hansen, N. , Germain-Renaud, C. and Bondon, P. Scalable structural break detection. In: Applied Soft Computing, Elsevier, Vol. 12(11) : p. 3408-3420. 2012.
- Auger, A. , Bader, J. , Brockhoff, D. and Zitzler, E.. Hypervolume-based Multiobjective Optimization: Theoretical Foundations and Practical Implications. In: Theoretical Computer Science. 2011.
- Furtlehner, C. , Sebag, M. and Xiangliang, Z.. Scaling Analysis of Affinity Propagation. In: Physical Review E: Statistical, Nonlinear, and Soft Matter Physics, Vol. 81 : p. 066102. 2010

- Bibai, J. , Savéant, P. , Schoenauer, M. and Vidal, V.. An Evolutionary Metaheuristic Based on State Decomposition for Domain-Independent Satisficing Planning. In Ronen Brafman, Héctor Geffner, Jorg Hoffmann and Henry Kautz, eds.: "ICAPS 2010", AAAI Press : p. 15-25.

5 (max) documents majeurs (autres que publications)

- CMA-ES (Nikolaus Hansen et al.): currently the best derivative-free continuous optimizer.
https://www.lri.fr/~hansen/cmaes_inmatlab.html
- Comparing Continuous Optimizers (Coco platform): the international benchmark for derivative-free continuous optimizers.
<http://coco.gforge.inria.fr/doku.php>
- The Grid Observatory portal (C. Germain): records and manages the traces of grid usage for exploitation by the computer science community. Energy consumption data are particularly relevant to green computing.
<http://www.grid-observatory.org>
- ACM-ES (Ilya Loshchilov): derivative-free continuous optimization of expensive functions.
<http://www.lri.fr/~ilya>

5 (max) faits illustrant le rayonnement ou l'attractivité académique

- CNRS, Médaille de bronze, Y. Ollivier.
- Invited paper in Communications-ACM:
Gelly, S. , Schoenauer, M., Sebag, M. , Teytaud, O. , Kocsis, L. , Silver, D. and Szepesvari, C.. The Grand Challenge of Computer Go: Monte Carlo Tree Search and Extensions. In: Communications- ACM, ACM, Vol. 55(3), 2012.
- ChessBase award for the biggest contribution to computer games (2009) (<https://www.lri.fr/~teytaud/mogo.html>)
- The Evolutionary Planner Divide-and-Evolve (DAE; ANR Descarwin; coll. Thalès) won the 2011 IPC temporal satisficing track at ICAPS 2011. Even though the embedded planner is single-objective, DaE can handle multi-objective problems.
DAE won the Silver Humies Award (2010); this award acknowledges human-competitive results obtained by means of evolutionary computation.
- M. Sebag was co- programme chair of the Eur. Conf. on Machine Learning & Principles and practice of Knowledge Discovery from Data Mining, Barcelone 2010 (600+ paper submissions).
- Invited plenary talks or invited tutorials: A. Auger & N. Hansen (GECCO 2010); M. Schoenauer (IEEE-CEC 2011); M. Sebag (ECAI 2012; CP 2012).

5 (max) faits illustrant les interactions de l'équipe avec son environnement socio-économique ou culturel

- Virtual Data Center in Univ. Paris-Sud. Joint initiative Lab. Accélérateur Linéaire & LRI, Cécile Germain.
- Ilab Metis, Olivier Teytaud. Joint lab with SME Artelys. Software suite for optimal energy management.
- Mathematic Park, Institut Henri Poincaré, Yann Ollivier: <http://www.ihp.fr/seminaire/mathematic-park>
- Innov'Nation: Serious games for participative ideation (Appel Offre Ministère de l'Economie Numérique, 2011-2012. Coll.: SMEs BlueNove & ParaSchool; CEA).
- MoGo has been invited in many demonstrations: e.g. in Taiwan, Sciences En Fête in France, games in Clermont-Ferrand, Rennes, Toulouse, games in the US Open of Go, tournoi de Paris, Jeju's Island computer-Go competition, Taipei's invited games.

Principales contributions de l'équipe à des actions de formation

- Licence Informatique, responsable Cécile Germain.
- VP Enseignement, IUT Orsay, Jamal Atif
- M2R IAC, Univ. Paris-Sud: Tronc commun Apprentissage Statistique et Optimisation (Anne Auger, Michèle Sebag); Modules Apprentissage Statistique et Optimisation Approfondis (Balázs Kégl, Anne Auger, Michèle Sebag); Robotique et Systèmes Autonomes (Jamal Atif, Michèle Sebag); Multi-Agents (Philippe Caillou).
- Module Apprentissage, L3/M1, ENS-Cachan (Michele Sebag)
- Formation Gamma, Univ. Can-Tho, Vietnam (Philippe Caillou; coll. IRD).

Research Group Members and evolution since 2008

Permanent Members (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
ATIF	Jamal	MCF	PARIS SUD
AUGER	Anne	CR1	INRIA
CAILLOU	Philippe	MCF	IUT Sceaux
FURTLERNER	Cyril	CR1	INRIA
FRANOVA	Martha	CR1	CNRS
GERMAIN	Cécile	PR1	PARIS SUD
HANSEN	Nikolaus	CR1	INRIA
OLLIVIER	Yann	CR1	CNRS
SCHOENAUER	Marc	DR1	INRIA
SEBAG	Michèle	DR1	CNRS
SPYRATOS	Nicolas	PR émérite	PARIS SUD
TEYTAUD	Olivier	CR1	INRIA

Doctoral Students (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
AIT ELHARA	Ouassim	AM	PARIS SUD
AKROUR	Riad	AM	SYMBRION IP
ARNOLD	Ludovic	MENRT	PARIS SUD
BENSADON	Jérémy	MENRT	PARIS SUD
CHOTARD	Alexandre	MENRT	PARIS SUD
COUETOUX	Adrien	AM	ANR IOMCA
FENG	Dawei	PhD	Académie des Sciences, Chine
DECOCK	Jérémie	PhD	Ilab METIS
GALICHET	Nicolas	MENRT	PARIS SUD
HOOCK	Jean-Baptiste	PhD	MASH Strep
ISAAC	Yoann	PhD	Digiteo
MARCEAU-CARON	Gaetan	CIFRE	Thalès
WANG	Weijia	MENRT	PARIS SUD
ZHANG	Guohua	PhD	Académie des Sciences, Chine

Visitors for 3 months or more (2008-2013)					
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>	<i>Arrival</i>	<i>Departure</i>
ALCHE-BUC	Florence	PR	U. Evry	1.09.2012	30.06.2013
OLLIVIER	Yann	CNRS	Ens-Lyon	1.9.2009	30.08.2010
PAUGAM-MOISY	Hélène	PR	U. Lyon-II	1.09.2008	30.08.2012

Temporary Personnel (2008-2013)

<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
AKIMOTO	Yohei	Postdoc	ANR OMD2
AUGER	David	Postdoc	INRIA
BRENDEL	Matthias	Postdoc	ANR Descarwin
BRESSAN	Marco	Postdoc	INRIA / Augure
BROCKHOFF	Dimo	Postdoc	ANR OMD2
CHEVALIER	Sylvain	Postdoc	ANR Asap
CHRISTOPHE	Jean-Joseph	Ingénieur	Ilab Metis
DA COSTA	Luis	Ingénieur	STREP FP7 EvoTest
DOGHMEN	Hassen	Ingénieur	INRIA
ÉLTETŐ	Tamas	Post-doc	Paris-Sud
GAURON	Philippe	Ingénieur	Paris-Sud
GOUY-PAILLER	Cédric	Postdoc	Digiteo
HAN	Yufei	Postdoc	INRIA
HEIDRICH-MEISNER	Verena	Postdoc	ANR OMD2
ILIJASIC	Lovro	Ingénieur	FUI TIMCO
KIM	Yusik	Postdoc	Paris-Sud
KHOUADJIA	Mostepha	Postdoc	ANR Descarwin
LAZAAR	Nadjib	Postdoc	MSR-INRIA
LOTH	Manuel	Postdoc	MSR-INRIA
MARTIN	Victorin	Postdoc	ANR Travesti
MEUNIER	David	Postdoc	ANR SydinMaLas
MISIR	Mustapha	Postdoc	ERCIM
MEUNIER	David	Postdoc	ANR Asap
MOURAUD	Anthony	Postdoc	ANR Asap
NAUROY	Julien	Ingénieur	ADT INRIA
NICOLAU	Miguel	Postdoc	STREP FP7 Gennetec
REBECCHI	Sébastien	Postdoc	ANR Asap
ROS	Raymond	Ingénieur	FUI CSDL
SAMSONOV	Maxime	Postdoc	ANR Travesti
SOKOLOVSKA	Nataliya	Postdoc	FP7 STREP MASH

Group evolution

In Sept. 2009, Nikolaus Hansen was hired as CR1 INRIA, strenghtening our expertise in continuous stochastic optimization. Yann Ollivier, CR CNRS in mathematics, joined us in August 2010 after a 1-year visit and contributed to the emergence of the geometric optimization theme, together with Anne Auger and Nikolaus Hansen. Jamal Atif was hired as associate professor in 2011, bringing new competences in machine learning, specifically regarding representation changes and regularization. Nicolas Bredèche was hired as professor at Paris VI in Sept. 2012; his leave weakens our research programme on robotics. Pr. Nicolas Spyrtos, emeritus, joined A & O in 2012 to explore the coupling of databases and machine learning.

Pr. Hélène Paugam-Moisy (U. Lyon) was in delegation at A & O (2008-2010; 2011-2012), notably contributing to the design of spiking neuron-based methods for robotics. Pr. Florence d'Alché-Buc (U. Evry) was in delegation at A & O/Bio-Info (2012-2013).

2/ A & O

Research Description

The overall goals of the Apprentissage & Optimisation (A & O) team are to model, to predict, to understand, and to control physical or artificial systems, through a unified perspective on machine learning and optimization. The research activity is structured along five focused themes, investigated by special interest groups (SIGs) in tight cooperation.

Stochastic Continuous Optimisation (SCO)

Participants: **A. Auger, N. Hansen**, Y. Ollivier, M. Schoenauer, M. Sebag, O. Teytaud

Collaborators: D. Arnold (Dalhousie U.), D. Brockhoof (INRIA-Lille), H. Fournier (Paris-6), C. Grangé, U. Laval Québec), E. Zitzler (ETH)

The stochastic continuous optimization (SCO) SIG takes advantage of the fact that A & O is acknowledged the best French research group and one of the top international groups in evolutionary computation (EC) from a theoretical and algorithmic standpoint (346). The main research priorities regards theoretical guaranties and algorithmic advances for adaptive, distribution-based optimization approaches, specifically the covariance matrix adaptation evolution strategy (CMA-ES), currently acknowledged to be the world best derivative-free continuous stochastic optimizer. A second priority is to continue the EC tradition of industrial breakthrough applications.

Theory

A fundamental result relying on information-geometric optimization (IGO) was obtained by Y. Ollivier, A. Auger and N. Hansen. IGO is a canonical way to turn any smooth parametric family of probability distributions on an arbitrary, discrete or continuous search space X into a continuous-time black-box optimization method on X . Rooted on the Fisher metric, IGO features invariance properties under various parameterizations of the distribution family (413, 50, 51), with optimality guarantees in continuous time. It is shown that CMA-ES is a special case of IGO (with Gaussian probability distributions); the generality of the approach has also been demonstrated in the boolean case, considering Restricted Boltzman Machines (L. Arnold 's PhD (418)).

Other major results include the non-validity of the No-Free-Lunch Theorem in continuous optimization (5). Lower bounds for black-box optimization have been obtained using ML-based tools (150). In the same spirit, new lower and upper bounds for distributed derivative-free optimization have been obtained (20, 368, 435), showing that most evolutionary algorithms are poorly parameterized for the parallel case (330). In F. Teytaud's PhD (434), new distributed evolutionary methods were proposed, asymptotically delivering the optimal $\log(\lambda)$ speed-up with λ processors, and a linear speed-up $\Theta(\lambda)$ for a number of processors of order at most the dimensionality of the problem.

In M. Jebalia's PhD, the noisy optimization setting was investigated regarding the EA convergence rate (28), showing the inappropriateness of formulating noisy optimization in terms of expectation optimization in the multiplicative noise case (119) (see also the MAB SIG).

At the core of CMA-ES fame is its invariance w.r.t. monotonous transformations of the objective function and linear transformations of the coordinate space. The general role of invariances for optimization robustness has been clarified (413, 27) (best paper award ACM-GECCO 2010 (57)).

Other results regard the convergence of simplified variants of CMA-ES: proving that its covariance matrix converges to the inverse Hessian on convex-quadratic functions (49); analyzing the convergence of continuous time trajectories associated to step-size adaptive Evolution Strategies on monotonic C^2 -composite functions and proving the local convergence towards local minima (50); analyzing the step-size adaptation algorithm of CMA-ES on linear functions using the theory of Markov Chains (11) (A. Chotard's PhD); revisiting the step-size adaptation schedule in non-elitist evolutionary algorithms (O. Ait Elhara's PhD).

Quasi-random initialization and mutation have been analyzed in (148), showing the stability and generality of derandomized approaches (221).

Algorithmic results

CMA-ES extensions A CMA-ES variant aimed at mixed optimization (discrete and continuous variables) has been designed (395). New selection schemes combined with derandomization have been designed with theoretical and empirical justifications (63, 64). The combination of CMA-ES with oracle-based solutions has been investigated (396). In R. Ros' PhD, variants of CMA-ES with a linear or subquadratic complexity have been proposed (433).

Multi-objective optimization (MOO) We have investigated theoretically multi-objective algorithms based on the hypervolume (2, 59, 3, 349), with application to the identification of the parameters of an ODE-

based model for a Genetic Regulatory Network (234) (best paper award at the EvoBIO'09 conference). A simple but effective improvement for step-size adaptation in MO-CMA-ES has been proposed (152).

Surrogate models Ilya Loshchilov's PhD (429) designed a hybridization of CMA-ES with rank-based surrogate learning, named ACM-ES, first surrogate-based optimization approach to preserve all CMA-ES invariance properties (128). New restart mechanisms, providing an automatic parameterization of the (parameter-light) CMA-ES, have been proposed (127). A local search algorithm using an adaptive coordinate descent has been proposed (126).

Surrogate models for MOO have also been proposed (283, 125, 124), together with new selection operators based on tournament and multi-armed bandits (284).

Industrial and other applications

Numerical engineering is a main source of applications for A & O (*Optimization Multi-Disciplinaire* RNTL/ANR project (OMD 2005-2009; OMD2 2009-2012); CSDL System@tic project), motivating advances in expensive optimization and multi-objective optimization.

Mouadh Yagoubi's PhD (436), a CIFRE cooperation with Peugeot-Citroen automotive industry, addresses the multi-disciplinary multi-objective optimization of a diesel engine; an asynchronous parallelization scheme of expensive objective functions (circa 2 days per evaluation) was proposed (154). Zyed Bouzarkouna's PhD (421), a CIFRE PhD in cooperation with Institut Français du Pétrole–Energies Nouvelles, proposes new variants of CMA-ES coupled with local-meta-models for expensive optimization (73), with application to the well placement problem in oil industry (421, 6).

Evolutionary algorithms have been applied for optimizing the discrepancy of a point set (coll. Laval University at Quebec, Best Paper Award at ACM-GECCO 2009) (96, 13).

Benchmarking methodology

A significant contribution in the 2008-2013 period regards the extension and dissemination of a benchmarking framework. The COCO (COmparing Continuous Optimizers) platform¹ has been acknowledged as "the" international continuous optimization benchmark, defining an international standard for the assessment of new algorithms. We have organized the ACM GECCO 2012 workshop on Black-Box-Optimization Benchmarking and benchmarked different variants of the CMA-ES algorithms (209, 212, 211, 210, 285, 286, 287). At the core of our ANR project NumBBO, (starting end 2012) is the extension of the COCO framework to large-scale, expensive, constrained and multi-objective optimization.

Optimal decision making under uncertainty (MAB)

Participants: **Olivier Teytaud**, Michele Sebag, Marc Schoenauer
Collaborators: David Auger (USVQ), B. Kégl (LAL, Orsay) The optimal decision making under uncertainty (MAB) SIG benefits from the world-level expertise of MoGo; MoGo and MoGoTW (coll. U. Tainan, Taiwan) (281), remain the world leading programs in computer-Go (24, 35) and the ChessBase Award 2009 for the biggest contribution to computer-games was given to O. Teytaud and some MAB members²; survey papers have been published in Communications of the ACM (24) and as a chapter (362). MAB, with extensive expertise in multi-armed bandits (MAB), upper confidence trees (UCT) and Monte-Carlo tree search (MCTS), aims at theoretical and algorithmic advances in the domain of reinforcement learning and noisy optimization, with motivating applications in the domains of energy management (FP7 project Citines; ADEME project POST; INRIA joint lab Metis with the SME Artelys), and games (Go, MineSweeper, NoGo (45)). Another application domain, the optimal selection of heuristics – particularly in relation with constraint programming – is tackled in cooperation with the SELF-* SIG (section SELF-* SIG; European *Massive set of heuristics* Strep (269)).

¹<http://coco.gforge.inria.fr/doku.php?id=bbob-2013>

²<http://chessprogramming.wikispaces.com/ICGA\#BestPublicationAwards>

Theory

A main result, proved by D. Auger and O. Teytaud (2) is that partially observable games are undecidable even in the case of finite state spaces and deterministic transitions. This major result contradicts former decidability results: while the classical decision setting used in most analytical works concerns the existence of a winning strategy against any opponent strategy, we focused on the selection of the move with optimal winning probability. It is argued that the latter issue is the only relevant one in a game perspective, although the former one has been studied for its equivalence to choosing optimal play in the case of fully observable games. Along the same lines, some lower and upper bounds on the value of some partially observable games were proposed (332)

The consistency of MCTS with no exploration term was shown for some games (196).

In cooperation with the SCO SIG, the first penalization rule provably avoiding the “bloat” effect in the Genetic Programming framework has been published (164). Multi-armed bandits have been applied to genetic programming (270), yielding a provably consistent algorithm within a given (user-defined) confidence.

Noisy optimization was also investigated, comparing surrogate model-based optimization and multi-armed bandit approaches (72, 315, 314, 92) in terms of upper and lower confidence bounds and/or experimental results. Depending on whether the noise decreases to 0 around the optimum, the bandit approach or the surrogate-approach must be preferred.

Algorithmic results and applications

Among the main challenges facing MAB and MCTS methods are the use of side information and the coupling of MCTS with induction (43, 312). MCTS was extended to use short-term partial information (334), with application to the widely played Urban Rival game (over 17 millions of registered users). Meta-learning in MCTS features excellent performances against professional players in Go and is shown to improve on the best state of the art in other games such as MineSweeper (225) (Excellent paper award, TAAI conference 2012). Some generic improvements of MCTS, including the use of (fast) decisive and anti-decisive moves for games, were proposed in F. Teytaud’s PhD (434), with application to the game of Havannah (331). The extension of Upper Confidence Trees to continuous or large domains (states and/or actions) and to domains with high expertise or strong structure has been done (228), in particular taking advantage of the combinatorial structure of the domain for e.g. job-shop scheduling (322) or MineSweeper (325, 214), in cooperation with the SELF-* SIG. Nested Monte-Carlo was shown to yield state of the art results for some traveling salesman variants (311).

MCTS was applied to Machine Learning issues. In P. Rolet’s and R. Gaudel’s PhDs respectively, MCTS was applied to active learning (135, 137) and feature selection (111) (note that the search horizon is unknown in the feature selection problem). MAB can also be applied to tune MCTS methods (72), yielding a simple yet efficient approach based on Bernstein races.

The RAVE (Rapid Action Value Estimate) heuristics was extended to continuous action spaces (91). The “double progressive widening” trick was applied to Q-Learning (326) and MCTS (229). Optimization algorithms for direct policy search have been designed (149).

A challenge concerns information or resource-bounded settings. A MCTS version for partially observable problems with bounded horizon was proposed in (192). An experimental analysis of bandit algorithms for small budget cases (225) got the excellent paper award at TAAI 2012.

Other applications include: the on-line choice of the components of the SPIRAL library, involved in the decomposition of Fast Fourier Transform (95, 431) (A. Rimmel’s PhD, coll. with Carnegie Mellon University); optimal safe policies, with applications to robotics (162) (N. Galichet’s PhD); multi-objective reinforcement learning (153, 39), improving on the scalarisation-based state of the art (W. Weijia’s PhD).

Industrial applications and softwares

The application of MAB to energy management (159) motivated O. Teytaud’s invitation by U. Tainan (Taiwan, 2011-2012). The main challenges related to energy management involve i) stochastic uncertainties (e.g. price, demand, weather); ii) large-scale combinatorial problems (as induced by nuclear power plants) with non-linear effects; iii) high dimension (including several hundred hydroelectric stocks); iv) multi-scale horizons (minutes, days, years, long-term investments).

A wealth of applications was provided by the international ANR projects *IOMCA* (Including Ontologies in Monte-Carlo Tree Search and Applications, coordinated by O. Teytaud), and *EXPLORA* (EXPLOitation pour l'Allocation efficace de Ressources), including the control of algorithmic platforms (see also section SELF-*).

Anytime algorithms for discrete time control (note that classical stochastic dynamic programming is by no means anytime) have been developed and integrated in the Metis software platform.

New criteria (CRIT)

Participants: J. Atif, N. Bredèche, P. Caillou, **C. Furtlehner**, Y. Ollivier, M. Schoenauer, M. Sebag
Collaborators: A. Eiben (VU, Netherlands), E. Suzuki (U. Kyushu, Japan)

The CRIT SIG emerged at the crossroad of two perspectives. Firstly, the design of new criteria is at the core of machine learning and optimization, aimed at statistical consistency and computational efficiency. Secondly, the design of autonomous cognitive systems also involves the definition of intrinsic motivations, or embedded criteria. Besides robotics, sources of applications for the CRIT SIG are autonomic computing (section BIG), traffic modelling (TRAVESTI ANR project) and serious games (*INNOV NATION*, Simulation multi-agent de diffusion et d'évolution d'idées dans un réseau social dynamique).

A statistical physics perspective

Modelling or optimizing large scale distributed systems (e.g. road traffic on large scale networks or large scale computational grids) raise critical scalability issues.

Basic tools from statistical physics (scaling, mean-field techniques and associated distributed algorithms, exactly-solvable models) have been adapted to define generic criteria:

- a scaling analysis of the "affinity propagation" algorithm and a related renormalization-based method (with well-defined assumptions) was proposed to find the true number of clusters in a dataset (23, 156) (X. Zhang's PhD; coll. EGEE) in cooperation with the BIG SIG (section BIG);
- the representation of traffic patterns through belief propagation fixed points was used for traffic reconstruction and prediction (244) (ANR project TRAVESTI);
- new approximate solutions to the inverse Ising and Gaussian MRF problems (274, 390), with applications to traffic congestion inference (356) (V. Martin's PhD, 2013);
- exactly solvable models relevant to the understanding of the fundamental diagram of traffic flow (22, 416, 323);
- message passing algorithm for sampling the Pareto Front of a bi-objective 3-SAT optimization problem (391, 247) (STREP Gennetec).

Changes of representation and feature design

The rise and impressive experimental performances of deep networks emphasize that the search for appropriate representations is at the core of supervised machine learning. In L. Arnold's PhD (ASAP ANR project), the reconstruction error has been applied to layer-wise optimization of deep architectures hyper-parameters (158, 58). The consistency of a layer-wise learning criterion for stacked restricted Boltzmann machines or deep networks has been proved (370).

In image understanding, a saliency criterion is used to guide a sequential segmentation framework (19), with application to the segmentation of internal brain structures in magnetic resonance images. Within the ANR project LOGIMA, our goal is to address sequential object recognition as an abduction process (371). In Y. Isaac's PhD (Digibrain project, Digiteo), the search for overcomplete dictionaries enforcing a smooth spatio-temporal decomposition has been tackled, motivated by the analysis of brainwave data (coll. CRICM, La Pitié Salpêtrière) (118).

In multi-agent based simulations, the most interesting phenomena often occur at the intermediate level of (unknown) *groups of agents*; a generic platform has been designed (coll. CEA LIST) together with activity indicators, enabling to identify, describe, follow and reproduce (80, 219, 46) relevant clusters of agents.

In Gaëtan Marceau-Caron's PhD (CIFRE Thalès in the domain of air traffic control), plane flows are modelled using Bayesian networks (256, 257) and the air traffic is globally optimized using multi-objective Evolutionary Algorithms (293, 292).

Autonomous robotics

Within the European IP Symbion and the SyDynMaLAS project (ANR-JST, coll. University of Kyushu), the stress was put on simulator-free approaches for swarm robotics, preventing the so-called reality gap (193, 122). An open-ended evolutionary process (J.-M. Montanier's PhD (300, 76)) used the mere reproduction performances as implicit fitness (thus measuring navigation and social skills), amenable to on-board online evolution with no ground truth. Likewise with no-ground truth, criteria based on the information theory were used as on-board optimization goal (98), providing robust incentives for the robot to explore its sensori-motor space (curiosity "instinct").

The robot behavior was shaped by combining preference learning and reinforcement learning (R. Akrou's PhD (53, 54)); the improvement compared to inverse reinforcement learning is that it does not require the expert to know the target behavior.

During H. Paugam-Moisy's delegation, an individual, 2 spiking neuron-based decision making process has been shown to support the emergence of group synchronisation at the macro-scale. This model reproduces the different regimes of synchronization observed by biologists for the division of labor in insect societies (223, 85).

Algorithm control and parameter tuning (SELF-*)

Participants: Olivier Teytaud, **Michele Sebag**, **Marc Schoenauer**

Collaborators: Balazs Kégl (LAL, Orsay); Y. Hamadi (Microsoft Cambridge); C. Schulte (KTH, Sweden).

As algorithmic platforms in e.g. machine learning, evolutionary computation, constraint programming, planning, increase in complexity to face problem diversity, selecting the best algorithm and/or parameter setting depending on the problem instance at hand becomes a critical issue to deliver decent performances outside the research labs. The algorithm control and parameter tuning (SELF-*) SIG investigates two settings, respectively the offline and online settings. The offline setting is concerned with algorithm selection and offline optimization of the algorithm hyper-parameters; the online setting focuses on the dynamic adjustment of the algorithm hyper-parameters during the run. The SELF-* SIG works in tight co-operation with the MAB SIG (in particular within the *Massive sets of heuristics for Machine Learning* STREP).

Offline SELF-*

The offline selection of the best setting depending on the problem at hand defines a noisy optimization problem; the variance of the noise does not decrease to zero around the optimum and therefore surrogate model-based approaches dominate MAB-based approaches (section SCO).

Some approaches were proposed respectively in A. Arbelaëz's PhD (417, 345) for lifelong learning in a constraint solver (coll. INRIA-Microsoft, with application to protein structure prediction (166)) and in I. Loshchilov's PhD for the automatic parameterization of CMA-ES (127), improving on the best state of the art.

An approach based on Gaussian process-based surrogates (rank-based surrogate) and expected global improvement was proposed in (65).

Offline parameter tuning was systematically used for the evolutionary AI planner *Divide and Evolve* (DAE) (J. Bibai's PhD, CIFRE Thalès, followed by the DesCarWin ANR project, coll. Thalès and Onera). In DAE, a planning problem is sequentially sliced into hopefully simpler problems that are handled by a classical planner, and evolution optimizes the slicing (420, 200, 70, 69). DAE was awarded the *Silver Medal* at ACM-GECCO 2010 Humies Award³, and won the Deterministic Temporal Satisficing track 7th Intl Planning Competition at ICAPS 2011. Furthermore, because Evolutionary Algorithms are easily turned into multi-objective optimizers, DAE has also become the very first Pareto-based multi-objective AI planner (276, 278, 277).

³This award acknowledges best human-competitive results obtained by means of evolutionary computation.

Online SELF-*

Quite the contrary, the noise vanishes around the optimum in the online setting. Elaborating on (192), belief-based MCTS approaches were combined with constraint satisfaction, with application to MineSweeper (230, 335).

The online adaptive operator selection (AOS) in evolutionary computation was tackled in A. Fialho's PhD (coll. Microsoft-INRIA joint lab (424)). MAB was applied, improving on the best state of the art thanks to the design of an original AUC-inspired reward, enforcing invariance under fitness monotonous transformations (18, 105, 240, 104, 363).

In collaboration with Christian Schulte (KTH, Stockholm), one of the main contributors to the well-known general-purpose CP solver *GECODE* (<http://www.gecode.org/>), and within the Microsoft-INRIA joint lab-Adapt project, ideas from UCT have been integrated in GECODE and applied to dynamic value ordering with good first results (289), and new results have just been presented at the CP'13 conference in September.

Large scale modelling (BIG)

Participants: **C. Germain**, C. Furtlehner, Y. Ollivier, M. Sebag

Collaborators: B. Kégl (LAL Orsay)

The pervasive theme of data science and big data was first faced by A & O in the context of Autonomic computing and grid computing for e-science. The flagship European production grid EGEE (Enabling Grids for e-Science in Europe, now EGI-Inspire) exemplified the need for empirical behavioral models in order to support self-monitoring, self-installing and more generally self-* facilities. A first and major step for the behavioral modelling of the EGEE grid was to create a data curation process⁴ (253, 254, 114), with support from EGI, Digiteo, INRIA (Action Développement Technologique), CNRS (PEPS program), and U. Paris Sud.

In Xiangliang Zhang's PhD, this massive data motivated new data streaming approaches for scalably and traceably monitoring the system state (392, 156, 341)⁵, involving a self-calibration of the model based on scale invariance (see the CRIT SIG). In Davey Feng's PhD, fault management was tackled as a collaborative prediction problem, reducing the number of probes by an order of magnitude (102, 237, 17).

The modelling of the grid workload raises technical issues, due to its non-stationarity and the importance of extreme values. In Tamás Elteto post-doc, it was shown that simple piecewise models could efficiently account for the non stationarity (as opposed to the popular long-term memory models) (101, 16), involving application-independent improvements of segmentation algorithms (formulated in terms of bilevel optimization and handled with CMA-ES) (15). In Yusik Kim post-doc, latent Dirichlet allocation was used to provide generative and interpretable models of file access (279); future work will consider the coupling of the LDA approach with the segmentation models. In Julien Perez's PhD, the optimization of the quality of service of the grid was tackled as a reinforcement learning problem (307, 34, 309).

The extensive computational power of EGEE is primarily targeted at e-science. Along this line, we participated to a most visible study driven by INSERM U525, concerning the identification of gene clusters related to coronary artery disease (38); we also launched an interdisciplinary project aimed at e-science (DEMAIN, des Données Massives aux Interpretations) in collaboration with several Labs within Paris Sud. Our long collaboration with the Laboratoire de l'Accélérateur Linéaire (CNRS-IN2P3), and specifically with the statistical machine learning group⁶ headed by Balázs Kégl led to proposing a pluri-disciplinary *Data Science Institute* at the crossroad of Computer Science, Mathematics and Physics, supported by the Digi-Cosme, Jacques Hadamard and P2IO Labexes, and gathering ML groups from 19 Labs in Paris-Saclay partner institutes.

Last but not least, an emerging research question examined by the BIG SIG regards the design of new ML criteria and methodologies suited to massively distributed architectures, in cooperation with the SCO and MAB SIGs (FUI TIMCO, started end 2012).

⁴<http://www.grid-observatory.org/>

⁵See also X. Zhang, C. Furtlehner, C. Germain-Renaud, and M. Sebag, "Data Stream Clustering with Affinity Propagation", to appear in *IEEE Transactions on Knowledge and Data Engineering*, 2013.

⁶All members of the AppStat group in LAL are associated members of A & O.

Collaborations

Participation to national and international collaborative research projects

- LOGIMA (ANR 2012-2016) coord. C. Hudelot (ECP). ECP, LTCI, LRI
- NUMBBO (ANR 2012-2016) coord. A. Auger (INRIA) INRIA Saclay, INRIA Lille, Ecole des Mines de St. Etienne, TU Dortmund, Czech Technical University.
- OMD2 (ANR 2009-2013) coord. RENAULT. SMEs: CD-adapco, SIREHNA, ACTIVEEON; Academic: INRIA, ENSM-SE, UTC, ECP, IRCCyN, ENS CACHAN; consortium DIGITEO.
- TRAVESTI (ANR 2009-2012). coord. Lasgouttes. INRIA Saclay, INRIA Rocquencourt, Lab of Transportation Economics, Robotics lab of Mines Paris.
- INNOV'NATION (INRIA, 2009-2011). INRIA-Saclay, CEA-LIST.
- EGEE-III (FP7 2008-2010). coord. CERN; LAL, LRI, + 42 partners.
- PPF DEMAÏN (U. Paris-Sud 2006-2009) coord. C. Germain. LRI, LAL, Lab. Maths, IBBMC, LIMSI, L2S.
- Neurolog (ANR 2006-2008) I3S - Rainbow, Grenoble Institut des Neurosciences (GIN), Visioscopie, LARIA, Business Objects, IRISA, Visages, INRIA, Asclépios, LRI, IFR 49.
- SIMINOLE (ANR 2010-2013) coord. B. Kégl. LAL, LRI, LTCI.
- ASAP (ANR 2009-2012), coord. A. Rakotomamonjy. INSA-Rouen, LRI, Paris-6, U. Marseille.
- DESCARWIN (ANR 2009-2012), coord. P. Savéant. Thalès, INRIA-Saclay, Onera.
- EvoTest (STREP 2006-2008), coord. Instituto Tecnológico de Informática (Valencia, Spain), Daimler Chrysler (Berlin, Germany), Fraunhofer FIRST (Berlin, Germany), INRIA (Paris, France), Kings College (London, UK), Berner& Mattner (Berlin, Germany), RILA (Sofia, Bulgaria), EUR (Greece)
- Gennetec (STREP 2006-2008). coord. F. Képès. ECP, CNRS, INRIA, ICTP (It), ISI (It), IST (Port.), NorayBio
- Grid Observatory (U. Paris-Sud). coord. C. Germain.
- SYMBRION (EU IP, 2008-2013). coord. U. Stuttgart. U. Karlsruhe, VU Amsterdam, U. Graz, ULB Belgium, UWE UK, U. Tübingen, INRIA.
- DigiBrain (Digiteo, 2007-2009), coord. M. Sebag, LRI, CEA-LIST
- Feder Jasmin (FUI, 2010-2011), coord. C. Chaplais. Dassault, CADLM, LRI.
- PASCAL (NoE, 2003-2008; 2008-2013), coord. J. Shawe-Taylor, 56 partners (2003-2008) then 17 partners (2008-2013).
- Sydinmalas (ANR-JST, 2009-2012), coord. M. Sebag. LRI, U. Kyushu, Japan.
- Unsupervised-Brain (Digiteo, 2011-2014), coord. M. Sebag. LRI, CEA-LIST.
- Nova (U. Paris-Sud), coord. N. Spyrtatos.
- Citines (STREP, 2011-2014). SME Artelys, Austrian Institute of Technology, TUPRAS (Turkey), MUNICIPALITY OF CESENA (ITALY), Emilia-Romagna Development Agency, INESC PORTO, INRIA-Saclay, Schneider, Armines, Bologna.
- IOMCA (ANR, 2010-2013). Artelys, INRIA-Saclay.
- MASH (STREP, 2010-2014). coord. F. Fleuret. IDIAP, INRIA-Saclay, U. Postdam, Weierstrass Institute Berlin.
- ADAPT (joint project Microsoft-INRIA, 2008-2012). coord. M. Schoenauer & Y. Hamadi. INRIA-Saclay, MSR-Cambridge.

Collaborations with other laboratories

- Laval University at Quebec: (96) optimizes low-discrepancy sequences using Evolutionary Algorithms.
- CISUC, University of Coimbra, Portugal. Multi-agent systems for Social Modelling (217, 232).
- CS Department, University of Sao Paolo, Brazil. Multi-agent systems for Social Modelling (301).
- Maastricht University, Dept. of Knowledge Engineering (83) on computer Go.
- SPIRAL team, Carnegie Mellon University, Pittsburg: applications of UCT to the spiral library (95).
- National University of Tainan (NUTN, Taiwan): computer Go (29).
- IST Lisboa, within GENNETEC project: 1 month visit of Daniele Muraro at TAO, working on multi-objective system identification for a GRN model (234).
- ETH Zürich, Switzerland, SOP group headed by Eckart Zitzler (62, 3, 61, 60).
- Vrije Universiteit Amsterdam (206): self-adaptive autonomous robot, within Symbion project.
- Dalhousie University, Halifax, Canada: (56) considers a new constraint handling mechanism in evolution strategies.
- Imperial College London: monitoring and modeling EGEE (253)
- TU Dresden, Germany. Felix Distel: (168)
- Phillips Medisys, France. Olivier Nempont: (30)
- Memorial University, Newfoundland - Prof. W. Banzhaf (306) on GRN for Control.
- U. Iceland, T.P. Runarsson (322): using MCTS within Pilot algorithms for scheduling problems.

- KTH, Stockholm, Sweden, Prof. C. Schulte (289): using MCTS within Gecode, a generic CP solver.
- NUTN (National University of Tainan, Taiwan): O. Teytaud was invited for 1 year, several papers were written.

Visits to and from International Teams

- Pr Darrell Whitley (Chair of the Department of Computer Science at Colorado State University) visited us in 2010 for 2 months.
- Pr. Wolfgang Banzhaf (head of the Department of Computer Science of Memorial University of Newfoundland) visited us in 2010 for 1 month; Marc Schoenauer (1 week) and Miguel Nicolau (1 month) visited him in 2011 (306).
- Thomas Runarsson (U. Iceland) visited us for one month in Fall 2012 (322).
- Christian Schulte (KTH Stockholm, Sweden) visited us for 1 week in Fall 2012 (289).
- J.-C. Régin, U. Nice, visited us in 2013 and gave a talk (Machine Learning applied to Constraint Satisfaction).
- S. Epstein, Hunter College, Department of Computer Science N-Y, visited us in 2013 and gave a talk about Hyper-Parameter Optimization.

Other Collaborations

Participation to national and international networks

- NoE Pascal: M. Sebag, member of the steering committee 2005-2013.
- Eur. Steering Committee on Machine Learning and Data Mining: M. Sebag, member (2010-)
- EGEE-III, Networking Activity Application Identification and Support: C. Germain, member of the Steering Committee (2008-2010).

Participation to “investissement d’avenir” program

- Labex DigiCosme, members of the Executive Committee: M. Sebag, head of the DataSense programme; Marc Schoenauer, chair of the Research Committee.
- Sénat Université Paris-Saclay: M. Sebag, senator.

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Volunteer Professional Service

Management Positions in Scientific Organisations

International

- THRaSH, *Theory of Randomized Search Heuristics workshop*: Anne Auger, member of Steering Committee
- EGEE, Enabling Grids for E-Science : Cécile Germain-Renaud member of the NA4 steering committee, and head of the Grid Observatory cluster (2008-2010).
- ACM SIGEVO (Special Interest Group on Evolutionary Computation), Marc Schoenauer, Executive Board Member since 2000, member of Business Committee (2011-2013), SIG Secretary since 2012.
- Parallel Problem Solving from Nature: Marc Schoenauer, Member of Steering Committee, (since 1998).
- PASCAL NoE (Pattern Analysis, Statistical modelling, Computational Learning), Michele Sebag, member of the Steering Committee (PASCAL 2004-2008; PASCAL2, 2009-2013).
- European Machine Learning and Knowledge Discovery from Databases Steering Committee, Michèle Sebag, member since 2010;

National

- Cécile Germain-Renaud, présidente du groupe thématique *Sciences de l’ingénieur et informatique* de l’exercice national de prospective sur les grilles de production. Whitepaper: <http://www.idgrilles.fr/IMG/pdf/livreBlancecran.pdf>.

- Michèle Sebag, member of the CoNRS; Senior Advisory Board CHIST-ERA; member of the CSFRS (Conseil Supérieur de la Formation et Recherche Stratégique);
- AFIA – Association Française pour l’Intelligence Artificielle: Michèle Sebag, president, (2004-2010), Marc Schoenauer, member of Executive Committee.
- EA – Association Evolution Artificielle: Marc Schoenauer, founding president and member of Executive Committee (1994-2002), now member of Advisory Committee. Anne Auger and Nicolas Bredèche, members of Executive Committee (2008-).
- SimTools Network (RNSC Network). Philippe Caillou, coordinator (2011-).

Université Paris-Sud

- Jamal Atif, “Directeur d’études” at Computer Science department of IUT d’Orsay ; membre de la CCSU 27 (membre du Bureau) (2012-) ; membre élu au conseil d’Institut, IUT d’Orsay ; membre du Bureau du département Informatique de l’IUT d’Orsay (2011-) ; correspondant évaluation des enseignement du département Informatique de l’IUT d’Orsay (2011-2012)
- Anne Auger, membre du Conseil du Laboratoire de Recherche en Informatique (2012-) ;
- Nicolas Bredèche, membre du Conseil du Laboratoire de Recherche en Informatique (2004-2012); membre de la Commission de Spécialistes du Département d’Informatique (2003-2009).
- Philippe Caillou, coordinateur de formation continue à l’IUT de Sceaux (2009-)
- Cécile Germain-Renaud, membre élue du Conseil de l’UFR de Sciences (2007-) et membre du Bureau (2010-)
- Michèle Sebag, membre du Conseil du Laboratoire de Recherche en Informatique (2004-) ; membre de la Commission de Spécialistes du Département d’Informatique (2003-2008).
- Olivier Teytaud, représentant des B pour le comité d’évaluation du LRI.

INRIA Saclay

- Anne Auger, membre de la Commission de Suivi Doctoral ; représentante du centre de Saclay à la Commission des Jeunes Chercheurs.
- Marc Schoenauer, président de la Commission Scientifique (2008-2010), puis Délégué Scientifique (2010-).
- Olivier Teytaud, représentant CUMI (2008-).

Organisation of Conferences and Scientific Events

International conferences

- ECML-PKDD 2010 (European Conference on Machine Learning – Principles and Practice of Knowledge Discovery in Databases). Michèle Sebag, co-programme chair with F. Bonchi, J. Balcazar and A. Gionis.
- LION’6 conference (Learning and Intelligent OptimizatiON) in Paris, January 2012. Marc Schoenauer, co-programme chair with Youssef Hamadi (MSR Cambridge).

International workshops

- *BBOB Black-Box Optimization Benchmarking* workshop at the ACM GECCO Genetic and Evolutionary Computation Conference 2009, 2010, 2012 and 2013. Anne Auger, Nikolaus Hansen, Raymond Ros, Marc Schoenauer, co-organizers.
- *IROS workshop on exploring new horizons in Evolutionary Design of Robots*, Nicolas Bredeche co-organizer, 2009.
- *Grid Observatory session at EGEE’09*, 2009. Cécile Germain-Renaud, organizer
- *Grids Meet Autonomic Computing Workshop (GMAC)*, at the 6th and 7th IEEE International Conferences on Autonomic Computing. Proceedings published by ACM. Cécile Germain-Renaud, organizer, 2009 and 2010.
- International Workshop on LEarning and data Mining in Robotic (LEMIR) at ECML PKDD, 2009; and LEMIR-II at ECML PKDD 2010; M. Sebag co-organizer with Einoshin Suzuki, U. Kyushu.
- ThRaSH 2010 – 4th workshop on “Theory of randomized search heuristics”, March 2010. Anne Auger, Dimo Brockhoff, Nikolaus Hansen, Olivier Teytaud, co-organizers.
- Dagstuhl Seminar *Theory of Evolutionary Computation*, Anne Auger, co-organizer, 2010.
- Computer Science session at the 5th EGEE User Forum, Uppsala, April 2010. Cécile Germain-Renaud co-organizer.
- Monitoring the Infrastructure session at the 1st EGI Technical Forum, Amsterdam, September 2010. Cécile Germain-Renaud co-organizer.
- PPSN Workshop *Self-tuning, self-configuring and self-generating search heuristics (Self* 2010)*, Marc Schoenauer, co-organizer with G. Ochoa, U. Nottingham).
- DevLeaNN workshop 2010, a two-day workshop on Development and Learning in Artificial Neural Networks, Paris, France. Nicolas Bredèche, co-organizer.
- International Workshop on LEarning and data Mining for Robots (LEMIR) at IEEE-Int. Conf. on Data Mining, Vancouver dec. 2011. Michèle Sebag, co-organizer with Einoshin Suzuki, U. Kyushu.

- Dagstuhl Seminar 13271 *Theory of Evolutionary Algorithms*, 2013: Nikolaus Hansen, co-organizer.
- Taiwanese Forum (<http://top.twman.org/2012frtw>) for developing collaborations between European and Taiwanese experts of energy management. Olivier Teytaud, co-organizer.

National workshops

- *Journée thématique JET*, Nicolas Bredèche, co-organizer, 2009.
- Colloque Interfaces Recherche en grilles et Grilles de production (<http://graal.ens-lyon.fr/~desprez/FILES/ProdRech.html>), Cécile Germain-Renaud, co-organizer, 2009.
- Apprenteo, Machine Learning Group in Digiteo, Michèle Sebag, animatrice, 2006- .
- RTE workshop, a one-day RFIA associated workshop on Reasoning on Space and Time. Jamal Atif, co-organizer.
- One-day interdisciplinary workshop <https://who.rocq.inria.fr/Jean-Marc.Lasgouttes/workshop/> on Information processing in complex systems with applications to traffic forecasting at Inria place d'Italie in Paris. Cyril Furtlehner, co-organizer.

Participation to conference organization

- IEEE-CEC (Congress on Evolutionary Computation) 2011, New-Orleans, USA. Marc Schoenauer, *Invited Speaker* co-Chair.
- ACM-GECCO 2012. Anne Auger, Proceedings chair.
- ACM-GECCO 2012. Nicolas Bredèche, co-chair of the ALIFE track.
- ECAI 2012 European Conference on Artificial Intelligence (Montpellier, August 2012); Michèle Sebag, Workshop Chair.

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Honors

- Yann Ollivier, Médaille de bronze du CNRS, 2011;
- Michèle Sebag, ECCAI Fellow, 2011;
- Marc Schoenauer, Honorary Adjunct Professor, School of Computer Science, University of Adelaide, Australia (2009-2015).

Prizes and Awards

- Mogo, developed by the team with collaborations in Amsterdam and Taiwan, has been during the evaluation period the first ever Go program to win a human professional player in non-blitz even game (9x9 Go, 5th Dan pro, Paris 2008); a human professional player in 19x19 Go, handicap 9 (US Open, Portland, 2008). With the first (and only) win as black in 9x9 Go against a top professional player (in Taipei, 2009), the first (and only) win with H7 against a top professional player (in Tainan 2009), and the first (and only) win with H6 against a pro (in Tainan, 2009).
MoGo and its branch MoGoTW (joint work with the national university of Tainan (281)) still are among the best computer-Go players. MogoTW won the gold medal in 9x9, in 13x13 and in 19x19 Go in the TAAI computer-Go competition in 2010.
Olivier Teytaud and several members of A & O were awarded the ChessBase award in 2010.
- Alvaro Fialho and co-authors won the Best Paper Award at LION'09 conference in January 2009 (238).
- Miguel Nicolau, Marc Schoenauer, and their co-authors from the GENNETEC project won the Best Paper Award at the EvoBIO'09 conference in April 2009 (234).
- Olivier Teytaud, together with F.-M. De Rainville, C. Gagné, and D. Laurendeau (U. Laval, Québec): best paper award in the "Real World Application" track at the ACM-GECCO 2009 (96).
- Jacques Bibai and Marc Schoenauer, together with Pierre Savéant and Vincent Vidal: Silver Medal at the ACM-GECCO 2010 Humies Award (Human-Competitive Results using Evolutionary Computation), for their work on Satisficing AI Planning.
- Nikolaus Hansen, together with D. Arnold: Best paper award in the ES-EP track at the ACM-GECCO 2010 (57).

Keynote Addresses

International

- Marc Schoenauer,
 - *Genetic Programming in Theory and Practice*, May 2008: Crossing the Chasm - Lessons from the continuous case.
 - *8th International Symposium on Experimental Algorithms, Dortmund, 2009: Experimental Comparisons of Derivative Free Optimization Algorithms*.
- Michèle Sebag:
 - *IEEE Forum on Data Mining, Hong-Kong 2008: Which Parameters/Algorithm/System should I use?*
 - *COE Program for Next Generation Information Technology, Sapporo, 22/01/09, Toward Autonomic Computational Systems*
 - *Eur. Conf. on Complex Systems'09, Warwick, 22/09/2009, Self Organization and Learning in Cellular Robotics*
 - *22th International Conference on Tools with Artificial Intelligence (ICTAI 2010): Self-driven rewards for an autonomous robot: An information theoretic approach*.
 - *Second International Conference of Soft Computing and Pattern Recognition (SoCPaR 2010): SpikeAnts: A Spiking Neuron Net modelling the Division of Labor in an Ant Colony*.
 - *36th Annual Conference of the German Classification Society Hildesheim, 2012*.
 - *Turing's heritage session at ECAI 2012, Montpellier 2012. August 27-31, 2012*.
- Olivier Teytaud:
 - *TAAI 2010: Monte-Carlo Tree Search, applications to Computer-Go and Beyond*.
 - *National Center for High-Performance Computing, Taiwan 2010: Artificial Intelligence and Optimization with Parallelism*.
 - *MCTS workshop 2010 of the "AI and Games" network, London*.
- Nikolaus Hansen, invited talk at the PPSN Workshop *Self-tuning, self-configuring and self-generating search heuristics (Self* 2010)*.

France

- Michèle Sebag, *4th Franco-Japanese Wkshop, Paris 2008: Data Streaming with Affinity Propagation*
- Marc Schoenauer, *Modelling, Computation and Optimization in Information Systems and Management Sciences (MCO'08), Metz, September 2008. Bio-inspired algorithms for continuous optimization: the Coming of Age*.
- Marc Schoenauer, *Journées FREMIT, Toulouse, décembre 2008: Stratégies d'évolution + adaptation de la matrice de covariance = des stratégies gagnantes pour l'optimisation continue sans contraintes*.
- Olivier Teytaud, *Journée Digiteo, Paris 2008*.
- Marc Schoenauer, *ArchiLab, Orléans, 19/11/2009 Les algorithmes évolutionnaires, outils de créativité artificielle ?*
- Anne Auger, *Workshop on Advanced Methods and Perspective in Nonlinear Optimization and Control, Toulouse February 2010*.

Other Honors

Invited talks

- Anne Auger: GECCO 2012 Tutorial, LION 2012 Tutorial, CMAP Seminar (2012)
- Cyril Furtlehner: 4th YSM-SPIP workshop in Sendai, 2012.
- Yann Ollivier: in 2012,
 - Oxford (probability and statistics seminar),
 - Orsay (probability and statistics seminar),
 - IRCAM (information geometry seminar).
- Marc Schoenauer:
 - EVOLVE, 3rd conference, Luxembourg (May 2011).

- 18th CREST Open Workshop, *Managing and Optimising Multiplicity Computing*, UCL, London, UK, 22-23 March 2012;
- Complex Adaptive Systems Laboratory seminar, University College Dublin, Ireland, 25 May 2012;
- ECODAM, Doctoral Summer School on Evolutionary Computation and Data Mining, Faculty of Informatics, Iasi University, Romania, 18-23 June 2012;
- Séminaire du département de génie de la production automatisée, Ecole Supérieure de Technologie, Montreal, Canada, 7 Dec. 2012.
- Michèle Sebag:
 - *Women in ML workshop at NIPS 2009*, Vancouver, 7/12/09, Pro-Active Challenges
 - *Planning to Learn Workshop at ECAI*, Lisboa 2010);
 - KAUST, Saudi Arabia (Feb. 2011);
 - U. Zurich, Switzerland (March 2011);
 - U. York, UK (Nov. 2011);
 - Spring Workshop on Mining and Learning; at Traben-Farbach 2008 and Bad Neuenahr, 2012.
 - Sixth "Starting Artificial Intelligence Research" Symposium, August 27, 2012.
 - Invited tutorial, International Summer School on Resource-aware Machine Learning, Dortmund, Germany, Sept. 4-7, 2012.
 - Invited tutorial, Constraint Programming 2012, Québec, Canada, Oct. 8-12, 2012.
- Olivier Teytaud:
 - invited in several universities in Taiwan during his one-year stay in 2011-2012: Kaohsiung NUK; Hsinchu NDHU; Hsinchu NCTU; Hualien NDHU; Tainan NUTN.
 - Bielefeld "search methodologies" seminar 2012 (<http://www.math.uni-bielefeld.de/ahlsweide/zif/2012/final2.pdf> booklet).
 - "Unexpected Results" workshop at ECML-PKDD, Sept. 2012.

Invitations

- Olivier Teytaud (CR1) is invited researcher in NUTN (National University of Tainan, Taiwan) for one year in 2011.
- Adrien Couëtoux (ph.D. student): NUTN (National University of Tainan, Taiwan) for 6 months in 2011.
- Jérémie Decock (ph.D. student): NUTN (National University of Tainan, Taiwan) for 5 months in 2011.
- Jean-Baptiste Hooch (ph.D. student): Univ. Potsdam (October 2011) for the Mash project in 2011 (12 days).

Evaluation of Research

Editorial Boards

International

- ECJ, *Evolutionary Computation*, MIT Press: M. Schoenauer (Editor in Chief, 2002-), A. Auger (Editorial Board, elected in 2009), N. Hansen (Editorial Board, elected in 2009)
- GPEM, *Genetic Programming and Evolvable Machines*, Springer: M. Schoenauer and M. Sebag (Associate Editors, 2000-)
- MLJ, *Machine Learning Journal*, Springer: M. Sebag (Editorial Board, 2002-2008)
- ASOC, *Applied Soft Computing*, Elsevier: M. Schoenauer (Editorial Board, 2000-)
- *Natural Computing Series*, Springer Verlag: M. Schoenauer (Editorial Board)
- JoGC, *Journal of Grid Computing*, special issue EGEE applications and supporting grid technologies, 8:2, 2010: C. Germain
- JMLR (Journal of Machine Learning Research), O. Teytaud action editor, 2013.

National

Program Committees

Chair

- ECML/PKDD, *European Conference on Machine Learning / Practice of Knowledge Discovery in Databases*, Europe: M. Sebag, Area Chair (2008), Program co-Chair (2010)
- KDD, *Knowledge Discovery from Databases*: M. Sebag, Area Chair (2008, 2009)
- ICML, *International Conference on Machine Learning*: M. Sebag, area Chair (2008, 2009),
- ACML, *Asian Conference on Machine Learning*: M. Sebag, area Chair (2009),
- GMAC, *Grids Meet Autonomic Computing Workshop*: C. Germain-Renaud, Chair (2009, 2010).

Member (international events)

- J. Atif regular reviewer for Information sciences, Fuzzy Sets and Systems and occasional reviewer for SIAM on Imaging Sciences, IEEE Transactions on Fuzzy Systems, etc.
- Nicolas Bredeche: GECCO 2011, RIVF 2011, EuroGP 2011, Evostar 2012, Evorobot 2012, CEC 2012, SAB 2012.
- Philippe Caillou: EPIA 2011, V2CS 2011
- Cécile Germain-Renaud: IEEE/ACM Cluster, Cloud and Grid Computing (CCGRID) since 2009; Utility Cloud Computing (UCC) since 2011; IFIP International Conference on Network and Parallel Computing since 2005; SP Cloud workshop; EGEE/EGI user forum since 2008.
- Nikolaus Hansen: most of the important conferences in the area of Evolutionary Computation
- Marc Schoenauer: all important conferences in the area of Evolutionary Computation
- Michèle Sebag: all important conferences in the area of Machine Learning
- Olivier Teytaud: EvoStar, ICML, Lion, Advances in Computer Games, TAAI, STACS, TCIAIG.
- ACM-GECCO, *Genetic and Evolutionary Computation Conference*, USA: A. Auger (2006-), N. Bredèche (2006-), N. Hansen (2003-), M. Schoenauer (1999-), M. Sebag (2009-)
- ACS (Autonomic Computational Science) Workshop in conjunction with IEEE/ACM Grid2010: C. Germain (2010)
- CCGRID IEEE/ACM (Cloud, Cluster and Grid Computing): C. Germain (2009-)
- EGEE UF, *EGEE User Forum*: C. Germain (2007-2010)
- EGI TF, *EGI Technical Forum*: C. Germain (2010)
- EvoStar, *Series of Conferences and Workshops in Evolutionary Computation*: M. Schoenauer (1998-), N. Bredèche (2006-), N. Hansen (2008-), A. Auger (2008-), M. Sebag (2009-)
- ESANN, *European Symposium on Artificial Neural Networks*: H. Paugam-Moisy (1994-)
- FOGA, *Foundations of Genetic Algorithms*: A. Auger (2004-), M. Schoenauer (1996-)
- IEEE-CEC, *Congress on Evolutionary Computation*: A. Auger (2006-), N. Hansen (2005-), M. Schoenauer (1999-), O. Teytaud (2005-)
- IPL, *Information Processing Letters*: O. Teytaud (2009)

- ICML, *International Conference on Machine Learning*: H.Paugam-Moisy (2009), O. Teytaud (2009)
- ICML, *International Conference on Machine Learning*: M. Schoenauer(2010)
- IJCNN, *IEEE-INNS International Joint Conference on Neural Networks*: H.Paugam-Moisy (2006-)
- ILP, *Inductive Logic Programming*: M. Sebag (2003-)
- LION (Learning and Intelligent Optimization: M. Schoenauer (2006-), O. Teytaud (2009)
- NIPS, *Neural Information Processing Systems*: M. Sebag (2008-), O. Teytaud (2009)
- NPC, *IFIP Network and Parallel Computing*: C. Germain (2007-)
- PPSN, *Parallel Problem Solving from Nature*: A. Auger (2008-), N. Hansen (2004-), M. Schoenauer (1994-), M. Sebag (1996-), O. Teytaud (2008-).
- SAB, *International Conference on Simulation of Adaptive Behavior*: N. Bredèche (2010)
- UCC, *6th IEEE/ACM International Conference on Utility and Cloud Computing*, Dresden, Germany: Cécile Germain (2013)
- Resilience, *6th Workshop on Resiliency in High Performance Computing (Resilience) in Clusters, Clouds, and Grids*, Aachen, Germany: Cécile Germain (2013)
- EPIA, *16th Portuguese conference of Artificial Intelligence*, Angra do Heroísmo, Portugal: Philippe Caillou (2013)

Member (national events)

- SFC, *Société Française de Classification*: M. Sebag (2009).
- EA, *Evolution Artificielle* (national conference with international Program Committee and international audience): A. Auger (2005-), N. Bredèche (2005-), N. Hansen (2007-), M. Schoenauer (1994-), M. Sebag (1994-), O. Teytaud (2005-)
- NeuroComp, *Conférence plénière française de Neurosciences Computationnelles*: H. Paugam-Moisy (2006-2009)
- CAP, *Conférence d'Apprentissage*: H. Paugam-Moisy (2010), M. Sebag (1999-), O. Teytaud (2005-)
- RFIA, *Reconnaissance des Formes et Intelligence Artificielle*: M. Sebag, comité éditorial (2004-)
- JFPDA, Olivier Teytaud, 2013.

Evaluation Committees and Invited Expertise

International

- European Commission (FP7 projects), EU: M. Schoenauer (STREP PERPLEXUS) (2009-2011);
- Irish Science Foundation: Marc Schoenauer, External expert for a 4 years project (2009 and 2013)
- Swiss Science Fund: Marc Schoenauer (2009)
- ERC Starting Grants, Marc Schoenauer (2009-2013)
- ERC Starting Grants, Michèle Sebag (2009-2013)
- FNRS (Belgium), Michèle Sebag (2009)
- NSWO (Netherlands), Michèle Sebag (2009)
- FP7 Marie Curie IEF-IIF-IOF, Europe: Germain (2012-)
- ICT call FP7-ICT-2013-10 (STREP), Europe: Germain (2012-)

National

- ANR SYSCOMM (Complex Systems and Mathematical Modeling): Marc Schoenauer, Président du Comité d'Évaluation, 2009 and 2010.
- AERES: Michèle Sebag, chair of the evaluation committee of UBIA, INRA, Toulouse, 2009; member of the evaluation committee of CEMAGREF Clermont-Ferrand, 2011.
- Commission de sélection *Problématiques informatiques intégrant l'aléatoire* at Rennes 1 University (Professorship), Marc Schoenauer, 2010.
- Research projects for Région des Pays de la Loire: Marc Schoenauer, 2010.
- Commission de sélection, Michèle Sebag: INSA Rouen (professorship, 2013); Telecom-Paris Tech (MdC, 2013); U. Paris-Diderot (MdC, 2012); INRIA-Lille (CR, 2013; 2011).

Other evaluation activities

- All team members have reviewed numerous PhD (and HDR) dissertations.
- CIFRE PhD grants: Germain (2013)

Interactions with the social, economic and cultural environment

- Ilab Metis: collaboration with Artelys (www.artelys.com); stochastic sequential decision making; optimization of power systems. <http://www.lri.fr/~teytaud/ilab.html>. Contact: O. Teytaud.
- Organization of the visit of a Taiwanese delegation, about power systems and eLearning mainly; more information at <http://www.lri.fr/~teytaud/france2013.html>. Contact: O. Teytaud.
- March 2013: visit at Taiwan around power systems; meeting companies and universities. Contact: O. Teytaud.
- Virtual Data Center in Univ. Paris-Sud. Joint initiative Lab. Accélérateur Linéaire & LRI, Cécile Germain.
- Innov'Nation: Serious games for participative ideation (Appel Offre Ministère de l'Economie Numérique, 2011-2012. Coll.: SMEs BlueNove & ParaSchool; CEA).
- MoGo has been invited in many demonstrations: e.g. in Taiwan, Sciences En Fête in France, games in Clermont-Ferrand, Rennes, Toulouse, games in the US Open of Go, tournoi de Paris, Jeju's Island computer-Go competition, Taipei's invited games.

Popularisation of Research Results

- The collection of Chairs, designed within a collaboration between TAO and with the architect consortium ECZT, were exhibited from April 2007 until April 2009 in the permanent Design Collection of Beaubourg, the French National Modern Art Museum (<http://www.inria.fr/saclay/resources/computer-culture/a-rt-lgorithm-design-informed-by-mathematics>).
- MoGo (computer-go tool) was exhibited
 - Taiwan invited games.
 - Jeju's computer Go event (Korea, 2009).
 - Events in France: Rennes, Toulouse (2009).
 - Cadiz Go tournament, 2009.
 - Taipei's computer Go event, 2009.
 - Alternative party in Finland, 2009.
- Mogo's successes also reported in many newspapers, in Europe, United States and Asia (see <http://www.lri.fr/~teytaud/mogo.html>).
- Sciences en Fête 2009: Olivier Teytaud in the LRI (Computer Go) and Nicolas Bredeche, Jean-Marc Montanier, Pierre Delarboulas (Learning Robots).
- Popularization around artificial intelligence in 3 schools, Olivier Teytaud (see <http://www.lri.fr/~teytaud/sef.pdf>).
- Sciences en Fête 2010 at LRI: Olivier Teytaud (Computer Go) and Nicolas Bredèche, Jean-Marc Montanier (Learning Robots).
- Olivier Teytaud has written a popularization paper on Chess algorithms at http://interstices.info/jcms/int_70460/programmation-des-echecs-et-dautres-jeux in Interstices.
- We made two demonstrations, in Taiwan, of parallel automatic player evaluation; the events were advertised in general audience newspapers (see MoGo Web page at <http://www.lri.fr/~teytaud/mogo.html>. Our Taiwanese partner has a motivation around PISA (international student assessment) and eTeaching.
- We also made in Brisbane a general audience demonstration of games against humans, with 7 wins out of 12 against professional players in fair games in 7x7 (see again MoGo Web page at <http://www.lri.fr/~teytaud/mogo.html>).
- Yann Ollivier organizes a bi-monthly math seminar for undergrad students on Saturdays at Institut Henri Poincaré (together with X. Caruso, I. Kortchemski, R. Mansuy and A. Tavenaux), with 100+ participants at each session.
- Yann Ollivier takes part in the organization of the European Union Contest for Young Scientists (science fair for high school students from 30+ countries organized by the European Commission).
- Yann Ollivier belongs to the scientific steering committee for the elaboration of a brochure *L'explosion des mathématiques* presenting a wide range of applications of mathematics, edited by the SMF and SMAI.
- Philippe Caillou was a teacher at the GAMA Winter School in Can Tho (Vietnam) in November 2012. The winter school objective was the diffusion of multi-agent based simulation methodology with the GAMA Platform to non-computer scientist in Can Tho Biology and Environment University.
- Jamal Atif. A magazine paper on the work of Jamal Atif entitled: " Guyane : des images pour décoder le monde " appeared in "sciences actualités" the journal associated with "la Cité des sciences" in Paris: <http://www.universcience.fr/fr/science-actualites/enquete-as/wl/1248115311492/guyane-des-images-pour-decoder-le-monde/>
- Interview au Palais de la Découverte (société de production Stand Alone Media, <http://www.youtube.com/watch?v=uEW32KikKJ8>), Michele Sebag

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)

Type	Name	Managing Institution	Start / Duration	Amount
ANR	LOGIMA	Université Paris XI	10.2012 / 48 mo.	136.18 k€
ANR	ANR NUMBBO	INRIA	10.2012 / 48 mo.	289.20 k€
ANR	OMD2	INRIA	01.2009 / 42 mo.	131.45 k€
Subvention	INNOV'NATION	INRIA	11.2009 / 18 mo.	69.35 k€
ANR	TRAVESTI	INRIA	01.2009 / 36 mo.	108.70 k€
Subvention	DEEPHY	CNRS	01.2012 / 12 mo.	6.00 k€
PPF	DEMAIN	Université Paris XI	10.2006 / 36 mo.	120.00 k€
Contrat européen	EGEE III	CNRS	05.2008 / 24 mo.	45.58 k€
DIGITEO	GO	Université Paris XI	08.2008 / 24 mo.	161.69 k€
Subvention	GRILLE	CNRS	01.2012 / 12 mo.	4.50 k€
Subvention	GRILLES	CNRS	01.2007 / 36 mo.	22.00 k€
Subvention	Observatoire de la Grille	CNRS	01.2008 / 24 mo.	16.00 k€
Subvention	PEPS-CGO	CNRS	01.2012 / 12 mo.	4.50 k€
ANR	TLOG NeuroLOG	CNRS	12.2006 / 36 mo.	21.81 k€
ANR	ANR SIMINOLE	INRIA	10.2010 / 48 mo.	222.09 k€
ANR	ASAP	INRIA	11.2009 / 36 mo.	178.00 k€
ANR	DESCARWIN	INRIA	01.2009 / 47 mo.	201.10 k€
Contrat européen	EvoTest	INRIA	09.2006 / 36 mo.	231.00 k€
Contrat européen	GENNETEC	INRIA	09.2006 / 39 mo.	379.00 k€
Contrat européen	SYMBRION	INRIA	02.2008 / 60 mo.	420.88 k€
DIGITEO	DIGIBRAIN	Université Paris XI	10.2007 / 45 mo.	48.00 k€
DIGITEO	DIM DIGIBRAIN	INRIA	10.2007 / 45 mo.	13.20 k€
Contrat européen	EGI-INSPIRE	CNRS	05.2010 / 48 mo.	42.58 k€
Region IDF	FEDER JASMIN	INRIA	12.2010 / 24 mo.	205.33 k€
Contrat européen	KDUBIQ	Université Paris XI	12.2005 / 30 mo.	12.00 k€
ANR	MISTR	CNRS	04.2005 / 36 mo.	16.00 k€
DIGITEO	MODELES SIMPLIFIES ET APPRENTISSAGE	Université Paris XI	10.2007 / 36 mo.	95.25 k€
Contrat européen	PASCAL	Université Paris XI	12.2003 / 51 mo.	137.00 k€
Contrat européen	PASCAL2	CNRS	03.2008 / 60 mo.	26.52 k€
ANR	SYDINMALAS	INRIA	01.2009 / 36 mo.	158.00 k€
DIGITEO	TecCSTES	INRIA	09.2011 / 36 mo.	102.20 k€
DIGITEO	Unsupervised-Brain	Université Paris XI	10.2011 / 36 mo.	5.00 k€

Public contracts and grants (jan 2008 - jun 2013)

Type	Name	Managing Institution	Start / Duration	Amount
Subvention	NOVA	Université Paris XI	01.2010 / 48 mo.	0.00 k€
Contrat européen	CITINES	INRIA	10.2011 / 30 mo.	84.10 k€
Subvention	I-LAB Metis	INRIA	09.2011 / 36 mo.	40.00 k€
ANR	IOMCA	INRIA	01.2010 / 36 mo.	119.60 k€
Contrat européen	MASH	INRIA	01.2010 / 42 mo.	394.51 k€

Private contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
Industriel	Adaptive Combinatorial Search	INRIA	01.2008 / 48 mo.	110.00 k€
CIFRE	CIFRE J.BIBAI	INRIA	10.2007 / 36 mo.	15.00 k€
CIFRE	CIFRE MARCEAU INRIA/THALES	INRIA	05.2011 / 36 mo.	45.00 k€
CIFRE	CIFRE/M.Yagoubi	INRIA	02.2009 / 36 mo.	45.00 k€
CIFRE	CIFRE/Z.Bouzarkouna	INRIA	12.2008 / 36 mo.	24.00 k€
Pole de competitivite	FUI CSDL	INRIA	10.2009 / 36 mo.	725.33 k€
Pole de competitivite	FUI TIMCO	INRIA	06.2012 / 36 mo.	432.14 k€
Industriel	MODYRUM	INRIA	02.2013 / 24 mo.	150.00 k€

Software Licensing and Distribution

GridObservatory - Grid Observatory

<http://www.grid-observatory.org>

Contact: GERMAIN-RENAUD

COCO - Comparing Continuous Optimizers

<http://coco.gforge.inria.fr/doku.php>

Contact: HANSEN

CMA-ES - Covariance Matrix Evolution Strategy

http://www.lri.fr/~hansen/cmaes_inmatlab.html

Contact: HANSEN

MultiBoost - MultiBoost

<http://www.multiboost.org/>

Contact: KÉGL

GUIDE - A Graphical User Interface for EA C++ library development

<http://tao.lri.fr/tiki-index.php?page=GUIDE>

Contact: SCHOENAUER

MoGo - Computer-Go program

<http://www.lri.fr/~teytaud/mogo.html>

Contact: TEYTAUD

Metis - Metis

Contact: TEYTAUD

Contributions to the GNU Scientific Library - Contributions to the GNU Scientific Library

Contact: TEYTAUD

Mash-WP6 - A stochastic dynamic programming framework

<http://opendp.sourceforge.net/wiki/>

Contact: TEYTAUD

Training and Education

Graduate Courses

- M1 Computer Science (U. Paris-Sud), Parallelisme, Cécile Germain-Renaud (approx. 50h), 2009- .
- Master 2 Recherche (U. Paris-Sud), Data Mining and Machine Learning (24 h): Michèle Sebag, Balazs Kégl, Antoine Cornuéjols, 2009.
- Master 2 Recherche (U.Paris-Sud), Artificial Evolution and Evolutionary Robotics (24 hours): Anne Auger, Nicolas Bredèche and Marc Schoenauer, 2009.
- Master 2 Recherche (U.Paris-Sud), Artificial and Natural Perception : Nicolas Bredèche (6h), 2009.
- Master 2 Recherche (U.Paris-Sud), Systèmes multi-agents : Philippe Caillou (6h), 2009.
- Master 2, (U. du Liban, Beyrouth), APprentissage et Fouille de Données (20h), 2009.
- Master 2 Recherche (U. Paris-Sud), Statistical Machine Learning and Optimization - basic course (24 h + 24h hands-on experiments): Michèle Sebag, Pierre Allegraud, Anne Auger (with François Yvon, LIMS), 2010.
- Master 2 Recherche (U. Paris-Sud), Advanced Machine Learning and Optimization (24 h): Michèle Sebag, Balazs Kégl, Anne Auger, 2010.
- Master 2 Recherche (U.Paris-Sud), Systèmes multi-agents : Philippe Caillou (18h), 2010.
- Master 2 Recherche (U.Paris-Sud), Robots et Agents Autonomes : Nicolas Bredèche (12h), 2010.
- Master 2 Recherche (U. Paris-sud), Optimisation, Anne Auger (12h), 2011- .
- Master 2 Recherche (U. Paris-Sud), Machine Learning, Michèle Sebag (24h), 2011- .
- Master 2 Recherche (U. Paris-Sud), Evolutionary Robotics, Nicolas Bredèche (15h), 2011-2012.
- Master 2 Recherche (U. Paris-Sud), Multi-Agents Systems, Philippe Caillou (27h), 2011- .
- Master 2 Recherche Paris-Dauphine, Multi-Agent Based Simulation, Philippe Caillou (3h), 2011- .
- Doctoral level : Anne Auger, 4h (Stochastic numerical optimization by Evolution Strategies) Evolution Artificielle Summer School, 2h (Covariance Matrix Adaptation Evolution Strategy - together with N. Hansen) ACM-GECCO Tutorial, 2h (CMA-ES tutorial) LION Conference invited tutorial

Undergraduate course

- Anne Auger: Ecole Centrale Paris, cours "Contrôle avancé" (part: Genetic Algorithms), (12h), 2009, 2010.
- Nicolas Bredèche: "Vie Artificielle", Université Paris-Sud, Licence 2 (50h), 2010-2011
- Nicolas Bredèche: "Robotique Autonome", Polytech 5eme année, formation continue (16h), 2010
- Nicolas Bredèche: "Intelligence Artificielle", Polytech 4eme année (15h), 2010
- Nicolas Bredèche: "IA et Jeux Vidéos", Polytech 5eme année (17h), 2010
- Jamal Atif : approx. 192h (Computer science), L1, IUT Orsay, Univ. Paris-Sud, 2010- .
- Anne Auger : 20h (Stochastic Optimization), Ecole Centrale Paris, 2011- .
- Nicolas Bredèche : approx. 80h (Artificial Life), L2, Univ. Paris-Sud, 2011-2012.
- Philippe Caillou : approx. 192h (Computer science for managers), L1, IUT Sceaux, Univ. Paris-Sud, 2011- .
- Cécile Germain-Renaud : approx. 120h (Computer Architecture, head of Licence) L2, L3, Polytech, Univ. Paris-Sud, 2009- .
- Michèle Sebag: Approx. 24h (Introduction to Machine Learning), L3 ENS-Cachan, 2011- .

Other research-related teaching activities

At Ecole Polytechnique:

- Majeure "SEISM" (Engineering Science, Grégoire Allaire): one lesson (amphi) on Evolutionary Topological Optimum Design, Marc Schoenauer, 2009, 2010;
- Majeure Combinatorial Optimization (Philippe Baptiste): one lesson (amphi) on Evolutionary Methods for Combinatorial Optimization, Marc Schoenauer, 2009, 2010;
- *Stages d'option* (internships), Michèle Sebag, 2009, 2010.

Summer schools, tutorials, invited seminars

- Anne Auger and Nikolaus Hansen, ACM GECCO Conference tutorial, Montreal, Canada, July 2009.
- Anne Auger and Nikolaus Hansen, TRSH Theory of Randomized Search Heuristics workshop tutorial, Birmingham, UK, October 2009.
- Philippe Caillou, invited talk at ICAS 09 (workshop on Activity in Simulations), Cargese, 2009.
- Anne Auger, JET Summer School, Tutorial, Porquerolles, 2009.
- Nicolas Bredeche, VU Amsterdam, seminar, February 2009.
- Nikolaus Hansen, INRIA Paris-Rocquencourt, Seminar Constraints, November 2009.
- Nikolaus Hansen, Université Paris 6, Seminar Laboratoire d'Analyse Numerique, April 2009.
- Arpad Rimmel, Bandit-based optimization on graphs with application to library performance tuning. Ecole des Mines de Paris, SMILE seminar
- Philippe Rolet, institut Henri Poincaré, "Upper Confidence Trees and Billiards for Optimal Active Learning". SMILE seminar.
- Marc Schoenauer, "Automatic Parameter Tuning", invited tutorial at First ACM Genetic and Evolutionary Summit, Shanghai, June 2009.
- Marc Schoenauer, "Bandit-based Method for Adaptive Operator Selection", Bristol Institute of Technology, University of the West of England, December 2009.
- Marc Schoenauer, École Nationale d'Architecture, Malaquais, Paris, mai 2009, *Les algorithmes évolutionnaires, outils de créativité artificielle ?*
- Michèle Sebag, U. Kyushu, Japan, Avril 2009, *Data Streaming based on Affinity Propagation, Application to Automatic Computing*.
- Olivier Teytaud, Journées "Algorithmes stochastiques", Dijon 2009 <http://math.u-bourgogne.fr/algostoc09/>: Fouille Monte-Carlo d'Arbres.
- Olivier Teytaud, Systems and Modeling Research Unit, Leuven University: Monte-Carlo Tree Search for Planning: the Game of Go and beyond.
- Olivier Teytaud, LAIC, Clermont-Ferrand: complexity and parallel complexity with oracles http://www.lri.fr/~teytaud/clermont2009_6.pdf
- Olivier Teytaud, Inria Rocquencourt, "Le modèle et l'algorithme": prise de décision séquentielle dans l'incertain. Application au jeu de Go. Video: <http://extranet.paris-rocquencourt.inria.fr/rendez-vous/modele-et-algo/prise-de-decision-sequentielle-dc>
- Olivier Teytaud, invited talk (university of Cadiz), December 2009.
- Olivier Teytaud, AHL's research department, Man Group plc, London; invited talk. December 2009. Duplex with delay to the Hong-Kong office of Man Group plc.
- Olivier Teytaud, invited talk at IEEE Fuzz special session for computer-Go, Korea 2009.
- Olivier Teytaud, invited talk at Smi 09 (mini-symposium "Recherche opérationnelle : théorie et application"). http://smi.emath.fr/smi2009/programme_detaille.php
- Anne Auger and Nikolaus Hansen, ACM GECCO Conference tutorial, Portland, USA, July 2010.
- Anne Auger, Evolution Artificielle Summer School, Advanced tutorial, Calais, June 2010.
- Marc Schoenauer, Evolution Artificielle Summer School, Introductory Tutorial, Calais, June 2010.
- Cécile Germain, panelist at ACS (Autonomic Computational Science), October 2010
- Nicolas Bredèche, Journée IA embarquée, Univ. Cergy-Pontoise, June 2010.
- Nicolas Bredèche, Séminaire LISIC, Univ. du Littoral, Calais, October 2010.
- Nicolas Bredèche, Séminaire iPAC, LORIA, Nancy, October 2010.
- Nicolas Bredèche, SMA team seminar, LIP6, June 2010.
- Nicolas Bredèche, Journée Franco-Taiwanaise de l'IA, LRI, July 2010.

Thesis

Habilitation à Diriger des Recherches

Name	Defense
Nicolas BREDECHE	12.2009
Nikolaus HANSEN	02.2010
Olivier TEYTAUD	04.2011

Defended thesis

Name	Start	Defense	Funding	Advisor
Alejandro ARBELAEZ RODRIGUEZ	12.11.2007	31.05.2011	CDD sur contrat INRIA	SEBAG
Ludovic ARNOLD	01.09.2010	19.09.2013	Alloc. Ministère	PAUGAM-MOISY (50%)
Jacques BIBAI	01.10.2007	08.10.2010	CIFRE	SCHOENAUER
Zyed BOUZARKOUNA	01.12.2008	03.04.2012	CIFRE	AUGER, SCHOENAUER
Phuong Thao CAO	18.02.2010	20.06.2013	ETR	SPYRATOS
Alexandre DEVERT	01.10.2005	05.05.2009	CDD sur contrat INRIA	BREDECHE, SCHOENAUER
Alvaro Roberto SILVESTRE FIALHO	10.10.2007	22.12.2010	CDD sur contrat INRIA	SCHOENAUER, SEBAG
Romarc GAUDEL	01.10.2006	14.12.2010	Alloc. Ministère	CORNUEJOLS, SEBAG
Cédric HARTLAND	01.10.2005	16.11.2009	Alloc. Ministère	BREDECHE, SEBAG
jean-Baptiste HOOCK	01.11.2009	14.04.2013	CDD sur contrat INRIA	TEYTAUD
Mohamed JEBALIA	01.09.2004	19.12.2008	ETR-EGIDE	AUGER, SCHOENAUER
Fei JIANG	01.11.2006	16.12.2009	CDD sur contrat INRIA	SCHOENAUER (50%)
Anh-Tuan LY	01.10.2009	08.07.2013	Bourse France-Vietnam "Sandwich"	SPYRATOS
Ilya LOSHCHIOV	01.09.2009	08.01.2013	CDD sur contrat INRIA	SCHOENAUER, SEBAG
Jean-Marc MONTANIER	01.10.2009	01.03.2013	Alloc. Ministère	BREDECHE
Julien PEREZ	01.10.2006	17.09.2010	Alloc. Ministère	GERMAIN-RENAUD
Arpad RIMMEL	01.10.2006	15.12.2009	Alloc. Ministère	CORNUEJOLS, TEYTAUD
Philippe ROLET	01.12.2007	22.12.2010	Digiteo	SEBAG, TEYTAUD
Raymond ROS	01.10.2005	21.12.2009	Alloc. Ministère	HANSEN, SEBAG
Fabien TEYTAUD	01.09.2008	08.12.2011	Alloc. Ministère	SCHOENAUER, TEYTAUD
Mouadh YAGOUBI	09.02.2009	03.07.2012	CIFRE	SCHOENAUER
Jitao YANG	1.09.2008	05.06.2012	China Schol. Council	SPYRATOS
Xiangliang ZHANG	01.09.2006	28.07.2010	CDD sur contrat INRIA	GERMAIN-RENAUD, SEBAG

Thesis in progress

Name	Start	Funding	Advisor
Ouassim AIT ELHARA	01.10.2012	Alloc. Ministère	AUGER, HANSEN
Riad AKROUR	01.11.2010	CDD sur contrat INRIA	SEBAG (50%)
Jérémy BENSADON	01.10.2012	Alloc. Ministère	OLLIVIER
Marie-Liesse CAUWET	01.09.2013	CDD sur contrat INRIA	TEYTAUD
Alexandre CHOTARD	01.10.2011	Alloc. Ministère	AUGER, HANSEN
Adrien COUETOX	01.09.2010	CDD sur contrat INRIA	TEYTAUD
Jérémie DECOCK	03.10.2011	CDD sur contrat INRIA	TEYTAUD
Davei FENG	01.10.2010	ETR	GERMAIN-RENAUD
Nicolas GALICHET	01.10.2011	Alloc. Ministère	SEBAG
Yoann ISAAC	01.10.2011	CDD sur contrat	SEBAG (50%)
Jialin LIU	14.03.2013	CDD sur contrat INRIA	SCHOENAUER, TEYTAUD
Gaetan MARCEAU CARON	14.12.2010	CIFRE	SCHOENAUER
Weija WANG	01.10.2010	Alloc. Ministère	SEBAG
Guohua ZHANG	01.09.2011	ETR	SEBAG (50%)

Self Assessment

A unique specificity of Apprentissage & Optimisation is the diversity of its scientific background: from maths to statistical physics to computer science, from high performance computing to numerical engineering. This diversity is at the core of most A & O achievements and specifically our internationally visible outcomes in the 2008-2013 period:

MoGo and MoGoTW remain among the world leading programs in computer-Go. Games, and particularly the game of Go, epitomize the problem of sequential decision making under uncertainty in large state-action spaces. The extension of the MCTS approach pioneered in MoGo, to policy learning is at the forefront of our research plan, with applications to optimal energy management.

MCTS also led to some breakthroughs for games such as Havannah and MineSweeper, where the combination of MCTS with constraint programming opens promising perspectives.

CMA-ES currently is acknowledged the best derivative-free continuous optimizer. From an algorithmic perspective, its performances are evidenced from academic benchmarks and industrial applications (7 PhDs directly or indirectly funded by industry in the period). In the meanwhile, its theoretical study has made a quantum leap, analyzing the covariance matrix adaptation and the related invariance properties in terms of information geometric optimization and natural gradient.

These major advances, only made possible by the high diversity and quality of A & O scientific background, significantly contribute to its attractivity for researchers and students. As this diversity might entail a risk of dispersion for A & O, the risk was mitigated by structuring the team in five special interest groups, each permanent member participating to two or three SIGs. Each SIG holds meetings on a regular basis (ranging from twice to once a month) and Apprentissage & Optimisation holds plenary seminars (usually with invited speakers) once or twice per month. Thereby PhDs and post-docs are provided the opportunity to acquire a broad scientific culture, while participating into focused and in-depth debates.

Learning lessons from our main shortcoming in the previous period⁷, we created a joint lab with the SME Artelys, in charge of the valorisation of the Metis software platform.

Due to Nicolas Bredèche's hiring as professor at ISIR (Paris-6), the robotics activity of A & O was reduced in the last year; the SYMBRION IP ends in 2013 and the ANR SyDynMaLAS ended in 2012. As the two contributions made in the period (open-ended evolution and preference-based reinforcement learning) have been well received and are already well cited by the international community, we hope that a further hiring will help resuming the A & O robotics activities, in interaction with the companion robotics group at LIMSI.

The strategy and five-year project of the A&O team can be found in Section 2.12.

Strategy and five-year project

As already mentioned, Apprentissage & Optimisation actively participated in the elaboration of Labex DigiCosme research proposal. The DataSense programme (currently led by M. Sebag) comprises machine learning and optimization as two core enabling methodologies to face the many faceted challenges of data science.

Accordingly, Apprentissage & Optimisation scientific perspectives have been partly elaborated in the context of the DigiCosme roadmap. Another motivation for thoroughly considering our research priorities is that the 12-year tenure of the TAO Inria project will end in 2014. While the exact configuration of A & O

⁷The non-valorisation of MoGo was due to the regretted lack of agreement among the organisms sharing the intellectual property rights on MoGo: CNRS, INRIA, Université Paris-Sud, Ecole Polytechnique.

after the end of TAO is not fully defined yet, A & O members wish to preserve their research interactions and resume their participating in A & O interdisciplinary environment.

The new directions for A & O rest on two main facts. Firstly, ML and Optimization increasingly face sequences of problems, whereas in the standard setting problems are solved in isolation once for all. Furthermore, in this iterative frame, the user/expert reformulates and modifies the problem setting until finding satisfactory results, because *the definition of what is a satisfactory result is unknown* to the user himself beforehand when dealing with ill-defined and open-ended problems. This frame differs from the transfer learning and domain adaptation settings in ML (which mostly palliate the lack of labelled data in the target domain by reusing data from the source domain): In transfer learning, the uncertainty refers to facts (e.g. labels of target instances). In the above iterative frame, the uncertainty refers to the goal itself. The learner-optimizer works with knowledge-bounded resources; the user/expert works with computation-bounded resources; their interaction leads to gradually make explicit the user's priors and expectations.

Secondly, the data-driven approach defines a third paradigm for knowledge building, besides the theory- and experiment-driven ones. In the domain of sciences, this new paradigm has been acknowledged under the name of e-science. In the realm of everyday life, this phenomenon takes place too, yielding individual knowledge. In the literature, such individual knowledge is often handled through aggregation, potentially raising privacy issues, and/or in a very circumscribed way (task-related personalisation). The issue is whether such individual knowledge can be understood and used in a broader way.

In these two contexts, algorithms face sequences of problems, either of same type, or related to a same user. Several milestones will be considered to tackle the long-term goal of lifelong problem solving, generalization and improvement across problems:

M1. Taking advantage of the fact that users/computing elements usually consider related families of problems, this problem distribution will be characterized with the goal of solving and *learning to better solve* problems. As an example, the overall MoGo performances have been boosted by the offline optimization of game opening libraries. In a similar spirit, the intermediate constructs of CMA-ES can be analyzed and exploited in an offline fashion, delivering e.g. an optimal control of the step size after the Kullback-Leibler distance between the successive sampling distributions.

M2. The sheer amount of data calls for new statistical and algorithmic principles, providing both scalability and confidence guarantees. The scale invariance principle will be interpreted and confronted to the bootstrap methodology. Renormalization operators are meant to enforce the result stability along a multi-scale analysis (e.g. divide and aggregate). Indeed the stability property is relevant and desirable from both theoretical and computational perspectives when facing big data. It is expected that scale invariance and more generally statistical physics tools can inspire new approaches for distributed ML and O, distributing data and aggregating partial results.

M3. It is reaffirmed that prediction and optimization must be tackled in an integrated way (e.g. the prediction goal must reflect and compensate for the decision-related cost of errors). The spirit of information geometry (invariance w.r.t. linear changes of representation; invariance w.r.t. monotone transformations of the objective function) will be reconsidered in a sequential decision perspective (additional information will be needed to order cumulative rewards).

Fundamental advances will be confronted to, and motivated by, our usual domains of application: games, energy management, autonomic computing, algorithm selection, robotics, e-science. Note that beyond their apparent diversity, all above domains face closely related challenges:

- The general goal is to model and control a complex system;
- The system under exam involves sources of uncertainty and/or stochasticity;
- In some cases, the long-term goal is to make this system an autonomous (self-managed) one, endowed with on-board state indicators, able to monitor its state and to adapt to diverse types of unexpected events.
- The state space and/or the interaction of the system with its environment is endowed with a structure (e.g. a combinatorial or spatio-temporal structure); the approximate characterization and exploitation of this structure (through RAVE, forward or surrogate models) is key to the system self-management.
- The performance is measured in relation with time. On the one hand, the system must be able of anytime behavior, mastering the computational resources needed to take any single decision. On the other hand, the system is engaged in solving a series of problems: the point is to maximize the cumulative performance (e.g., in energy management).

- Any support, from the expert or others, is badly needed to tame the complexity. As already mentioned, the expert not infrequently ignores what he knows, making the expression of his priors a trials and errors process. Another possibility is to exploit information from a community (of users or problems); collaborative filtering principles can be leveraged to grasp the *latent features* behind the problem instances and/or the system modes.



A&O Publications

Journal articles

Major international journals

- (1) J. Atif, C. Hudelot, and I. Bloch. Explanatory reasoning for image understanding using formal concept analysis and description logics. *IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans*, pages 1–20, 2013.
- (2) D. Auger and O. Teytaud. The frontier of decidability in partially observable recursive games. *International Journal on Foundations of Computer Science*, 2012. Accepted.
- (3) A. Auger, J. Bader, D. Brockhoff, and E. Zitzler. Hypervolume-based Multiobjective Optimization: Theoretical Foundations and Practical Implications. *Theoretical Computer Science*, Dec 2011.
- (4) A. Auger, N. Hansen, and M. Schoenauer. Editorial introduction to the special issue on benchmarking of continuous black box optimization algorithms. *Evolutionary Computation*, 20(4):481, 2012.
- (5) A. Auger and O. Teytaud. Continuous lunches are free plus the design of optimal optimization algorithms. *Algorithmica*, 2009. accepted.
- (6) Z. Bouzarkouna, D. Y. Ding, and A. Auger. Well Placement Optimization with the Covariance Matrix Adaptation Evolution Strategy and Meta-Models. *Computational Geosciences*, pages 1–18, Sep 2011.
- (7) N. Bredeche, J.-M. Montanier, W. Liu, and A. Winfield. Environment-driven Distributed Evolutionary Adaptation in a Population of Autonomous Robotic Agents. *Mathematical and Computer Modelling of Dynamical Systems*, 18(1):101–129, 2012.
- (8) P. Caillou, S. Aknine, and S. Pinson. Searching pareto-optimal solutions for the problem of forming and restructuring coalitions in multi-agents systems. *Group Decision and Negotiation*, 19:7–37, 2010.
- (9) P. Caillou, J. Gil-Quijano, and X. Zhou. Automated observation of multi-agent based simulations: a statistical analysis approach. *Studia Informatica Universalis*, 2013. page : to appear.
- (10) B. Cessac, H. Paugam-moisy, and T. Viéville. Overview of facts and issues about neural coding by spikes. *Journal of Physiology-Paris*, 104:5–18, 2010. ANR MACCAC.
- (11) A. Chotard, Adrien, A. Auger, and N. Hansen. Cumulative Step-size Adaptation on Linear Functions: Technical Report. *Parallel Problem Solving From Nature*, Jun 2012.
- (12) A. Cornuéjols and M. Sebag. A note on phase transition and computational pitfalls of learning from sequences. *Journal of Intelligent Information Systems*, 31(2):177–189, 2008.
- (13) F.-M. De Rainville, C. Gagné, O. Teytaud, and D. Laurendeau. Evolutionary Optimization of Low-Discrepancy Sequences. *ACM Transactions on Modeling and Computer Simulation*, 22(2):9:1–9:25, 2012.
- (14) A. Devert, N. Bredeche, and M. Schoenauer. Robustness and the Halting Problem for Multi-Cellular Artificial Ontogeny. *IEEE Transactions on Evolutionary Computation*, 2011.
- (15) T. Élteto, N. Hansen, C. Germain-renaud, and P. Bondon. Scalable structural break detection. *Applied Soft Computing*, 2012.
- (16) T. Élteto, C. Germain-renaud, P. Bondon, and M. Sebag. Towards Non-Stationary Grid Models. *Journal of Grid Computing*, Dec 2011.
- (17) D. Feng, C. Germain-renaud, and T. Glatard. Efficient Distributed Monitoring with Active Collaborative Prediction. *Future Generation Computer Systems*, 2013. To appear.
- (18) A. Fialho, L. D. costa, M. Schoenauer, and M. Sebag. Analyzing bandit-based adaptive operator selection mechanisms. *Annals of Mathematics and Artificial Intelligence - Special Issue on Learning and Intelligent Optimization*, Sep 2010.
- (19) G. Fouquier, J. Atif, and I. Bloch. Sequential model-based segmentation and recognition of image structures driven by visual features and spatial relations. *Computer Vision and Image Understanding*, 116(1):146–165, 2012.

- (20) H. Fournier and O. Teytaud. Lower bounds for comparison based evolution strategies using vc-dimension and sign patterns. *Algorithmica*, 2010.
- (21) C. Furtlehner, J.-M. Lasgouttes, and A. Auger. Learning multiple belief propagation fixed points for real time inference. *J. Phys. A*, 389(1):149–163, 2010.
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3/ Bioinfo

Bioinformatics



équipe Bioinformatique

Responsable: Christine Froidevaux, Alain Denise

Le but de l'équipe Bioinfo du LRI est de concevoir et développer de nouvelles méthodes informatiques pour résoudre des problèmes issus de la grande masse de données biologiques actuellement disponibles. A cet égard, l'équipe est impliquée dans d'étroites collaborations avec des biologistes, qui peuvent être des expérimentateurs, ce qui permet d'envisager une phase de validation des méthodes et modèles qu'elle conçoit.

Les membres de l'équipe Bioinfo ont des compétences complémentaires en informatique (algorithmique, combinatoire, apprentissage automatique, automates stochastiques, bases de données, représentation des connaissances et raisonnement) et une grande expérience de la recherche interdisciplinaire avec des biologistes, ce qui leur permet de relever le défi de trouver un bon compromis entre exactitude biologique et efficacité informatique. En particulier, l'équipe poursuit son partenariat privilégié avec l'équipe bioinformatique de l'IGM (Institut de Génétique et Microbiologie, Orsay).

Son programme scientifique est structuré en deux thèmes, qui recouvrent deux domaines biologiques importants : (i) Bioinformatique structurale; (ii) Biologie des Systèmes (comprenant l'intégration des données).

Les travaux en bioinformatique structurale portent sur la prédiction des interactions intermoléculaires (interaction protéines-protéines à partir de séquences, amarrage protéines-protéines, amarrage protéines-ARN), et des structures secondaires et tertiaires des grandes molécules d'ARN.

Concernant le second thème, l'équipe Bioinfo étudie la conception, l'analyse, la modélisation et la simulation des réseaux biologiques (e.g. réseaux de régulation de gènes, réseaux métaboliques, et réseaux de signalisation). L'équipe explore aussi des approches pour intégrer des ensembles de données biologiques massives, nécessaires pour la conception de tels réseaux (construction et analyse de workflows scientifiques, méthodes pour aider les biologistes à faire face au déluge des données disponibles).

L'équipe Bioinfo fait partie de l'équipe projet INRIA AMIB (Centre de Saclay), en partenariat avec l'équipe Bioinformatique du LIX (UMR CNRS et Ecole Polytechnique).



Bioinformatics

Head: Christine Froidevaux, Alain Denise

The goal of the Bioinfo group is to design and develop new computational methods to efficiently tackle biological issues. In this regard, the group is involved in tight collaborations with biologists, especially experimentalists, thus allowing considering validation steps for the methods and models designed by the group.

The Bioinfo group has complementary skills in computer science (algorithmics, combinatorics, machine learning, stochastic automata, databases, knowledge representation and reasoning), and a strong interdisciplinary research experience with scientists, that enables it to address the trade-off between biological accuracy and computational efficiency. In particular, it continues its close partnership with the joint research group in Bioinformatics at IGM (Institut de Génétique et Microbiologie, Orsay).

Its scientific programme is structured into two themes according to two major biological fields: (i) Structural Bioinformatics, and (ii) Systems Biology (including data integration).

Works of the Bioinfo group on structural bioinformatics include both prediction of intermolecular interactions (protein-protein interactions from sequences, protein-protein docking and protein-RNA docking), and prediction of the secondary and tertiary structures of large RNA molecules.

Works of the Bioinfo group on the second theme include designing, analyzing, modeling and simulating biological networks. Different kinds of molecular networks are studied: gene regulatory networks, metabolic networks, and signaling networks. Also the Bioinfo group investigates approaches to integrate the massive biological data sets necessary to the construction of such networks (building and analyzing scientific workflows, and helping scientists face the deluge of biological data available).

The Bioinfo group is part of the INRIA AMIB project team (INRIA - Saclay), in partnership with the Bioinformatics group from LIX (UMR CNRS and Ecole Polytechnique).

Synthetic presentation

Nom du responsable de l'équipe : **Christine FROIDEVAUX**

Effectifs de l'équipe

Au 1er janvier 2008, l'équipe comprenait 5 EC (2 PR dont un à 70%, 3 MCF), 1 CR1 CNRS (en séjour pour 1 an au LRI), 9 doctorants et 1 post-doc.

Personnels ayant quitté l'équipe pendant le contrat en cours

1 CR1 (12 mois) a rejoint l'IGM Orsay fin 2008; 1 MCF a soutenu son HDR et est devenu PR à l'Université de Montpellier 2 (LIRMM) au 01-09-2013 ; 12 doctorants (294 mois) ont soutenu leur thèse et sont partis, la plupart pour des post-docs dans des laboratoires reconnus à l'étranger (Montréal, San Diego, NIH à Bethesda, Tel-Aviv, Bielefeld, etc); 7 post-docs (63 mois) et un ingénieur (4 mois) ont quitté l'équipe.

Nombre de recrutements réalisés au cours de la période considérée et origine des personnels

1 MCF en 2010 (après un Post-doc sur le projet européen BasysBio), 1 DR CNRS émérite en 2012 (venu de l'IGM Orsay), 1 CR2 CNRS (après un post-doc à l'ETH Zurich, arrive en octobre 2013). De plus, 1 PR (UEVE, IBISC) a été en délégation INRIA à mi-temps dans l'équipe (2012 et 2013).

Production scientifique au cours de la période écoulée

1. La prédiction d'interactions entre protéines est un problème crucial pour la construction de réseaux d'interactions entre protéines, réseaux à partir desquels nous pouvons prédire les fonctions des différentes protéines. Les travaux présentés dans (PLoS One 2012 et EGC 2013) permettent à la fois de mieux prédire les interactions entre paires de protéines et de reconstruire des complexes faisant intervenir plusieurs protéines, à partir de la simple prédiction des interactions entre paires de protéines.
2. Lorsque les réseaux sont complexes, on peut obtenir une explosion combinatoire du nombre de modes élémentaires de flux, ce qui empêche de tirer des conclusions simples de leur analyse. Nous avons développé un algorithme de biclustering basé sur l'agglomération de motifs communs (logiciel ACoM) pour classer les modes élémentaires de flux qui partagent un ensemble de réactions communes, appelé motif commun, dans un petit nombre de classes. L'analyse des motifs communs, en nombre beaucoup plus faible, et la compréhension de leur signification biologique sont ainsi plus aisées (Biosystems 2011).
3. Le travail présenté dans (ICDE 2009) est l'un des premiers travaux relatifs à la conception de structures de graphes expressives pour les workflows scientifiques qui permettent de concevoir des algorithmes polynomiaux alors que les problèmes sous-jacents (ici la comparaison de structures) sont NP-difficiles dans le cas général. Cet article a été suivi d'autres travaux de la communauté impliquant (mais non limité à) des co-auteurs, par des thèses au LRI et à l'Université de Pennsylvanie.
4. Nos travaux ont permis de faire des avancées notables vers la prédiction de la structure tertiaire de molécules d'ARN de plusieurs centaines de nucléotides, en proposant en particulier une approche prometteuse de prédiction à gros grain, basée sur la théorie des jeux (IEEE/ACM TCBB 2013). Ce travail, poursuivi actuellement à travers une thèse (financement Digiteo), s'appuie sur les avancées que nous faisons sur la recherche et la classification des motifs structurels d'ARN (RNA 2008, Computational Biology and Chemistry 2012), en collaboration notamment avec le PRISM de Versailles et l'IBMC de Strasbourg.
5. En collaboration avec l'IGM, nous avons proposé un modèle fournissant, pour la première fois, une explication à l'allure sigmoïde de la courbe de survie de bactéries de type streptomycetes en fonction de la force de promoteurs contrôlant un gène de résistance à un antibiotique. Cette courbe étant précédemment supposée être linéaire, nous avons montré que toute mesure prise aux alentours du seuil de la sigmoïde peut donner des résultats d'une très grande variabilité (AMB Express 2013 et Applied Microbiology and Biotechnology 2012).

Bilan quantitatif des publications de l'équipe

• Articles de revues: majeure internationale: 31, autres: 8	• Édition de livres: 9
• Article de conférences: majeures internationales: 11, autres: 18	• Chapitres de livres: 3

5 publications majeures

- Efficient Prediction of Co-Complexed Proteins Based on Coevolution, D. M. de Vienne, J. Azé, in PLoS One, 2012 (7).
- The construction of a library of synthetic promoters revealed some specific features of strong streptomycetes promoters, N. Seghezzi, P. Amar, B. Koebmann, P. R. Jensen, and M.-J. Virolle, Appl. Microbiol. and Biotech., 90(2), 615-623, 2011.
- Differencing provenance in scientific workflows, Z. Bao, S. Cohen-Boulakia, SB. Davidson, A. Eyal, S. Khanna, in IEEE 25th International Conference Data Engineering (ICDE), 2009, 808-819.

- ACoM: a classification method for elementary flux modes based on motif finding S. Pérès, F. Vallée, M. Beurton-Aimar, J-P. Mazat, in Biosystems, volume 103, 2011.
- An algorithmic game-theory approach for coarse-grain prediction of RNA 3D structure, A. Lamiable, F. Quessette, S. Vial, D. Barth, and A. Denise, in IEEE/ACM Trans. on Comp. Biology and Bioinformatics, 2013 Jan-Feb, 10(1):193-9.

5 (max) documents majeurs (autres que publications)

- Hsim V2.0 intègre deux nouvelles fonctionnalités : un moteur de résolution approchée stochastique global très efficace, et la traduction d'un modèle en ODE et son exportation en Scilab (SASB 2012).
- Dépôt APP de GeneValorization. Informations liées à l'utilisation (Google Analytics, du 15/12/2009 au 09/06/2013) : 1 800 visites, 100 utilisateurs ont utilisé plusieurs fois l'outil, avec des utilisateurs d'Europe, du Canada et des US.
- Varna, développé en collaboration entre le LRI, le LIX, l'IGM et l'équipe-projet AMIB est utilisé par plusieurs logiciels et bases de données en ligne, dont Rfam, qui est la base de données mondiale de référence pour les données d'ARN. Varna a été téléchargé environ 10000 fois, l'article le décrivant a été cité plus de 140 fois depuis sa parution en 2009.
- BioGuide intègre un nouveau module BioConsert (<http://bioguide-project.net/bioconsert/>)
- Rapports de conjoncture 2010 de la CID 43 et de la section 7 du CoNRS (en collaboration avec les autres membres du CoNRS concernés) : <http://www.cnrs.fr/comiternational/doc/conjoncture.htm>.

5 (max) faits illustrant le rayonnement ou l'attractivité académique

- Prix du meilleur papier applicatif, EGC 2013 (J. Azé).
- Co-présidence de JOBIM-2011 à Paris (Institut Pasteur) (Ch. Froidevaux).
- Comités de programmes : ECCB'12, SSDBM'09 et '11, VLDB'11, MCBS'08 à '12, ICDE'10 et '12, DILS '08 à '12. . .
- Editorial board du Journal on data semantics (Jods) S. Cohen-Boulakia).
- Conférences invitées: Lacim 2010, GASCom 2012, Dagstuhl seminars 2012 (2), Benasque RNA workshop 2009, SFBT 2012 (P. Amar, S. Cohen-Boulakia, A. Denise, S. Peres).

5 (max) faits illustrant les interactions de l'équipe avec son environnement socio-économique ou culturel

- Contrat L'Oréal (J. Azé)
- Membre du CA de la SIF (Société informatique de France) et du Comité éditorial du bulletin de la SIF "1024" (avril 2013, Ch. Froidevaux)
- Exposé à la journée Femme et Sciences (avril 2013, Ch. Froidevaux)
- Séminaire d'Alembert (avril 2012, J. Azé)

Principales contributions de l'équipe à des actions de formation

- Responsabilités en lien avec des filières de formation :
 - Co-direction du Master mention Bioinformatique et Biostatistiques (BIBS, M1 et M2 Pro et Recherche) : A. Denise depuis sa création jusqu'en 2012 puis Ch. Froidevaux.
 - L'équipe est responsable de 6 UE du M2 Recherche BIBS.
 - ▷ En février 2011, le Master BIBS a fait les honneurs du journal Le Monde : il a été parmi les "9 masters plébiscités par les étudiants et les entreprises", toutes disciplines confondues au niveau national.
 - Vice-Président Enseignement du Département Informatique (A. Denise, depuis 2012)
 - Directeur des études de la 3e année cycle ingénieur à Polytech Paris-Sud et responsable des stages des 4ème et 5ème année cycle ingénieur à Polytech Paris Sud (J. Azé) ;
 - Responsable du recrutement en formation continue à Polytech et Coordinatrice pédagogique (directrice des études) 5ème année Polytech Paris Sud (Informatique) (S. Cohen-Boulakia) ;
- Correspondante STIC pour le groupe de travail "Formation" de l'Idex (Ch. Froidevaux, 2011).
- Membre du groupe de travail "Formation" de la School SEIST du Campus Paris-Saclay, chargé de la réflexion sur le Master Informatique de Paris-Saclay (A. Denise, depuis 2013)
- Co-responsable du groupe de travail sur le futur Master Bioinformatique de Paris-Saclay (Ch. Froidevaux, depuis 2013)
- Ecoles de jeunes chercheurs (cours) : Ecole thématique de la SFBT 2012 (P. Amar); École d'été BDA "Masses de Données" 2012 (S. Cohen-Boulakia) ; Advances in Systems and Synthetic Biology 2011-2013 et Ecole thématique interdisciplinaire de Berder 2013 (S. Peres).
- Enseignement dispensé à l'étranger : Cours de Bioinformatique de l'ARN (6h); entreprise ABLife, Wuhan, Chine, 2013 (A. Denise).

Research Group Members and evolution since 2008

The Bioinfo team includes 7 permanent members (2 Professors, 1 emeritus DR-CNRS, 1 CR-CNRS, 3 Assistant Professors), and 7 doctoral students. It has 10 associate members.

Permanent Members (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
AMAR	Patrick	MCFHC	Paris Sud
COHEN-BOULAKIA	Sarah	MCF	Paris Sud
DENISE	Alain	PR1	Paris Sud
FROIDEVAUX	Christine	PR1	Paris Sud
LABEDAN	Bernard	DR émérite	CNRS
PAULEVÉ	Loïc	CR2	CNRS
PERES	Sabine	MCF	Paris Sud

Note that Alain Denise is part-time at IGM Orsay (30%).

PhD. students (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Funding</i>	<i>Institution</i>
BOUFFARD	Marc	Alloc. Ministère	Paris Sud
BRANCOTTE	Bryan	Alloc. Ministère	Paris Sud
CHEN	Jiuqiang	ETR	Paris Sud
GUIHOT-GAUDEFFROY	Adrien	Alloc. Ministère	Paris Sud
ROUGNY	Adrien	Alloc. Normalien	Paris Sud
YANG	Bo	ETR	Paris Sud
ZENG	Cong	ETR	Paris Sud

Associate members (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
AZE	Jérôme	PR	University Montpellier 2 (LIRMM)
BERNAUER	Julie	CR	INRIA Saclay (LIX, AMIB)
BOUDARD	Mélanie	PhD student	UVSQ (PRISM)
D'ALCHE-BUC	Florence	PR	University Evry (IBISC)
HEINONEN	Markus	Post-doc	University Evry (IBISC)
IAKOVISHINA	Daria	PhD student	Ecole Polytechnique (LIX, AMIB)
LESPINET	Olivier	MC HDR	University Paris Sud (IGM)
PEREIRA	Cécile	PhD student	University Paris Sud (IGM)
PONTY	Yann	CR	CNRS (LIX, AMIB)
REGNIER	Mireille	DR	INRIA Saclay (LIX, AMIB)

Group evolution

On October 1st, 2013, the group includes seven permanent members (two Professors, one CNRS senior Emeritus researcher, three Assistant Professors and one CNRS junior researcher) and seven doctoral students (including two new doctoral students). During the five years twelve doctoral students have defended their PhD thesis and one assistant professor his HDR. The Bioinfo group is part of the LRI-LIX-INRIA joint group AMIB led by Mireille Régnier since its creation in 2009.

The Bioinfo group composition has changed as follows:

- Claire Toffano moved to the Institut de Génétique et Microbiologie (IGM Orsay) in December 2008 after a one-year stay at LRI.
- Sabine Peres joined the team in September 2010 as an Assistant Professor, strengthening the Systems Biology theme.
- Bernard Labedan left IGM Orsay and joined the group at LRI in January 2012 as an Emeritus Research Director (CNRS), bringing his broad expertise in biology.
- Loïc Paulevé has been hired as a junior CNRS researcher in 2013. He joins the group in early October, bringing his strong expertise in Systems Biology.
- Jérôme Azé was on leave at INRIA (delegation) between September 2011 and February 2013. He left the group in August 31, 2013. He is hired as a Professor at Montpellier 2 (LIRMM).
- Florence d'Alché-Buc, Professor at the University of Evry (U. EVE, IBISC) was in INRIA delegation in BioInfo / TAO groups (2011-2013), bringing her strong expertise in statistical learning.

3/ BioInfo

Research Description

Structural Bioinformatics

Participants: Jérôme AZÉ, Alain DENISE, Christine FROIDEVAUX . . .

In structural bioinformatics, we work on predicting both intermolecular and intramolecular interactions. Regarding intermolecular interactions, we have been working at large scales (predicting protein-protein interactions within sets of proteins) and at submolecular scales (protein-protein docking and protein-RNA docking). As for intramolecular interactions, we specifically work on RNA molecules, aiming at predicting the secondary and tertiary structures of large molecules. The originality of our work lies on investigating several fields in computer science, notably machine learning, graph algorithmics and combinatorics.

There is a structured and recognised worldwide community in each of the fields of protein-protein docking and of RNA computational biology. Our group is well-integrated in the two communities: we participate to the CAPRI protein docking contest, and we are regularly invited to the Benasque RNA meeting, a community-wide meeting occurring every three years. Additionally we have close collaborations with several groups in these communities.

Intermolecular interactions

The prediction of the network of molecular interactions in an organism is crucial for the understanding of biological processes and for the development of new drugs. Many international groups work on different aspects of the prediction of interactions between proteins. It covers a wide range of problems from the prediction of interactions solely based on sequences to the prediction of 3D interaction between proteins (docking).

In the bioinformatics group, we covered three different aspects of the study of these interactions: (i) protein-protein interactions (PPI) from sequences, (ii) protein-protein docking and (iii) protein-RNA docking. The latter is one of the most critical subject as protein nucleic acid complexes are now known to play crucial regulatory and enzymatic - roles: DNA repair, transcription regulation, and global control of the behavior of a large number of molecular machines. Thus it is necessary to understand protein-nucleic acid interactions and be able to predict them.

Protein-protein docking. Knowing that two proteins may interact is often not enough for many application such like drug design. We also need to know how they interact in three dimensions. This is known as protein-protein docking.

A protein-protein docking procedure traditionally consists in two successive tasks: a search algorithm that generates a large number of candidate conformations mimicking the complex existing *in vivo* between the two proteins, and a scoring function that is used to rank them in order to extract a native-like

one, a.k.a. near-native conformation. Our work is essentially focused on the search for new scoring functions that allow a better ranking of the generated candidates.

In our previous studies (72), we have already shown that using Voronoi-based constructions and a well chosen set of parameters, an accurate scoring function could be designed and optimized. However to be able to perform large-scale *in silico* exploration of the interactome, a near-native solution has to be found in the ten best-ranked solutions.

In (5), we have introduced a procedure that optimized conformational ranking. In (112), a set of scoring functions was developed using a genetic algorithm to learn a set of scoring functions. These functions were used to assign a rank to each possible conformation. These ranks were refined in a collaborative filtering scheme based on ensemble learning and provided much better results for the scoring.

This new approach was applied to the CAPRI scoring ensembles in a community-wide assessment experiment (16). In (70), new ways of combining scores obtained from several machine learning strategies were investigated. The generation step was done by the docking software Hex, developed by D. Ritchie at LORIA. The output of Hex was post-treated by a coarse-grain model, based on Voronoi tessellation, in order to reduce the number of attributes associated to each candidate (58).

As the last CAPRI meeting showed, our work introduced machine learning in the docking community providing both feedback on traditional and new descriptors but also more efficient and dedicated scoring functions.

Prediction of protein-RNA interactions. The study of interactions between proteins and nucleic acid from an experimental perspective is a difficult task. Traditional NMR and X-ray experiments, that are much harder for RNA/DNA, are even more time consuming and expensive. As shown above, computational structural biology can again provide insights for the understanding of these interactions by providing accurate predictions.

From the experience we acquired in protein-protein docking, we decided to focus on the design of dedicated protein-nucleic acid scoring functions to be embedded in existing docking procedures. We used datasets of experimentally solved 3D protein-nucleic acid complex structures and built both a coarse-grained model and a model at the atomic level. We applied machine learning strategies both on the atom/pseudo atom based representation and on the Voronoi diagram. This work is performed in the context of the PhD of Adrien Guillot-Gaudeffroy. Preliminary results were presented in the Stanford-Sweden Multiresolution Molecular Simulation Workshop in Uppsala (89).

Protein-protein interactions from sequences. Machine learning methods have been successfully applied to the prediction of PPI in Yeast by the integration of multiple direct and indirect biological data sources (Lu et al, 2005). However, experimental data are not available for most organisms. In collaboration with Damien M. de Vienne (CRG, Barcelona), we have proposed an ensemble machine learning approach for the prediction of PPI that depends only on features independent from experimental data. Proteins that interacts, whether through physical interaction or not, are expected to be co-evolving. Any evolutionary event affecting one protein might thus indirectly or directly impact all of its interacting partners (see review in Lovell and Robertson, 2010). In order to take into account this coevolution, we have developed new estimators of the coevolution between proteins and combined them in an ensemble learning procedure (11). Our new method has been successfully applied to a dataset of known co-complexed proteins in *Escherichia coli* and compared to previously published methods.

In a recent work (59), we focused on the identification of protein-protein complexes based on the putative interaction between pairs of proteins as the sole source of information. From the results obtained on *E. coli*, we started working on the prediction of multi-body protein complexes from sequence information alone. This work will be extended to other organisms.

Analysis and prediction of RNA structures

The function of an RNA molecule is very closely related to its spatial structure. For this reason, the problem of RNA structure prediction from the sequence has been studied for more than forty years. Other related problems are of interest, like comparison of structures, and design of structures that is finding an RNA sequence that folds into a given secondary structure. We developed algorithms and software for dealing with these problems. Most of these algorithms rely on our studies on combinatorial properties of RNA structures. Compared to the other groups in the international community of RNA computational

biology, our particular combination of combinatorics-inspired techniques and practical software developments is unique.

Additionally, we focused on the problem of predicting the three dimensional structure of an RNA molecule, which is also called RNA structure modeling. The few automatic modeling programs, developed in recent years, are relevant for very small molecules only (a few dozens of nucleotides length). Beyond this limit, three-dimensional structure prediction requires, at all levels, the skills of an expert. For going further, we investigated new approaches, notably based on parameterized complexity, or on game theory.

Secondary structures: comparison, design and drawing. We developed and studied dynamic programming approaches for comparing RNA secondary structures. We notably presented the first polynomial algorithm for the alignment of secondary structures which uses the acknowledged set of relevant operations (4). We also established that the average-case complexities of both our algorithm and the classical Jiang-Wang-Zhang tree alignment algorithm are quadratic (17), a surprising result given the same quadratic complexity of the Smith-Waterman sequence alignment. Besides, we developed, together with a large part of the French RNA community, a general framework for evaluating RNA secondary structure comparison softwares (32). The above works were done within the ANR Brasero project which was leaded by the group.

In their initial definition, secondary structures can be associated with non-crossing matchings of the RNA sequence. However, this restriction is more motivated by algorithmic reasons than by strictly intrinsic molecular properties. In practice, complex crossing motifs, called pseudoknots, occur within experimental structures. Condon and coauthors gave a hierarchical classification of exact RNA structure prediction algorithms according to the types of pseudoknots. We completed this classification by adding two recent prediction algorithms (28), quantifying the hierarchy by giving closed-form or asymptotic formulas for the theoretical number of structures of given size n in all the classes but one. This allows to assess the tradeoff between the expressiveness and the computational complexity of RNA structure prediction algorithms. This work led to the development of a general combinatorial framework for designing dynamic programming algorithms for pseudoknotted RNA structures (55).

It is a natural pursue to build on our understanding of the secondary structure to construct artificial RNAs performing predetermined functions, ultimately targeting therapeutic and synthetic biology applications. Towards this goal, a key element is the design of RNA sequences that fold into a predetermined secondary structure, according to established energy models (inverse-folding problem). Quite surprisingly, and despite two decades of studies of the problem, the computational complexity of the inverse-folding problem is currently unknown. We explored language-theoretic constructs, namely products of finite-state automata and context-free languages, to force or forbid the presence of identified functional motifs within designed sequences (Zhou et al. 2013, to appear in Proc. ACM BCB 2013). Our methodology was partially based on our general work on the biased random generation of combinatorial structures (13). We applied our methodology, in collaboration with a molecular biology group, in order to study the effect of RNA structures in some splicing process (22).

Additionally, we participated to the development of Varna, a software (Java applet) dedicated to the quick drawing of RNA secondary structures (10). Varna accepts a wide range of documented and illustrated options, and offers editing interactions. Varna is now used by several online RNA softwares and databases, including Rfam, the leading international database for RNA families.

Towards 3D modeling of large molecules Briefly, modeling of large RNA 3D structures, that is predicting the three-dimensional structure of a given RNA sequence, relies on two complementary approaches. The approach by homology is used when the structure of a sequence homologous to the sequence of interest has already been resolved experimentally. The main problem then is to calculate an alignment between the known structure and the sequence. The ab initio approach is required when no homologous structure is known for the sequence of interest (or for some parts of it). We worked in both directions. We did notable progress towards the ab initio prediction of the 3D structure of large RNAs, a problem which is beyond the scope of current approaches: we proposed a promising coarse-grained approach based on game theory (18) that scales up to several hundreds of bases. This result benefited from our previous works on research and classification of RNA structural motifs (14, 19). Regarding the approach by homology, we developed a general setting for the general problem of RNA structure-sequence comparison which is known to be NP-hard. Our approach is based on tree decomposition of structures and gives rise to a general parameterized algorithm, where the exponential part of the complexity depends on the family of structures (56). This framework unifies and generalizes a number of recent works on specific families. The

above works were done within the ANR AMIS ARN project which was leaded by the group.

Systems Biology and data integration

Participants: Patrick AMAR, Jérôme AZÉ, Sarah COHEN-BOULAKIA, Alain DENISE, Christine FROIDEVAUX, Bernard LABEDAN, Sabine PERES

Systems Biology has emerged in early 2000s as a major field of biology and is now one of its most studied fields. It aims at studying as a whole the complex networks formed by various biological objects and their numerous interactions. In this section, we present the work we performed on the study and design of biological networks while introducing the approaches we followed to integrate the massive biological data sets necessary to the construction of such networks. We have investigated methods in various computer science fields, notably, in stochastic automata, graph algorithmics, machine learning, knowledge representation, and data integration.

Systems biology

Systems Biology includes the study of interaction networks such as gene regulatory, metabolic, or signalling networks. It involves both designing the topology of the networks and predicting their dynamic and spatiotemporal aspects. It requires the import of concepts from across various disciplines and crosstalk between theory, benchwork, modelling and simulation. The originality of our group is that, beyond modeling, analyzing and simulating molecular networks, it also focuses on synthetic biology by investigating how principles discovered in systems biology can be applied to synthesize biological systems in the context of a medical application.

Topological analysis of metabolic networks. Elementary flux mode analysis is a powerful tool for the theoretical study of metabolic networks. However, when the networks are complex, the determination of elementary flux modes leads to combinatorial explosion of their number which prevents from drawing simple conclusions from their analysis. To deal with this problem we have developed a polynomial biclustering algorithm based on the Agglomeration of Common Motifs (ACoM) (38) for classifying elementary flux modes which share a set of common reactions, called common motifs, in few classes.

As a consequence, the analysis of common motifs, which are in much lower number, is now easier and their biological meaning can be readily understood.

In general, the common motifs gather together successive reactions that appear as sub-networks in a larger metabolic network. They can also associate some reactions with transporters that are needed to feed the sub-network, but they can also unveil associations of reactions that are not necessarily obvious.

Evolution of metabolic networks. Recently, we started a new collaboration with IGM on the evolution of metabolic networks (PEPS grant). We aim to understanding of how such networks have been able to build over time among the variety of species, and how these changes could be responsible for characteristic life traits. In a first step, we developed a methodology based on machine learning, in order to characterize the evolutionary origin of the enzymatic repertoire of different fungal groups. Our preliminary results were presented at JOBIM 2013 (64).

Reasoning for Signalling networks. Signalling pathways involving G protein-coupled receptors (GPCR) are excellent targets in pharmacogenomics research. Large amounts of experiments are available in this context while globally interpreting all the experimental data remains a very challenging task for biologists.

In collaboration with INRA BIOS we have introduced a logic-based method to infer molecular networks. Unlike other logic-based works for molecular networks (e.g. Dyliss team), our approach consists in designing the network using a knowledge-based system describing experimental facts and ontological relationships on background knowledge, together with a set of generic and expressive rules, that mimic the expert's reasoning. Provenance of inferred data has been carefully collected, allowing quality evaluation. Our method takes into account various kinds of biological experiments and their origin and automatically builds and draws the inferred network (69). Comparing the automatically deduced network with an already known fragment of the FSHR network allowed us to obtain new interesting hypotheses that are currently being experimentally tested by the biologists from the INRA group.

Besides, in collaboration with K. Inoue, through the *NII International Internship Program*, we have studied the System Biology Graphical Notation language, a standard for expressing molecular networks, especially signalling networks, and proposed a translation of SBGN-AF into a logical formalism (to appear in LNMR'2013).

Gene regulatory network inference Complex regulatory mechanisms at work in the cell involve non-linear dynamics. Partially observed through kinetics of gene expression, these dynamics can be represented by a first order autoregressive model. Existing sparse linear vector autoregressive models have been extended to nonlinear ones using either multiple local scalar-valued kernels or operator-valued kernels (21, 93). The latter model allows to tackle vector-valued function approximation in a principled way. It enjoys a new family of learning algorithms based on boosting and proximal gradient algorithms. We called this new framework, OKVAR, for Operator-valued Kernel Vector Auto Regressive model. Applied to DREAM3 challenges devoted to time-course data, it outperforms other existing methods.

We also developed a hybrid approach that combines first order logic and statistical learning using the framework of Markov Logic Network (7).

Also we have studied parameter and hidden variables estimation in a system of ordinary differential equations describing the dynamics of a biological network. In the framework of experimental design, we have developed a new approach based on active learning and state-space models-based on ODE in collaboration with A&O team. This approach ranked third at the DREAM7 challenge in 2012 and is currently under submission.

Modelling, Simulation and Complex systems. In collaboration with microbiologists, the group of M-J. Virolle from IGM, we have proposed the first explicative model for the sigmoidicity of the shape of the survival curve of bacteria (*S. lividans*) having a antibiotic resistance gene, expressed at different levels, in presence of a constant concentration of antibiotics (29, 30). This is particularly important since this method of inclusion of an antibiotics resistance gene to report the activity of its promoter is widely used in the streptomyces community.

A great number of methods have been proposed for the study of the behavior of large biological systems. Many methods have been developed and are in use in the group, depending on the specific problems under study: the first one is based on a discrete and direct simulation of the various interactions between the reactants using an entity-centered approach, the second one implements a variant of the Gillespie stochastic algorithm very efficient and that can be mixed with the entity-centered method to get the best of both worlds, and the third one uses differential equations automatically generated from the set of reactions defining the network we want to analyse.

These three methods have been implemented in an integrated tool, the Hsim system (41). This new version of Hsim allows us to use the same input model with any one of these methods, using the most appropriate one depending on the specific constraints of the model. This has been applied to the modelling of the circadian clock of the cyanobacterium, and has shown pertinent results regarding the spontaneous appearance of oscillations and the factors governing their period (47).

A good definition of a complex system may be: *a system where many actors interact in multiple and varying ways*. The continuing modifications of the elements of a complex system and their interactions make its behaviour hard to predict. From this point of view, a living organism is a complex system, its phenotype being the consequence of (or emerges from) the interactions of the multiple biomolecules they are made of. In his PhD thesis (118), Th. Moncion worked on the characterisation of emerging phenomena in a complex system. He used data collected from entity-centered simulations to build a dynamic graph of interactions and to compute topological measures on this graph that reveal if, and when, an emergent phenomenon appears.

Synthetic biology. Synthetic biology begins to be a very popular domain of research. We focus on using synthetic biology for medical diagnostic purposes. In a collaboration with the Sysdiag lab. at Montpellier, we have started designing an artificial embedded biological nano-computer in order to detect the biological markers of some human pathologies (colorectal cancer, diabetic nephropathy, etc.).

This biological nano-system is made of a lipidic vesicle (liposome), or droplet, that embarks an artificial metabolic network designed to sense the markers of the disease, to compute an integrated response, and to show the results (using colorimetry for example). The heart of the nano-computer uses enzyme/metabolites based logical gates to implement the boolean function needed to interpret the output

of the sensors. This artificial metabolic network is designed using a variant of the CellDesigner software, BioNetCAD (26). BioNetCAD can translate the metabolic network to the list of biochemical reactions that use HSIM (41, 47) to test the system *in silico*. These simulations are used to validate the behaviour of the network and to quantify the initial concentrations of metabolites used.

Analysing and integrating omics-data

Faced with the deluge of new sequenced genome sequences and the amount of data produced by high-throughput approaches, the need to cross and compare massive and heterogeneous data is more important than ever to improve functional annotation and design biological networks. Challenges are numerous and include providing support to scientists to perform and share complex and reproducible complex biological analyses and guiding users in selecting and querying large-scale data sources in an integrated way.

Our group is very active in the international community of Data Integration for the Life Sciences, participating to several international working groups such as the series of “Principles of Provenance” and “Provenance Challenges” meetings. Fruitful collaborations are being followed with major international actors of the community from the USA and Europe, especially the groups directly in charge of designing scientific workflow systems used in bioinformatics.

Scientific workflows for analyzing biological data We have addressed the problem of enhancing faster analysis of biological data in two ways.

First, in collaboration with INRA MIG and in the context of the PRES AFON project, we have proposed a method for semi-automatic functional annotation (63) by investigating automatic protein annotation with terms of a functional hierarchy, using two decision-trees techniques (tested on two bacteria genomes). We have introduced hierarchical measures to evaluate them (71). Identifying correspondences between concepts of two ontologies was needed to share annotations in the *Microbiogenomics* data warehouse. We have designed *O’Browser* (82, 94), a semi-automatic method for mapping two functional hierarchies using two sets of carefully annotated proteins by INRA. *O’Browser* combines different kinds of matchers and places the expert at the center of the process.

Second, in a more general setting, we have considered the use of scientific workflows management systems to specify and manage bioinformatics experiments. Their programming model appeals to bioinformaticians, who can use them to easily specify complex data processing pipelines. Such a model is underpinned by a graph structure, where nodes represent bioinformatics tasks and links represent the dataflow. As underlined both in a study (57) and a review of existing approaches (9) we performed (in collaboration with members of the U. zu Berlin) the complexity of such graph structures is increasing over time, making them more difficult to share and reuse. Providing means to reduce the structural complexity of workflow while ensuring that any structural transformation will not have an impact on the executions of the transformed workflows, that is, preserving *provenance* (99) is crucial. In *ZOOM*, we introduced an approach creating an abstract view of the original workflow based on the tasks of interest given by the user (50, 74) (computing automatically composite tasks). The *PDiffView* (48, 49) system allows to compare two executions of the same workflow (using graph edit distance techniques), allowing the user to understand why they may not have provided the same output.

Interestingly, in both projects (performed in collaboration with members of the db group at UPenn), complex graph operations have to be performed (clustering and comparing graph structures) leading to NP-hard problems when workflow structures are (arbitrary) DAGs. However, polynomial time algorithms can be designed when Series-Parallel graphs (SP-graphs) are considered. Such graphs impose some restrictions on the general graph structure while being very expressive. In the *SPFlow* approach (60, 52), we have thus considered the problem of rewriting the structure of scientific workflows to SP graphs while ensuring that the transformation did not change the behavior of the original workflow, that is, preserving provenance (current J. Chen’s Ph.D thesis). Also, in collaboration with the Taverna group at the Univ. of Manchester, we focused on the presence of “anti-patterns” in the workflow structures, idiomatic structures that lead to over-complicated design. We have introduced the *DistillFlow* (87) approach for automatically detecting such anti-patterns and removing them, resulting in a reduction in the workflow’s overall structural complexity.

Querying biological data Another challenge for integrating biological data is to help scientists face the deluge of data available. The problem is actually two folds: the number of resources available is

increasing over time (100, 101) and the number of answers returned by even one resource may be too large to be dealt with.

We have worked on addressing the first problem for many years. First, within the *BioGuide* project, we guide users navigating in the maze of available biological sources. With the *BioBrowsing* (54) system plugged on top of BioGuide, all the biological resources of NCBI can be now be exploited and the network of the NCBI resources is automatically updated in the system. Second, in the context of the ANR *Microbiogenomics*, we have designed a relational genomic warehouse, based on an original multi-layer model, on which we have developed a querying module, *GenoQuery*, allowing users to formulate SQL queries through an interface displaying the top layer (a graph of biological entities) (20).

More recently, we tackle the second problem and have provided solutions for ranking biological data. The main difficulty lies in considering various ranking criteria and combine them which may lead to design a ranking function. Instead, in collaboration with the University of Montreal, we have proposed to follow a *median ranking approach* named *BioConsert*: considering one ranking per ranking criteria for the same data set, and providing a consensus ranking that minimizes the disagreements between the input rankings. We have shown the benefit of using median ranking in several biological settings (51).

Additionally, in close collaboration with the Institut Curie, we have developed the *GeneValorization* tool (6) able to rank a list of genes of interest given as input with respect to a set of keywords representing the context of study. Here the single ranking criterion considered for each gene is the number of publications in PubMed co-citing the gene name and the keywords. Since December 2009, GeneValorization has one hundred regular users, with on average one to two use every day.

3/ BioInfo

Collaborations

Participation to national and international collaborative research projects

International projects

- *Sharing and Optimizing Scientific Workflows*, Partenariat Hubert Curien (PHC grant) (Campus France), Coordinator : S. Cohen-Boulakia, Partner : University of Humbolt zu Berlin. Joint Publications: (53, 9, 57)
- *Processing PhyLOData*, Consultant for the project (S.Cohen-Boulakia), Partner : University of Pennsylvania. Joint Publications: (50, 49, 48, 74, 75)
- *Réseau franco-québécois de recherche sur l'ARN*, CFQCU grant 2012-2014, participant (J. Azé, A. Denise, Ch. Froidevaux), Partners : LIX, Polytechnique; McGill University, Montreal; Université de Montréal. Joint publication: Zhou et al. 2013, to appear in Proc. ACM BCB 2013.
- *RNAomics*, Digiteo grant 2008-2013, participant (A. Denise, A. Lamiable, F. Lou, S. Saule), Partners : LIX, Polytechnique; Boston College. Joint publications: (23, 83, 73, 77, 28, 55)
- *RegRNAs*, French-Chinese Advanced Research Program (PRA) grant 2007-2008, coordinator (A. Denise, Y. Zhou), Partner : Wuhan University. Joint publications: (31, 39, 22); Zhou et al. 2013, to appear in Proc. ACM BCB 2013.
- *Inference and Learning for Systems Biology and Network Dynamics*, Collaborator: K. Inoue, NII (National Institute of Informatics, Tokyo); INRIA exchanges with "NII International Internship Program 2013; Participant: Adrien Rougny. Joint publication: to appear in LNMR'2013.

National projects

- *NGD-NSD*, ANR grant 2012-2015, participant (A. Denise), Partner : IGM, Paris-Sud.
- *Japarin3D*, Digiteo grant 2012-2016, coordinator (A. Denise, M. Boudard), Partner : PRISM, Versailles.
- *PEPS BMI Identification of metabolic capabilities of fungi by comparative genomics*, CNRS-INERM-INRIA PEPS grant 2012-2013, participants (J. Azé, P. Amar, A. Denise, Ch. Froidevaux, S. Peres), Partners : IGM, Paris-Sud ; UMR GV, CNRS. Joint publication: (64)
- *PRES Intégration et représentation de connaissances pour l'analyse et la prédiction d'interactions physiques entre protéines chez l'homme*, Cooperative research project between the Universities UEVE (Evry) and UPsud (Paris Sud); participants (J. Azé, Ch. Froidevaux, D. Labib), partners: IBISC (UEVE), INSERM (Paris Descartes) 2012-2013.
- *ASAM*, INRA-INRIA grant 2011-2012, coordinator for INRIA (Ch. Froidevaux), Partner: BIOS (INRA Tours), INRIA AMIB. Joint publication: (69)

- *AMIS ARN*, ANR grant 2009-2012, coordinator (A. Denise, M. Djelloul, A. Lamiable, Ph. Rinaudo), Partners : IBMC, Strasbourg ; PRISM, Versailles. Joint publications: (91, 19, 56, 18, 33)
- *AFON*, Annotation FONctionnelle (PRES UniverSud 2009-2011), coordinator (J. Azé, Ch. Froidevaux), Partner: MIG, INRA Jouy.
- *PASAPRES*, PRES UniverSud grant 2008-2009, participant (A. Denise, M. Djelloul, A. Lamiable), Partner : PRISM, Versailles.
- *PASAPAS*, Digiteo grant 2007-2010, participant (A. Denise, M. Djelloul, A. Lamiable), Partner : PRISM, Versailles. Joint publications: (14, 19, 18)
- *Microbiogenomics*, Masse de Données ANR grant 2006-2009, participant (J. Azé, D. Devienne, Ch. Froidevaux), Partners: IGM, Paris-Sud; INRA MIG (Jouy); INRIA Aviz, Saclay. Joint publications: (20, 82)
- *Brasero*, ANR grant 2006-2009, coordinator (A. Denise, Ch. Herrbach, C. Saule), Partners : LaBRI, Bordeaux ; CGM, Gif/Yvette ; LBBE, Lyon ; IGM, Paris-Sud ; LIFL, Lille ; MAEM, Nancy. Joint publications: (84, 10, 17, 4, 13, 32)
- *RNA RECOD*, ANR grant 2006-2009, participant (A. Denise), Partner: IGM, Paris-Sud.
- *PPF, Bioinformatique et Biomathématiques* (PPF Paris-Sud 2006-2009), co-leader Ch. Froidevaux; Partners: LRI, LIMSI, Laboratoire de mathématiques, IGM, IBP, IBBMC, CGM, Institut Curie Orsay and PGE.

Collaborations with other laboratories leading to joint publications

International collaborations

- D. M. de Vienne (CRG, Barcelona): *PPI* (11, 59)
- S. Hamel, DIRO (University of Montreal): *Consensus and Median Rankings* (51), *Consensus for protein-protein Docking* (70)
- C. Goble, A. Williams, University of Manchester: *Designing scientific workflows from the Taverna system* (87, 8)
- P. Missier, University of Newcastle: *Refactoring Scientific Workflows while preserving Provenance* (8).
- W. Tan, University of UC Santa Cruz: *Provenance*, (99).
- J. Wijsen (University of Mons) *Logical query languages* (66)

National collaborations

The Bioinfo group at LRI has close collaborations with the Bioinformatics team at LIX (Ecole Polytechnique) through the INRIA AMIB project. It leads to 13 joint publications (including 7 major international journals and conferences) on *structural bioinformatics* (72, 16, 5, 10, 13, 55, 56, 95, 28, 89, 96, 97, 98). In addition, the Bioinfo group has the following collaborations.

- D. Barth, J. Cohen, F. Quessette, S. Vial, PRISM, Versailles: *RNA bioinformatics* (19, 18, 56), *Random generation* (27)
- F. Molina, A. Thierry (SysDiag, Montpellier): *Biologie synthétique pour le diagnostic médical* (26)
- V. Norris (University of Rouen) F. Molina (SysDiag, Montpellier): *Calculer avec des bactéries* (79, 37, 36)
- V. Norris, C. Ripoll, M. Thellier (University of Rouen): *Functioning-Dependent Structures* (1, 24)
- J-M. Petit, LIRIS, Lyon: *Logical query languages* (66)
- L. Felicori, University of Minas Gerais, Brazil : *Plos one* 2013, to appear
- M.-J. Virolle, IGM, Orsay: *Métabolisme des streptomyces* (29, 30)
- A. Poupon, INRA Tours, BIOS Group (University Francois Rabelais): *Protein-protein Docking* (5, 16, 70, 58)
- D. Ritchie, INRIA Nancy (University of Lorraine): *Protein-protein Docking* (58, 70)
- M. Teisseire, S. Bringay, TETIS Lab and LIRMM, University of Montpellier 2: *Data mining for hydrological data* (67, 68)

Visiting professors and students (more than one week)

- Cédric Chauve, Simon Fraser University (Vancouver), Associate Professor, 1 month, 2008.
- Sylvie Hamel, Université de Montréal, Professor, 1 month, 2010
- Neocles Leontis, Bowling Green State University (Ohio), Professor, 1 week, 2009
- Ulf Leser, Humboldt Universität zu Berlin, Professor, 6 months, 2010
- Paolo Missier, University of Newcastle, Lecturer, 2 weeks, 2013
- Vladimir Reinharz, McGill University, PhD Student, 6 months, 2013.
- Jérôme Waldispühl, McGill University, Associate Professor, 1 month, 2012.

Other Collaborations

- B. Ludascher, University of UC Davis: *Provenance in scientific workflows*.
- R. Giegerich, University of Bielefeld: *RNA bioinformatics*.
- S. Schuster, University of Friedrich-Schiller, Germany : *Thermodynamic elementary flux modes*
- A. Levchenko, Yale University, US : *Eukaryotic chemotaxis using gradient sensing*
- M. Safey El Din, University of Paris 6: *Thermodynamic elementary flux modes*
- L. Simon, IASI and University of Bordeaux 1 (LABRI): Metabolic Network Analysis by SAT solvers
- Ph. Chatalic, IASI and Lahdak group: Reasoning for biological networks
- M. Herschel, BD and Lahdak group: Data management of massive heterogeneous data
- M-C. Gaudel, Fortesse and VALS group: Random generation and Test.

Group seminar

During the period, our seminar series (joint with the LIX within the AMIB project) has been very active: there were 87 talks. Most of them were given by invited researchers: 35 foreign researchers and 30 French researchers from other groups. The other talks were given during internal seminars by members or associate members of the group (from AMIB and IGM).

Participation to national and international networks

- The whole group is involved in GDR-BIM (Molecular Bioinformatics, <http://www.gdr-bim.u-psud.fr/>). Alain Denise was the director from its creation in 2006 to 2009. Since then, he is a member of the Scientific Committee. J. Azé has been the webmaster of the website from 2006 to 2012.
- Some members of the group participate to the *GdR Mathématique Informatique*, notably to the *ALEA* and *Co-matege* working groups.
- Most of the members of the group participate in the *Société Française de Bioinformatique*.
- Some members participate to the *Société Informatique de France*.
- The group is a member of the CAPRI scoring challenge.
- The group participates to the "Provenance Challenges" series.

Participation to "investissement d'avenir" program

The Bioinfo group belongs to the **labex DigisCosme** (all of its members fit into the "DataSense" action line).

It participates to the projects of the IMSV institute (**Institut de Modélisation des Sciences du Vivant**) which aims at promoting the interdisciplinary Systems Biology area within the IDEX Paris Saclay, and one of its members is in its steering committee.

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Volunteer Professional Service

Management Positions in Scientific Organisations

- *Conseil de Laboratoire du LRI*: P. Amar, member since 2010; A. Denise, member since 2006.
- *Polytech Paris-Sud*: J. Azé, Coordinator of the third year, 2008-2010.
- *Computer Science Department of Polytech Paris-Sud*: S. Cohen-Boulakia, Coordinator of the last year (5th), since 2009.

- *Polytech Paris-Sud*: S. Cohen-Boulakia, member of the advisory board of Polytech Paris Sud (conseil de perfectionnement).
- *Sénat Académique du Campus de Paris-Saclay*, A. Denise, member since 2013.
- *Computer Science Department of Paris-Sud University*: A. Denise, Deputy Director (in charge of teaching), since 2012.
- *GdR de Bioinformatique Moléculaire*: A. Denise, member of the Scientific Committee, since 2010; J. Azé webmaster.
- *GdR de Bioinformatique Moléculaire*: A. Denise, Director, 2006-2009.
- *UFR des Sciences, University Paris Sud*: A. Denise (since 2008) and Ch. Froidevaux (2009-2012), member of the Scientific Committee.
- *UFR des Sciences of Versailles University*: A. Denise, member of the Scientific Committee, 2003-2011.
- *Computer Science Department of Paris-Sud University*: Ch. Froidevaux, Director, 2009-2012.
- *Société Informatique de France (SIF)*: Ch. Froidevaux, Member of the board of directors (CA), since 2013.
- *IDEX Paris-Saclay*: Ch. Froidevaux, STIC correspondent for the IDEX Teaching working group (GT Formation), Saclay, 2011.
- *Paris-Saclay*: Ch. Froidevaux, co-head of the working group on the "Master of Bioinformatics" of the future university Paris Saclay, 2013.

Organisation of Conferences and Scientific Events

- Joint workshop to ICML, *Object, functional and structured data: towards next generation of kernel-based methods*, Edinburgh, 2012, F. d'Alché-Buc, co-organizer.
- MCBS, *Modelling Complex Biological Systems in the context of genomics*, Evry 2012 and 2010, Sophia Antipolis (2011), Nice (2009), Lille (2008): P. Amar member of the steering committee, Chair of the organizing committee.
- ASSB, *Advances in Systems and Synthetic Biology*, Nice (2013): P. Amar member of the steering committee, Chair of the organizing committee.
- DKQ, *Data and Knowledge Quality*, 2009-2011: J. Azé co-chair of the organizing committee, member of the steering committee.
- DILS, *Data Integration in the Life Sciences*, Evry, 2008: S. Cohen-Boulakia, Ch. Froidevaux, co-chairs of the organizing committee.
- DILS, *Data Integration in the Life Sciences*, since 2009: S. Cohen-Boulakia member of the steering committee.
- MOQA, workshop on *Metadata, Ontologies and Quality of Annotation*, GDR BIM, Orsay 2009: S. Cohen-Boulakia and Ch. Froidevaux.
- JOURNÉES DU GDR DE BIOINFORMATIQUE MOLÉCULAIRE, Paris 2009: A. Denise, co-chair of the organizing committee.
- PPF, *Journées du PPF Bioinformatique et Biomathématiques*, Seillac 2009: Ch. Froidevaux, co-chair of the steering committee.
- BSS, *Approches quantitatives de la complexité biologique*, Colloque fondateur du Pôle *Biologie Systémique et Synthétique* du PRES UniverSud Paris, Orsay 2008: Ch. Froidevaux member of the steering committee.

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Honors

Awards

- J. Azé, T. Bourquard and D. de Vienne, *Best application paper* (EGC 2013)
- S. Cohen-Boulakia, *ICDE*, 2010: Outstanding Reviewer Award

Keynote Addresses and invited talks

International

- S. Cohen-Boulakia, *Dagstuhl seminar on Principles on Provenance*, 2012: current challenges and opportunities in the field of Data Integration in the Life Sciences at Internet Memory.

- A. Denise, *GASCom: Random Generation of Combinatorial Structures*, Bordeaux 2012: Random generation in computational biology.
- A. Denise, *Workshop on Optimization and Machine Learning: Theory, Algorithms and Applications*, Metz 2011: RNA bio-algorithmics : some optimization problems in structural bioinformatics.
- A. Denise, *Lacim 2010 conference*, Montreal 2011: Combinatoire pour la bioinformatique des structures moléculaires.
- A. Denise, *Computational methods for RNA analysis*, Benasque 2009: The algorithmic complexity of RNA 2D structure alignment.
- S. Peres, *Dagstuhl seminar 12462 on Symbolic Methods for Chemical Reaction Networks*, 2012: Modelling Complex Biological Systems in the Context of Genomics.

France

- P. Amar, *Ecole de Printemps 2012 de la Société Francophone de Biologie Théorique*, Saint-Flour 2012: Comparative study of some methods for simulation of biochemical reactions.
- S. Cohen-Boulakia, *national thematic school Masses de données distribuées (Summer School)*: Data Integration in the Life Sciences.
- A. Denise, *Colloque "Les 20 ans du LaBRI"*, 2011: La bio-informatique : une avancée pour la biologie ou pour l'informatique ?

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Evaluation of Research

Editorial Boards

- JoDS, *Journal on Data Semantics*, Springer, S. Cohen-Boulakia (since 2008)
- TSI, *Technique et Science Informatiques*, Hermès, A. Denise
- 1024, *Bulletin de la Société Informatique de France*, SIF, Ch. Froidevaux (since 2013)

Program Committees

Chair

- DILS, *Data Integration in the Life Sciences*, co-program chairs and co-general chairs, S. Cohen-Boulakia and Ch. Froidevaux, 2008
- JOBIM, *Journées Ouvertes en Biologie, Informatique et Mathématiques*, co-program chair, Ch. Froidevaux, 2011

Member (international events)

- MCBS, *Modelling Complex Biological Systems in the context of genomics*, P. Amar, 2008 to 2013
- ICDE *International Conference on Data Engineering*, S. Cohen-Boulakia, 2012
- SWEET, *International workshop on Scalable Workflow Enactment Engines and Technologies*, S. Cohen-Boulakia, 2009-2012
- VLDB, *International Conference on Very Large Data Bases*, S. Cohen-Boulakia, 2011
- ICDE, *International Conference on Data Engineering*, S. Cohen-Boulakia, 2010
- SSDBM, *International conference on Scientific and Statistical Database Management*, S. Cohen-Boulakia, 2009 and 2011
- ISWC, *International Workshop on the role of Semantic Web in Provenance Management*, S. Cohen-Boulakia, 2009-2010
- DILS, *Data Integration in the Life Sciences*, S. Cohen-Boulakia and Ch. Froidevaux, 2008 to 2012
- CMBS, *International Symposium on Computer-Based Medical Systems, IEEE CBMS special track on Computational Proteomics*, Ch. Froidevaux, 2008-2010, 2012

- NETTAB, *International Workshop on Network Tools and Applications in Biology, on Integrated Bio-Search*, Ch. Froidevaux, 2012
- ICCS, *Workshop on Biomedical and Bioinformatics, Challenges to Computer Science*, Ch. Froidevaux, 2008-2009, 2012
- EDBT, *International Conference on Extending Database Technology*, Ch. Froidevaux, 2010
- IB, *International Symposium on Integrative Bioinformatics*, Ch. Froidevaux, 2010, 2011
- ECCB *European Conference on Computational Biology*, S. Peres, 2012

Member (national events)

- JOBIM, *Journées Ouvertes en Biologie, Informatique et Mathématiques*, F. D'Alche-Buc 2012, Ch. Froidevaux, 2009-2010, 2012-2013
- EGC, *Extraction et Gestion des Connaissances*, Bordeaux, J. Azé and Ch. Froidevaux, 2009-2012
- BDA, *Bases de données avancées*, S. Cohen-Boulakia, 2009 and 2012

Evaluation Committees and Invited Expertise

- Member of the *Comité National de la Recherche Scientifique*, Section 7 (*Sciences et Technologies de l'Information*) and CID 43 (*Modélisation des systèmes biologiques, Bioinformatique*), A. Denise, 2008-2012.
- Member of the *Comité National de la Recherche Scientifique*, CID 44 (*Modélisation des systèmes biologiques, Bioinformatique*), Ch. Froidevaux, 2003-2008.
- AERES EVALUATION COMMITTEES:
 - I3S (Université de Nice Sophia Antipolis and CNRS) and Rennes INRIA Research Center, AERES evaluation committees, A. Denise, 2011.
 - TIMC (Université Joseph Fourier and CNRS), LITIS (INSA de Rouen, Universités de Rouen et du Havre), IML (Université de la Méditerranée et CNRS), and SYSDIAG (CNRS et Bio-Rad) AERES evaluation committees, A. Denise, 2010.
 - LIRMM (Université de Montpellier and CNRS), and MIA Research Unit at AgroParisTech, AERES evaluation committees, A. Denise, 2009.
 - "Modélisation en Recherche Clinique" unit and "Atelier de BioInformatique" unit, AERES evaluation committees, A. Denise, 2008.
 - IRISA INRIA Research Center (Rennes), AERES evaluation committee, Ch. Froidevaux, 2010.
 - Lille INRIA Research Center, AERES evaluation committee, Ch. Froidevaux, 2009.
 - LIM laboratory (Laboratoire d'Informatique Médicale, Rennes) and LIFL (Lille) laboratories, AERES evaluation committee, Ch. Froidevaux, 2008.
- OTHER EVALUATION COMMITTEES:
 - UNIVERSITY OF LUXEMBOURG: A. Denise, external evaluation committee, 2008.
 - DGRI: : A. Denise, expert for the *Direction Générale de la Recherche et l'Innovation* of the French research Ministry, since 2008.
 - Member of the *Commission Scientifique Spécialisée "Mathématique, Bioinformatique et Intelligence Artificielle"* of the French Institute of research in Agronomy (INRA): A. Denise, 2003-2010.
 - Member of the Evaluation Committee and the Follow-up Committee of the programme "Masses de Données et Connaissances" of the ANR: A. Denise, 2006-2010.
 - Member of the transverse group of experts in Bio-Engineering of the CNRS ST2I Department: A. Denise, 2007-2008.
 - PES: Ch. Froidevaux, member of the national committee for selection of candidates for a Prime d'Excellence Scientifique, French Ministry, Paris, 2010.
 - DIM (Ile-de-France): Ch. Froidevaux, member of the committee, 2011.

Other evaluation activities

- HIRING COMMITTEES:
 - Member of hiring committees for an Associate Professor position (MCF), Bordeaux I University 2009, Nice University 2011: P. Amar.
 - Member of hiring committees for an Associate Professor position (MCF), ENSIEE 2009, AgroParisTech 2010 and Orsay 2007, 2008, 2010 and 2013: J. Azé.
 - Member of hiring committees for an Associate Professor position (MCF), Orsay 2013: S. Cohen-Boulakia.
 - President of hiring committees for an Associate Professor position (MCF), Ecole Centrale de Nantes 2012 (CNRS chairs program), Bordeaux I University 2009: A. Denise.

- Member of hiring committees for an Associate Professor position (MCF), Bordeaux I 2013, Nantes 2011, Nice and Orsay 2010, Marne-la-Vallée 2009 (CNRS chairs program) : A. Denise.
- Member of an hiring committee for a Full Professor position, University of Luxembourg 2008: A. Denise.
- Member of hiring (admission) committees for CNRS pluridisciplinary research positions (CR2 and CR1), 2010 and 2011: A. Denise.
- Member of hiring committees for a Full Professor position (Pr) Polytech Paris Sud, Orsay 2013 and INSA Lyon 2011: Ch. Froidevaux
- Member of an hiring committee for an Associate Professor position (MCF IGM), Orsay 2012: Ch. Froidevaux
- Member of hiring committees for INRIA research positions, CR2 and CR1 Bordeaux 2011 and CR2 Grenoble 2008: Ch. Froidevaux.
- DOCTORAL SCHOOL SCIENTIFIC COMMITTEES
 - Scientific Committee of the Science and Technologies (STV) Doctoral School of Versailles University: A. Denise, since 2010.
 - Scientific Committee of the "Genes, Genomes, Cells" (GGC) Doctoral School of Paris-Sud University: A. Denise, 2006-2009.
 - Scientific Committee of the Computer Science Doctoral School of Paris-Sud University: A. Denise, 2004-2012; Ch. Froidevaux, since 2012.
- REVIEWS FOR PHD THESES AND HABILITATIONS (HDR)
 - Reviewer of 13 PhD Theses and 6 HdRs: A. Denise, since 2008.
 - Reviewer of 4 PhD Theses: Ch. Froidevaux, 2011-2012.
- OTHER
 - Member of the *Conseil de Laboratoire du LRI*: P. Amar, since 2010, A. Denise, since 2006.
 - Member of the Scientific Committee of the *UFR des Sciences* of Versailles University: A. Denise, 2003-2011.
 - Co-chair of the *Commission Informatique de Centre* (CIC) of the INRA Jouy-en-Josas Research Center: A. Denise, 2010-2013.
 - Member of the CUB (*Centre Universitaire de Bioinformatique*) of the University of Geneva: Ch. Froidevaux, since 2011.

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Interactions with the social, economic and cultural environment

Interaction with the economic environment

Almost all the members of the group are implied in courses of the **professional track of the Master BIBS** (cohabilitation with Ecole Polytechnique since 2010) and thus contribute to the development of the bioinformatics and technology watch in the companies. We have developed continuous relationships with a few companies who welcome our master students and with our alumni. In that context, a first **partnership with l'Oréal** has been started (design of data mining and machine learning methods for l'Oréal needs).

Dissemination

- *iMatch* (INRIA Match Making Technologies) Bio-Med Tech: presentation of the HSiM, BioGuide and GeneValorization Software, P. Amar and S. Cohen-Boulakia.
- *Business Objects-SAP*: S. Cohen-Boulakia, presentation of BioGuide (with demo), mars 2008.
- *Internet Memory*: S. Cohen-Boulakia, presentation of BioGuide and GeneValorization (with demo), mai 2012.

Popularisation of Research Results

- *Seminar at Centre d'Alembert*, J. Azé, "Du génome à l'interactome à l'aube des NGS de 3ème génération", Orsay, University of Paris-Sud, April 2012.
- *Fête de la Science*: RNA folding algorithms, J. Azé, Moulon Saclay, 2011.
- *AB-Life company*, Wuhan (China), A. Denise, Course (6h): *RNA structure prediction*, February 2013.

- *1024, Bulletin de la SIF*: Ch. Froidevaux is member of the Editorial Board of 1024, the journal of the Société Informatique de France since 2013.
- *Femme et Sciences*, colloque "Nouveaux parcours, doubles cursus et passerelles à l'Université; Sont-ils favorables aux femmes dans l'entreprise et la recherche ?", Ch. Froidevaux, talk on "Le double cursus en bioinformatique", April 2013.

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
ANR	AMIS ARN	Université Paris XI	10.2009 / 36 mo.	73.47 k€
ANR	Brasero	CNRS	11.2006 / 36 mo.	94.00 k€
ANR	MICROBIOGENOMICS	CNRS	12.2005 / 43 mo.	138.67 k€
ANR	RNA-RECOD	CNRS	11.2006 / 36 mo.	55.69 k€
DIGITEO	JAPARIN-3D	DIGITEO	09.2012 / 48 mo.	102.2 k€
DIGITEO	PASAPAS	DIGITEO	10.2007 / 36 mo.	99.12 k€
DIGITEO	RNAomics	DIGITEO	06.2008 / 48 mo.	237.20 k€
PPF	Bioinformatique et Biomathématique	Université Paris XI	01.2006 / 48 mo.	167.00 k€
Public	AFON-PRES	PRES Uni-versSud	01.2010 / 24 mo.	15.00 k€
Public	FungiMass	CNRS	07.2012 / 18 mo.	5.00 k€
Public	GDR BIM	CNRS	01.2006 / 48 mo.	145.00 k€
Public	INCA	Université Paris Sud	01.2005 / 48 mo.	37.00 k€
Public	PI-Vert	CNRS	04.2005 / 36 mo.	3.00 k€
Public	RegRNAs	EGIDE	01.2007 / 24 mo.	10.00 k€
Public	RNA 3D Motifs	Région IdF	04.2008 / 46 mo.	7.50 k€
Public	PPI-RepCo	UEVE	07.2012 / 18 mo.	7.50 k€

AMIS ARN

Partners: PRISM Versailles, IBMC Strasbourg

See <https://www.lri.fr/~denise/AMIS-ARN/>

Type: ANR
Amount: 73.47 k€
Duration: 36 months
Scientific director for LRI:
Alain Denise

Briefly, modeling (large) RNA structures relies on two complementary approaches. The approach by homology is used when the structure of a sequence homologous to the sequence of interest has already been resolved experimentally. The main problem then is to calculate an alignment between the known structure and the sequence. The *ab initio* approach is required when no homologous structure is known for the sequence of interest. It is also used, complementarily to the approach by homology, to predict the structure of parts of the sequence that does not correspond with the known structure. We worked simultaneously on both approaches. For this purpose, we have developed algorithms that use particular concepts such as parameterized complexity, dynamic programming and game theory, and we have significantly improved and extended the functionality of the Assemble modeling platform developed by one partners.

Brasero

Partners: CNRS Nord Pas de Calais et Picardie, Université Bordeaux 1, Université Lyon 1

See <http://brasero.labri.fr/>

Type: ANR
Amount: 94 k€
Duration: 36 months
Scientific director for LRI:
Alain Denise

The purpose of this project was to provide relevant and efficient tools for the RNA comparison problem. By representing RNA structures at different scale levels by arborescent combinatorial structures, we developed new comparison algorithms and we thoroughly studied their properties. We also were able to give a precise idea of what makes intrinsically the problems of RNA structure comparisons computationally

difficult. Based on these above work, we developed several programs for comparing and visualizing RNA structures. We made them available online on web servers. In order to test them, we developed, in a close collaboration between computer scientists and biologists, a public benchmark based on real data and real case situations.

MICROBIOGENOMICS

Partners: IGM (Institut de Génétique Moléculaire), INRA Jouy MIG (Mathématique, Informatique, Génomique)

See <http://microbiogenomics.u-psud.fr/>

Type: ANR
Amount: 138.67 k€
Duration: 43 months
Scientific director for LRI:
Christine Froidevaux

This project aimed to meet the challenges raised by the present and future deluge of genomic data by designing an integrated resource for microbial genomics. We have gathered together the maximum of relevant data within a relational data warehouse and have made them available to various approaches of data mining in spite of their heterogeneity. A graphic interface has been designed to allow efficient, simple still expressive queries in order to extract relevant pieces of knowledge through a visual and interactive system.

RNA-RECOD

Partners: IGM Orsay (Université Paris-Sud 11), Division of Virology (University of Cambridge, UK), Division of Structural Biology (University of Oxford, UK)

Type: ANR
Amount: 55.69 k€
Duration: 36 months
Scientific director for LRI:
Alain Denise

Normal decoding could be diverted by sequences and structures on the mRNA and led to recoding (e.g. -1 and +1 frameshifting, pyrrolysine incorporation). Analysing these variations constitutes a powerful tool to understand the normal functioning of the translational machinery. The project gathered together several complementary approaches including biochemistry, genetics, molecular and structural biology and bioinformatics. Our group notably contributed in characterizing the secondary structure (PYLIS) that involves pyrrolysine incorporation in messenger RNAs in *archaea*.

PASAPAS

Partners: PRISM (Université de Versailles-St-Quentin)

Type: DIGITEO
Amount: 99.12 k€
Duration: 36 months
Scientific director for LRI:
Alain Denise

This project aimed to progress towards the problem of predicting the tridimensional structure of an RNA, from its sequence. We proposed an original approach, based on graph algorithms and game theory, for predicting a coarse-grained global architecture of a RNA molecule.

RNAomics

Partners: LIX (Ecole Polytechnique)

Type: DIGITEO
Amount: 237.20 k€
Duration: 48 months
Scientific director for LRI:
Alain Denise

This general project on RNA bioinformatics was linked to the Digiteo Chair of Peter Clote, in collaboration with LIX and LRI. It led to several collaborative works on RNA combinatorics and prediction of RNA structures.

JAPARIN-3D

Partners: PRISM (Université de Versailles-St-Quentin)

Type: DIGITEO
Amount: 102.2 k€
Duration: 48 months
Scientific director for LRI:
Alain Denise

This project follows the PASAPAS project: given the promising results that we we obtained, we aim to investigate further our coarse-game-theory approach for predicting the global shape of an RNA molecule.

AFON-PRES

Partners: INRA Jouy, MIG

In collaboration with INRA MIG, we have investigated a method for semi-automatic functional annotation with an active learning approach. We have proposed a refined annotation tool by placing the expert at the center of the process. This new method has been implemented and integrated into the AGMIAL platform at MIG.

Type: Public
Amount: 15.00 k€
Duration: 24 months
Scientific director for LRI:
Christine Froidevaux

FungiMass

Partners: IGM Orsay (Université Paris-Sud 11), UMR GV (INRA Moulon)

In collaboration with IGM and with UMR GV, we aim to understand how metabolic networks of fungi have been able to build over time among the variety of species, and how these changes could be responsible for characteristic life traits. We notably focus on the capability of some fungi groups to degrade the biomass.

Type: Public
Amount: 5.00 k€
Duration: 18 months
Scientific director for LRI:
Christine Froidevaux

PPI-RepCo

Partners: IBISC (UEVE), INSERM U 467 (Paris Descartes)

The aim of this project is to design an *in silico* method to predict new interaction targets in a protein-protein network, by enriching the protein descriptors. The method is applied to a network of human proteins around the CFTR protein, which plays a role in mucoviscidosis disorder.

Type: Public
Amount: 7.50 k€
Duration: 18 months
Scientific director for LRI:
Christine Froidevaux

Private contracts and grants (jan 2008 - jun 2013)

Type	Name	Managing Institution	Start / Duration	Amount
Industriel	LOREAL	CEPHYTEN	12.2010 / 31 mo.	25.00 k€

LOREAL

Partners: L'Oréal

In the context of this contract, we have developed specific data mining approaches able to meet the needs expressed by the company.

Type: Privé
Amount: 25 k€
Duration: 31 months
Scientific director for LRI:
Jérôme Azé

Software Licensing and Distribution

HSIM - Stochastic automaton for simulating biochemical processes in a virtual bacterium

<http://www.lri.fr/~pa/Hsim/index.html>

Contact: Patrick Amar

HSIM is a stochastic automaton driven by reaction rules between molecules used for modelling and simulating biochemical processes in a virtual bacterium. The stochastic simulation algorithm and its enhanced versions are adapted to simulate the behaviour of well stirred mixture of reactants when spatial localisation is not relevant; Conversely, in entity-centered methods, the causes and consequences due to spatial localisation are well handled.

GeneValorization - Gene List significance at-a-glance

<http://www.bioguide-project.net/gv/>

Contact: Sarah Cohen Boulakia

High-throughput technologies provide fundamental informations concerning thousands of genes. Most of the current biological research laboratories daily use one or more of these technologies and identify

lists of genes. Understanding the results obtained includes accessing to the latest publications concerning individual or multiple genes. Faced to the exponential growth of publications available, this task is becoming particularly difficult to achieve. Here, we introduce a web-based Java application tool named GeneValorization which aims at making the most of the text-mining effort done downstream to all high throughput technology assays. Regular users come from the Curie Institute, but also the EBI, Toronto (Canada), Bonn (Allemagne), and Montpellier and Bordeaux in France. GeneValorization gives a very clear and handful overview of the bibliography corresponding to one particular gene list.

BioGuide - Guiding scientists through biological sources

<http://bioguide-project.net/>

Contact: Sarah Cohen Boulakia

BioGuide/BioGuideSRS : this software helps the scientists choose suitable sources and tools, find complementary information in sources, and deal with divergent data. The paper related to the tool has been cited by ~26 research manuscripts (source: Google Scholar) so far. Since 2007 and up to now, BioGuide has 8,030 distinct users including regular users from the EBI (European Bioinformatics Institute), the Institut Curie and the Children's Hospital of Philadelphia.

SPFlow - SPFlow: Make your scientific workflows easier to use

<http://www.lri.fr/~chenj/SPFlow/>

Contact: Sarah Cohen Boulakia

Scientific workflow systems are numerous and equipped of provenance modules able to collect data produced and consumed during workflow runs to enhance reproducibility. An increasing number of approaches have been developed to help managing provenance information. Some of them are able to process data in a polynomial time but they require workflows to have series-parallel (SP) structures. Rewriting any workflow into an SP workflow is thus particularly important. SPFLOW answers this need and takes in a workflow (from the Taverna system) and provide a runnable and provenance equivalent (Taverna) workflow. The tool is currently used by Taverna's users from the University of Manchester and more generally by myExperiment users (a collaboration with Manchester has started and should significantly augment the number of potential users).

Cartaj - Classification Of RNA threeway Junctions

<http://cartaj.lri.fr/>

Contact: Alain Denise

CARTAJ automatically predicts the topological family of any RNA three-way junction, given only the information from the secondary structure: the sequence and the canonical Watson-Crick pairings can be used online. It is also meant for being part of RNA modelling softwares and platforms.

VARNA - VARNA: Visualisation Applet for RNA

<http://varna.lri.fr>

Contact: Alain Denise

A lightweight Java Applet dedicated to the quick drawing of an RNA secondary structure. VARNA is open-source and distributed under the terms of the GNU GPL license. Automatically scales up and down to make the most out of a limited space. Can draw multiple structures simultaneously. Accepts a wide range of documented and illustrated options, and offers editing interactions. Exports the final diagrams in various file formats (svg,eps,jpeg,png,xfig). VARNA currently ships in its 3.9 version, and consists in ~50 000 lines of code in ~250 classes. Downloaded ~10 000 times and cited by ~145 research manuscripts (source: Google Scholar).

Rna3Dmotif - Rna3Dmotif : Software for extracting RNA tertiary motifs

<http://rna3dmotif.lri.fr>

Contact: Alain Denise

Rna3Dmotif is a free bundle of three easy-to-install programs aimed to be used in combination to automatically extract recurrent RNA local tertiary motifs. The approach used is based on a graph representation of the RNA tertiary structure using LW nomenclature. It was applied to several widely studied

ribosomal RNA structures and the motifs thus found were deposited in a dedicated repository.

GenRGenS - GenRGenS: Generation of Random Genomic Sequences and Structures

<http://www.lri.fr/~genrgens/>

Contact: Alain Denise

A software dedicated to the random generation of sequences. Supports different classes of models, including weighted context-free grammars, Markov models, PROSITE patterns... GenRGenS currently ships in its 2.0 version, and consists in ~25 000 lines of code in ~120 Java classes. Downloaded ~5 000 times and cited by ~50 research manuscripts (source: Google Scholar).

GenoQuery - GenoQuery: A querying module for functional annotation in a genomic warehouse

<http://www.lri.fr/~chris/GenoQuery>

Contact: Christine Froidevaux

GenoQuery is a module for querying a relational genomic warehouse which is based on an original multi-layer architecture of the warehouse. The user can formulate SQL queries through an interface that displays the graph of biological entities. These queries allow searching for instances of biological entities and their properties in the different databases, without specifying in which database they have to be found.

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Training and Education

Master Internships

- Z. Aslaoui, Univ. Paris-Sud, 2009, 6 months
- W. Hamdam, Univ. Paris-Sud, 2009, 6 months
- A. Hamadi, Univ. Paris-Sud, 2010, 6 months
- N. Laignel, Univ. Paris-Sud, 2010, 6 months
- J. Li, Univ. Paris-Sud, 2010, 6 months
- A. Guilhaud-Gaudeffroy, Univ. Paris-Sud, 2011, 6 months
- M. Yahiaoui, Univ. Paris-Sud, 2011, 6 months
- M. Bouffard, Univ. Paris-Sud / SysDiag, 2012, 6 months
- B. Brancotte, Univ. Paris-Sud, 2012, 6 months
- H. Ibrahim, Univ. Paris-Sud, 2012, 6 months
- A. Rougny, ENS Lyon, 2012-2013, 9 months

Graduate Courses

MASTER OF BIOINFORMATICS AND BIOSTATISTICS (**BIBS**) of University Paris-Sud (M1 and M2, <http://www.bibs.u-psud.fr>): The master is co-headed by members of the group. A. Denise has co-headed the Master (M1 and M2) at the University Paris Sud until end August 2012. Ch. Froidevaux is co-heading it at the University since September 2012.

Since September 2010, BIBS is a joint Master between University Paris-Sud and Ecole Polytechnique (co-headed by J-M. Steyaert (LIX).

Most members of the group teach in Master BIBS and are in charge of courses in the "M2 Recherche":

- Modelling and Simulation of Biological Processes, 24h (P. Amar)

- Integration and Analysis of heterogeneous data from the Web, 24h, (J. Azé, S. Cohen-Boulakia, Ch. Froidevaux)
- Advanced Data Bases and Data Mining, 42h (S. Cohen-Boulakia, Ch. Froidevaux).
- Initiation to Research, 6h (Ch. Froidevaux)
- RNAomics and RNA Bioinformatics, 12h (A. Denise)
- Theoretical Computer Science, 30h (A. Denise)

MASTER OF COMPUTER SCIENCE, University Paris-Sud, M2 "Information, Apprentissage, Cognition", https://www.dep-informatique.u-psud.fr/formation/lmd/M2R_IAC:

- Données et connaissances pour le Web, 6h : Ch. Froidevaux (2010-2013)
- Intégration de données et Web Sémantique, 3h : Ch. Froidevaux or S. Cohen-Boulakia (2010-2013)

MASTER TELECOM BRETAGNE (ENSTB), "Introduction to bioinformatics, Data mining and Text Mining", 21h: J. Azé (2008-2010)

Internships

The Bioinfo group is involved in a **student partnership with McGill University**: partnership "France-Quebec" offering French and Canadian students co-supervised internships (short term -3 to 6 months- or long term -part of the PhD studies-).

Schools

- Ecole thématique de la SFBT (Société Francophone de Biologie Théorique), Saint-Flour 2012 (P. Amar)
- Summer school BDA "Masses de Données" 2012 (S. Cohen-Boulakia)
- Thematic research school Advances in Systems and Synthetic Biology, 2011 (Sophia Antipolis); 2012 (Evry); 2013 (La colle-sur-Loup) (S. Peres)
- Ecole thématique interdisciplinaire at Berder 2013 (S. Peres)

Other

Supervision of the Versailles **LEA** (Local Education Authority) Computer Science Junior lecturers' teaching programs for undergraduates (CIES): Ch. Froidevaux (2006-2009)

Honors

In February 2011, the Master of Bioinformatics and Biostatistics (**BIBS**) has been selected by the newspaper "Le Monde" among the "9 masters plébiscités par les étudiants et les entreprises".

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Thesis

Habilitation à Diriger des Recherches

Name	Defense
Jérôme AZÉ	11.2012

Defended thesis				
Name	Start	Defense	Funding	Advisor
Thomas BOURQUARD	01.12.2006	05.12.2009	Alloc. Ministère	A. Poupon (IBBMC), J. Azé
Mahassine DJELLOUL	01.12.2006	07.12.2009	Région IdF et Université	A. Denise
Lucie GENTILS	01.10.2004	26.09.2008	Alloc. Ministère	Ch. Froidevaux, J. Azé
Alexis LAMIABLE	01.09.2008	09.12.2011	Digiteo	A. Denise (avec D. Barth, PRISM)
Frédéric LEMOINE	01.10.2005	08.12.2008	Alloc. Ministère	Ch. Froidevaux (avec B. Labedan, IGM)
Feng LOU	01.09.2008	30.01.2012	Digiteo	A. Denise (avec P. Clote, Boston)
Thomas MONCION	01.11.2004	11.12.2008	Alloc. Ministère	A. Denise, P. Amar (avec G. Hutzler, IBISC)
Bastien RANCE	01.10.2005	28.09.2009	Alloc. Ministère	Ch. Froidevaux
Philippe RINAUDO	01.10.2009	05.12.2012	ANR	A. Denise (avec D. Barth, PRISM)
Cédric SAULE	01.10.2006	17.12.2010	Alloc. Ministère	A. Denise
Annelyse THEVENIN	01.10.2006	06.11.2009	Alloc. Ministère	A. Denise (avec S. Viallette, LIGM)
Yu ZHOU	01.09.2005	19.12.2008	Université (cotutelle)	A. Denise (avec Y. Zhang, Wuhan)

Thesis in progress				
Name	Start	Funding		Advisor
Mélanie BOUDARD	01.09.2012	Digiteo		A. Denise, (avec D. Barth et J. Cohen, PRISM)
Marc BOUFFARD	01.10.2013	Alloc. Ministère		P. Amar
Bryan BRANCOTTE	01.10.2012	Alloc. Ministère		A. Denise, S. Cohen Boulakia
Jiuqiang CHEN	15.09.2011	ETR-China Council	Scholarship	Ch. Froidevaux, S. Cohen Boulakia
Adrien GUILHOT-GAUDEFFROY	01.10.2011	Alloc. Ministère		Ch. Froidevaux, J. Azé (avec J. Bernauer, LIX)
Adrien ROUGNY	01.09.2013	Alloc. normalien		Ch. Froidevaux
Bo YANG	01.03.2011	Université (cotutelle)		A. Denise (avec Xiong-Dong Fu, Wuhan)
Cong ZENG	07.07.2011	China Scholarship Council		A. Denise

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Self Assessment

Strengths: The main strength of the Bioinfo group is to conduct works both leading to new theoretical results in computer science and significant biological findings. Our originality lies on the large pluridisciplinary aspect of the group. While we collaborate with various biological groups (joint Bioinformatics group at IGM; Sysdiag, a joint-institute between the biotech company Bio-Rad and CNRS, Montpellier; Curie Institute, Paris; IBMC, Strasbourg; INRA BIOS, Tours), our group also gathers computer scientists from various domains including algorithmics, graph theory, knowledge representation, databases, machine learning, and stochastic automata, making it possible to study a given biological problem from various and complementary perspectives. This high complementarity aspect has been strengthened by the creation of the INRIA AMIB project (INRIA Saclay) in 2009, gathering the Bioinfo group and LIX members with strong expertise in algorithmics and combinatorics on the structural bioinformatics theme.

Another important strength to notice is the visibility and the attractiveness of the group. At the international level, we have acquired a good visibility in several topics (especially RNA algorithmics and Data

integration) as evidenced by the (both mid-term and short-term) visits of several international professors in the group, financial agreements for co-supervising PhD theses, supporting travels, and common publications obtained. At the national level, we have been involved, often as leaders, in several projects (ANR, Digiteo). Our group has hired an assistant professor, a junior CNRS researcher and is happy to welcome an emeritus research director (DR). Our seminar series has also been very active with numerous invited talks, fostering discussion and exchange between biologists, bioinformaticians and computer scientists. Last but not least, from the local side, members of the Bioinfo group all teach in the Master of Bioinformatics and Biostatistics (BIBS, Professional and Research tracks, M2 joint Master between University Paris-Sud and Ecole Polytechnique) allowing to get contacts with companies on our research topics and to attract students with a strong pluridisciplinary background for internships and PhD theses (in the last five years, members of our group supervised 20 PhD students and doctors of our group have generally continued their research activity in recognized laboratories abroad).

Weaknesses: Members of the bioinfo group are very active in several aspects: collaborating with biological groups but also teaching and being strongly involved in the life of the computer science and bioinformatics communities. We consider all these aspects of our work as mandatory duties while they are, in essence, highly time-consuming.

Indeed, working in a bioinformatics setting implies waiting for experimental results to be performed to validate results, which may lead to publication delay. Additionally, it includes, even more than in other domains, developing softwares to provide proof-of-concepts of our approaches or make our solutions working in concrete contexts. No engineer belongs to the group to help in the development and valorization of our softwares.

Also, the very large majority of the group is strongly implied in teaching duties and involved in labor-intensive responsibilities both at national level (co-CNRS, GDR BIM) and local level (Computer Science department of the University, in the period of the creation of the "University Paris-Saclay" with the definition of a large computer science department and two Master programmes both in computer science and bioinformatics). The recent recruitment of a CNRS junior researcher (L. Paulevé) should tend to overcome this drawback.

Opportunities: From the scientific side, the new emerging technologies (high-throughput experiments) will provide many more biological data in a shorter time and at a lower price, requiring new developments of efficient bioinformatics methods, especially in Systems Biology and Comparative genomics. This will foster our research.

From the local organization of research side, the Bioinfo group will benefit from its involvement in the labex DigiCosme ("DataSense" action line), in the *Institut de Modélisation des Sciences du Vivant* (IMSV) whose objective is to promote the interdisciplinary Systems Biology area within the IDEX Paris Saclay, and in projects of the future *Université Paris Saclay*. See the Positioning part for more details.

Threats: Due to the leave of J. Azé to LIRMM (Montpellier) and the end of the INRIA delegation of F. d'Alché-Buc, research activities of the group based on Machine Learning approaches might be reduced in the next years but we plan to hire one of the next two assistant professors for the group on this thematic.

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Strategy and five-year project

Scientific Programme

We describe the main research topics that will be addressed during the next five years. As in the last period, we still want to address both computer science challenges raised by biological issues and bioinformatics challenges.

Structural bioinformatics

Our central object of study will be RNA: we will continue working on analysing and predicting how RNA folds and how it interacts with proteins, mainly at the three-dimensional level. Additionally, our expertise in

RNA 3D structure should allow us to make progress in analysing RNA-RNA intermolecular interactions.

Regarding RNA structure analysis and prediction, we will go on working both on the *ab initio* approach and the comparative approach. Our promising preliminary results on using a coarse-grained game-theory approach for predicting the global shape of a molecule have to be deepened. This is the subject of a common Digiteo project in collaboration with PRISM (Versailles). As for the comparative approach, we have to validate our still theoretical work: apply it on well-chosen benchmark sets, investigating relevant score parameters, developing user-friendly software for the community.

Meanwhile, we will study, notably in collaboration with IBMC (Strasbourg) and McGill (Montreal), how the so-called *interaction motifs* participate to building the 3D structure. RNA Interaction motifs are recurrent motifs, composed of canonical and non-canonical interactions, which connect two different secondary structure elements of a given molecule, or which connect two RNAs in the same complex. We will develop automated tools, based on graph representations, for extracting these motifs from known structures and for analysing their structural contexts. From these studies, we hope to be able to define new relevant criteria and parameters for predicting RNA 3D structures and intermolecular interactions.

Regarding RNA-protein interactions, our promising preliminary results on applying machine learning approaches at different scales have to be explored further. The scarcity of the experimental data available makes this ambitious project difficult. We plan to overcome this issue by combining our machine learning strategies with expert knowledge in structural biology. This could lead to an RNA-protein interaction prediction framework including thermodynamics and RNA sequence design based on knowledge-based strategies. The global aim of our project is to provide a generic efficient 3D modeling framework that could be refined through an iterative procedure involving experimentalists.

Systems biology and Data integration

As for the second activity, the two themes will be further developed.

Systems Biology Since a few years, we have established strong collaborations with several actors of systems biology, such as INRA Tours on the analysis of signalling networks, IGM on the evolution of metabolic networks, and Sysdiag on synthetic biology. These multiple collaborations bring new challenges on concrete applications, with a big potential for conducting new experiments.

We want to drive the development of innovative formal methods following the practical needs of these biologists. This goal both implies close communication with our partners in biology on specific applications, and theoretical developments in computer science in order to face the complexity of the biological systems.

Together with INRA Tours, our challenge is to get an expressive model of the GPCR networks in order to better understand the dynamics of the different signalling pathways. The objective is both to provide efficient automatic methods to infer potential interactions, and to propose modifications to the networks for altering their global dynamics. This could potentially lead to design side-effects-free drugs. Formalizations of the networks will be further investigated in collaboration with NII, and new collaborations with Potsdam University and INRIA Dyliss group are expected. Our collaborators at INRA Tours, in the context of the MAbImprove labex, are able to provide experimental data and conduct new experimentations to validate the hypothesis derived by our methods.

With IGM, we address the analysis of metabolic pathways evolution to better understand how characteristic life traits have emerged. Such a knowledge would then contribute to the design of new therapeutic molecules, bioremediation and biomass design. We are currently using machine learning and graphs comparison techniques, and we also plan to consider dynamical analysis. Our first focus is on fungi, and IGM both provides input data and conducts experimental validations.

We are also contributing to the determination of elementary flux modes (efms) in metabolic networks. The main scientific challenge is to improve the quality of automatically derived efms, by refining the relevance criteria, and reducing the computation time. For it, we aim at exploiting the latest advances in polynomial systems resolutions, SAT solving, diagnostic, and simulation. This project will be performed in collaboration with Jena University, LIP6, LaBRI, and LADHAK group at LRI and submitted to an ANR Jeunes Chercheurs program.

In a close collaboration with the Sysdiag lab, we will continue working on the ambitious synthetic biology project aiming to build a biological nano- computing device. This nano-computer is contained in

an artificial liposome, or in a droplet, and will be used for medical purposes, such as detection of human pathologies. The challenge is to test and implement new kinds of enzyme-based logical gates, and build a library of *biobricks*. At last, we plan to develop an integrated tool that will help the user to design, test and validate an artificial metabolic network that computes a given logical function.

Finally, we aim at developing new transversal techniques for modelling, simulating, and analysing the dynamics of biological networks, thanks to the recruitment of a CNRS researcher, L. Paulevé, and to its collaborations with ENS-Paris, IBM Research Zürich, DIMNP (Montpellier), and IRCCyN (Nantes). Such approaches include qualitative abstractions of the dynamics, model reduction, multi-scale modelling and large-scale verification of dynamical properties, as well as the identification of targets for controlling their emergence.

Investigating the dynamics of biological structures could be another promising research direction. Indeed, taking into account both structural and dynamical constraints should help narrowing current predictions of structures and interactions. Such a work will require expertise from the two fields studied by the group.

Data integration The current program has two main axes for which the team has International strong collaborations: (consensus) ranking of biological data and management of scientific workflows (with a specific focus on provenance). One of the first aims to achieve in our future work is to explore the relationships between those two domains, from the investigation of various specific problems posed by ranking scientific workflows to the problem of considering consensus workflows.

More generally, our aim is to collaborate more actively with National teams and in particular on the problems of interoperability of scientific workflow systems with the INRIA Zenith team in Montpellier. Last, recent results on ranking lead to the development of two software BioGuide and GeneValorization able to be connected to major NCBI databases. Very interestingly, such results are an outcome of a fruitful collaboration between specialists in algorithms and specialists in biological databases. This synergy will be amplified in the future.

Positioning in the local, national and international context

Researches in Bioinformatics have gained in attention and importance at Paris-Sud University in the last 10 years, and our group was one of the major players in this evolution. In particular, we were strongly involved in the creation of three entities: the Master of Bioinformatics and Biostatistics, the INRIA AMIB group with LIX, and the joint Bioinformatics research group with IGM. We have benefited from local collaborative clusters such as the RTRA Digiteo and the PRES UniverSud by granting collaborative projects of our group with LIX (Ecole Polytechnique), PRISM (Versailles) and IBISC (Evry). All the members of the Bioinfo group belong to the "DataSense" action line of the labex DigiCosme giving us the opportunity to extend our collaborations in computer science, and to be at the heart of an active and strong network on bioinformatics in the region. The next step is the creation of the Université Paris-Saclay: we participate to the multidisciplinary IMSV initiative (Institut de Modélisation des Systèmes Vivants) for modeling biological systems at several scales (IDEX project). The creation of the new Institute for Integrative Biology of the Cell (I2BC) at Gif/Yvette is another major opportunity to strengthen our collaborations with biologists. Last but not least, members of our group are major actors of the projects of creation of two new Masters (in Bioinformatics and Computer Science) of Paris-Saclay, involving a high number of partners including the University of Versailles and Evry, and several Engineering Schools.

At the national level, we are involved in the GdR "Bioinformatique Moléculaire" and "Mathématiques-Informatique", and in several working groups within these GdRs. We will continue our close collaborations with several groups in France, notably with computer scientists and bioinformaticians who work in the same fields as us, and with biologists who bring us their expertise in structural biology or in systems biology.

At the international level, we collaborate with several renowned groups (from USA, Canada, Germany, UK...) and we are involved in international networks within our communities. Up to now these collaborations have led to joint publications and fundings for exchange of researchers (mid-term visits). We are currently actively working in applying to international grants (notably European grants and French-North American grants).



BioInfo Publications

Journal articles

Major international journals

- (1) P. Amar, G. Legent, M. Thellier, C. Ripoll, G. Bernot, T. Nystrom, M. S. Jr, and V. Norris. A stochastic automaton shows how enzyme assemblies may contribute to metabolic efficiency. *BMC Systems Biology*, 2(27), 2008.
- (2) S. Angibaud, G. Fertin, I. Rusu, A. Thevenin, and S. Vialette. Efficient tools for computing the number of breakpoints and the number of adjacencies between two genomes with duplicate genes. *Journal of Computational Biology*, 2008.
- (3) M. Barba, N. Glansdorff, and B. Labedan. Evolution of cyclic amidohydrolases: A highly diversified superfamily. *Journal of Molecular Evolution*, pages 1–11, 2013.
- (4) G. Blin, A. Denise, S. Dulucq, C. Herrbach, and H. Touzet. Alignment of RNA structures. *IEEE/ACM Transactions on Computational Biology and Bioinformatics*, 7(2):309 – 322, 2010.
- (5) T. Bourquard, J. Bernauer, J. Azé, and A. Poupon. A collaborative filtering approach for protein-protein docking scoring functions. *PLoS One*, 6(4):e18541, apr 2011.
- (6) B. Brancotte, A. Biton, I. Bernard-Pierrot, F. Radvanyi, F. Reyat, and S. Cohen-Boulakia. Gene list significance at-a-glance with genevalorization. *Bioinformatics*, 27(8):1187–1189, 2011.
- (7) C. Brouard, J. Dubois-Chevalier, C. Vrain, D. Castel, M.-A. Debily, and F. d’Alche-Buc. Learning a Markov Logic Network for supervised gene regulatory network inference. *BMC Bioinformatics*, 14(1), Jun 2013.
- (8) S. Cohen-Boulakia, J. Chen, P. Missier, C. Goble, A. R. Williams, and C. Froidevaux. Distilling structure in taverna scientific workflows: A refactoring approach. *BMC Bioinformatics*, (to appear), 2013.
- (9) S. Cohen-Boulakia and U. Leser. Search, adapt, and reuse: the future of scientific workflows. *Sigmod Record*, 2011.
- (10) K. Darty, A. Denise, and Y. Ponty. VARNAs: Interactive drawing and editing of the RNA secondary structure. *Bioinformatics*, 25(15):1974–1975, Apr 2009.
- (11) D. de Vienne and J. Azé. Efficient Prediction of Co-Complexed Proteins Based on Coevolution. *PLoS One*, nov 2012.
- (12) A. Denise, M.-C. Gaudel, S.-D. Gouraud, R. Lassaigne, J. Oudinet, and S. Peyronnet. Coverage-biased random exploration of large models and application to testing. *JSTT, International Journal on Software Tools for Technology Transfer*, 14(1):73–93, 2012.
- (13) A. Denise, Y. Ponty, and M. Termier. Controlled non uniform random generation of decomposable structures. *Theoretical Computer Science*, 411(40–42):3527–3552, 2010.
- (14) M. Djelloul and A. Denise. Automated motif extraction and classification in RNA tertiary structures. *RNA*, 14(12):2489–2497, 2008.
- (15) I. Fagnot, G. Lelandais, and S. Vialette. Bounded list injective homomorphism for comparative analysis of protein-protein interaction graphs. *Journal of Discrete Algorithms*, 6(2):178–191, jun 2008.
- (16) S. J. Fleishman, T. A. Whitehead, E.-M. M. Strauch, J. E. Corn, S. Qin, H.-X. X. Zhou, J. C. Mitchell, O. N. Demerdash, M. Takeda-Shitaka, G. Terashi, I. H. Moal, X. Li, P. A. Bates, M. Zacharias, H. Park, J.-S. S. Ko, H. Lee, C. Seok, T. Bourquard, J. Bernauer, A. Poupon, J. Azé, S. Soner, and E. Al. Community-wide assessment of protein-interface modeling suggests improvements to design methodology. *Journal of molecular biology*, sep 2011.
- (17) C. Herrbach, A. Denise, and S. Dulucq. Average complexity of the Jiang-Wang-Zhang pairwise tree alignment algorithm and of a RNA secondary structure alignment algorithm. *Theoretical Computer Science*, 411(26-28):2423 – 2432, 2010.
- (18) A. Lamiable, F. Quessette, S. Vial, D. Barth, and A. Denise. An algorithmic game-theory approach for coarse-grain prediction of RNA 3D structure. *IEEE/ACM Transactions on Computational Biology and Bioinformatics*, 10(1):193–199, 2013.

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- (20) F. Lemoine, B. Labedan, and C. Froidevaux. GenoQuery: a new querying module for functional annotation in a genomic warehouse. *Bioinformatics*, 24(13):i322–329, 2008.
- (21) N. Lim, Y. Senbabaoglu, G. Michailidis, and F. d’Alche-Buc. Boosting an operator-valued kernel-based model for gene regulatory network inference. *Bioinformatics*, 29(11):1416–1423, Jun 2013.
- (22) W. Liu, Y. Zhou, Z. Hu, T. Sun, A. Denise, X.-D. Fu, and Y. Zhang. Regulation of splicing enhancer activities by RNA secondary structures. *FEBS Letters*, 584(21):4401–4407, 2010.
- (23) F. Lou and P. Clote. Thermodynamics of RNA structures by wang-landau sampling. *Bioinformatics (ISMB 2010)*, 26(15):i278–i286, Jun 2010.
- (24) V. Norris, P. Amar, G. Legent, C. Ripoll, M. Thellier, and J. Ovadi. Sensor potency of the moonlighting enzyme-decorated cytoskeleton. *BMC Biochemistry*, 14(3), 2013.
- (25) J. Oudinet, A. Denise, and M.-C. Gaudel. A new dichotomic algorithm for the uniform random generation of words in regular languages. *Theoretical Computer Science*, 502:165–176, 2013.
- (26) S. Rialle, L. Felicori, C. Dias-Lopes, S. Peres, S. El Atia, A. Thierry, P. Amar, and F. Molina. Bionetcad: design, simulation and experimental validation of synthetic biochemical networks. *Bioinformatics*, 26(18):2298–2304, 2010.
- (27) R. Rivière, D. Barth, J. Cohen, and A. Denise. Shuffling biological sequences with motif constraints. *Journal of Discrete Algorithms*, 6(2):192–204, June 2008.
- (28) C. Saule, M. Régnier, J.-M. Steyaert, and A. Denise. Counting RNA pseudoknotted structures. *Journal of Computational Biology*, 18(10):1339–51, oct 2011.
- (29) N. Seghezzi, P. Amar, B. Koebmann, P. R. Jensen, and M.-J. Virolle. The construction of a library of synthetic promoters revealed some specific features of strong Streptomyces promoters. *Applied Microbiology and Biotechnology*, 90(2):615–23, apr 2011.
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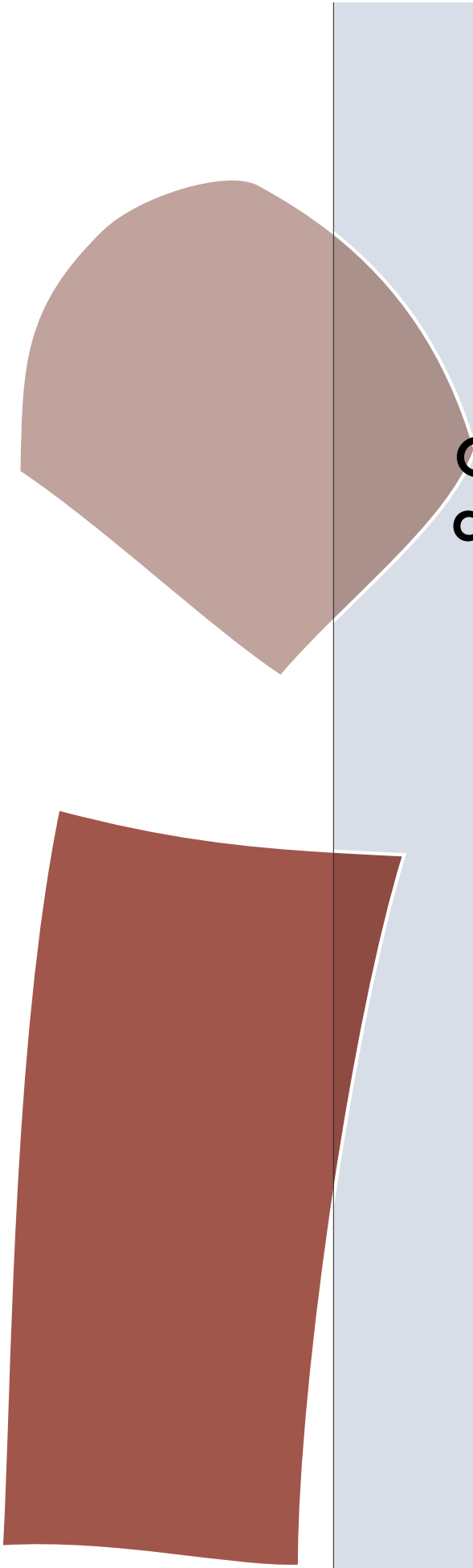
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4/ GALaC

Graphs, Algorithms and Combinatorics



équipe **Graphes, ALgorithmes et Combinatoire**

Responsable: Florent Hivert, Hao Li

L'équipe Algorithmique et Complexité est une équipe historique au LRI. Le travail est centré sur les fondements théorique du calcul: Algorithmique, Complexité et Combinatoire.

Le programme scientifique est structuré en trois activités: l'algorithmique des graphes, la combinatoire et la complexité des algorithmes classiques et quantiques. Le travail sur les graphes porte sur les graphes colorés par arêtes en vue d'applications à la biologie, au web et aux réseaux sociaux. En combinatoire sont étudiés divers aspect algébrique et énumératif (Algèbres de Hopf, théorie des représentations, partitions et q -série, combinatoire des mots) en lien avec les systèmes dynamiques, les systèmes de numération, et la complexité. La troisième activité s'intéresse au test de propriété, aux algorithmes en ligne, à la cryptographie, à la complexité de communication et aux algorithmes quantiques. La recherche s'appuie sur une forte composante expérimentale impliquant une participation importante au développement de logiciels de calculs (Sage).

Sur la période 2008-2013, l'équipe a connu une profonde réorganisation avec de nombreux départ et recrutement. En janvier 2013, l'équipe Algo s'est regroupée avec des membres des équipes Graphes, Parallélisme et Réseaux pour former l'équipe GALaC: Graphs, ALgorithms and Combinatorics.

En théorie des graphes, nos travaux portent sur des problèmes théoriques fondamentaux. Nous travaillons aussi sur la théorie des matroïdes et les approches spectrales dans les graphes. Certains problèmes étudiés ont des applications directes en réseaux de capteurs et réseaux sociaux.



Graphs, Algorithms and Combinatorics

Head: Florent Hivert, Hao Li

The Algorithmic and Complexity team is an historic team of the LRI. The work is centered on the theoretical foundations of computation: study of algorithms, complexity theory and combinatorics.

The scientific program is organized in three activities: Graphs algorithms, Combinatorics, and Complexity of classical and quantum algorithms. The work on graphs is mainly on edge-colored graphs, with important applications to biology, web technologies and social networks. In combinatorics various algebraic and enumerative aspects (combinatorial Hopf algebras, representation theory, partitions and q -series, combinatorics on words) are studied in relation to dynamical systems, numeration, and complexity analysis. The third activity covered mainly Property Testing, Streaming and Online Algorithms, Cryptography and Game Theory, Query and Communication Complexities as well as Quantum algorithms. The research work is strongly supported by computer experiments which require a large involvement in the development of open source mathematics software (Sage).

During the 2008-2013 time frame, the team witnessed a profound reorganization with many departures and hiring. Since January 2013, the Algo team gathered with former members of the Graphs, Parallelism and Network teams to create the GALaC team for Graphs, Algorithms and Combinatorics.

In graph theory, most of our work focuses on fundamental problems. We also work on matroid, and spectral approaches in graph theory. Some problems of graph theory that have practical background in energy conservation, in wireless sensor networks and social networks.

Research Group members

The GALaC team includes 16 permanent faculty (1 DR CNRS, 6 Professors, 3 CR-CNRS, 5 Assistant Professors), 11 doctoral students and 2 temporary personnel (post-docs).

Permanent Members (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
CHEN	Lin	MCF	PARIS SUD
COHEN	Nathann	CR2	CNRS
COHEN	Johanne	CR1	CNRS
DELAET	Sylvie	MCF	PARIS SUD
DEZA	Antoine	DR2	CNRS
DJELLOUL	Selma	MCF	PARIS EST
FIORENZI	Francesca	MCF	PARIS SUD
FLANDRIN	Evelyne	PREM	PARIS 5
FORGE	David	MCF	PARIS SUD
GOUYOU-BEAUCHAMPS	Dominique	PR1	PARIS SUD
HIVERT	Florent	PR1	PARIS SUD
LI	Hao	DR2	CNRS
MANOUSSAKIS	Yannis	PREX	PARIS SUD
MARTIGNON	Fabio	PR2	PARIS SUD
NASERASR	Réza	CR1	CNRS
THIÉRY	Nicolas	PR2	PARIS SUD

PhD students (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Funding</i>	<i>Institution</i>
ANGLES D'AURIAC	Jean-Alexandre	Alloc. Ministère	PARIS SUD
ARALDO	Andrea Giuseppe	DIGICOSME	PARIS SUD
BAI	Yandong	ETR	PARIS SUD
HE	Weihua	ETR	PARIS SUD
LEGAY	Sylvain	Alloc. Ministère	PARIS SUD
MANGILI	Michele	Alloc. Ministère	PARIS SUD
PRIEZ	Jean-Baptiste	Alloc. Ministère	PARIS SUD
SUN	Qiang	ETR	PARIS SUD
VIRMAUX	Aladin	Digitéo	PARIS SUD
YANG	Weihua	ETR	PARIS SUD
YU	Jihong	Alloc. Ministère	PARIS SUD

Temporary personnel (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
CHEN	Meirun	Post-Doc	PARIS SUD
MONTERO	Leandro Pedro	Post-Doc	PARIS SUD

The GALaC team is resulting from the merging of the Algo team and the Graphs theory group of the GraphComb team. The research activities of the Algo team over the five previous years will be first presented, followed by the research activities of the Graphs theory group, and finally the strategy and the five-year project of the GALaC team.

Algorithms: Synthetic presentation

Responsable de l'équipe : **Florent HIVERT** depuis Juin 2013 (Yannis MANOUSSAKIS jusqu'en mai 2013).

Effectifs de l'équipe

- Au premier janvier 2008, 13 permanents; enseignants-chercheurs: 1 MdC, 1 PR2, 3 PR1, chercheurs CNRS: 2 CR2, 3 CR1, 1 DR2, 2 DR1.
- Au 30 juin 2013, 6 permanents; enseignants-chercheurs: 1 MdC, 2 PR2, 1 PR1, 1 PrEx, chercheurs CNRS: 1 CR2.

Personnels ayant quitté l'équipe pendant le contrat en cours: 11

- Nisheeth Vishnoi, CR1, départ en mars 2009 pour UC Berkeley (USA)
- Sylvie Corteel, CR1 CNRS mutation en Septembre 2009 au LIAFA
- Jean-Paul Allouche, DR1 CNRS, mutation en Septembre 2010 à l'Institut de mathématiques de Jussieu
- Adi Rosen (DR2), Iordanis Kerenidis (CR1), Julia Kempe (DR2) et Frédéric Magniez (DR2), Miklos Santha (DR1), mutation en Octobre 2010 au LIAFA
- Pascal Ochem (CR2), Mutation en Juillet 2011, au Lirmm
- Sylvain Peyronnet, arrivé en fin 2010 depuis l'équipe Parall, MCF, recruté en Septembre 2012 professeur au GREYC, Université de Caen
- Sophie Laplante (PR2), mutation en septembre 2012 au LIAFA

Nombre de recrutements réalisés au cours de la période considérée et origine des personnels: 3 + 2

- Florent Hivert, Professeur Paris Sud, mutation en 2011 depuis le LITIS, Université de Rouen.
- Nicolas Thiéry, Professeur Paris Sud, recruté en 2012, était maître de conférences au laboratoire de Mathématiques d'Orsay.
- Nathann Cohen, CR CNRS 2012, était PostDoc à l'Université Libre de Bruxelles (Belgique) avec Jean Cardinal, thèse en 2012 à Sophia Antipolis.
- Deux chercheurs sont attendus: Johane Cohen (CR1 CNRS) en Septembre 2013 et Antoine Deza (DR2 CNRS) en janvier 2014.

Production scientifique au cours de la période écoulée

1. La définition et l'étude en profondeur des algèbres et monoïdes de BiHecke. Ce sont des contreparties algébriques d'algorithmes de tris, avec des applications en théorie des représentations et en combinatoire des polynômes multivariés. Cet exemple a permis de franchir la barrière formée par les monoïdes apériodiques, et on peut maintenant espérer étudier la théorie des représentations de tous les monoïdes.
2. L'étude combinatoire du modèle de physique théorique PASEP (Partially ASymmetric Exclusion Process) grâce aux tableaux de permutations. Cette étude a donné naissance à de nombreux nouveaux objets combinatoires.
3. Le projet Sage-Combinat : ALGO est coordinatrice d'une équipe internationale de développement de plus de cinquante chercheurs (organisation d'ateliers, nombreuses invitations, cours pour jeunes chercheurs, chapitres de livre).
4. La mise à jour de conditions suffisantes de type Dirac sur les degrés coloriés d'un graphe arête colorié, pour que le graphe en questions contienne des cycles et chaînes hamiltoniens. C'est la première fois que ce type de conditions est établi pour cette famille importante de graphes.
5. La détermination des paramètres optimaux du tirage à pile ou face et de la mise en gage de bit et étude d'autres primitives cryptographiques.

Bilan quantitatif des publications de l'équipe

- Articles de revues : majeures internationales : 49, autres : 18
- Livres et chapitres de livres: 3
- Articles de conférences : majeures internationales : 21, autres : 26
- Édition de livres: 3

5 publications majeures

1. Florent Hivert, Anne Schilling, and Nicolas M. Thiéry. The biHecke monoid of a finite Coxeter group and its representations, *Algebra and Number Theory*, Vol. 7(3), 595–671, 2013.
2. Dominique Gouyou-Beauchamps, Philippe Nadeau Signed enumeration of ribbon tableaux: an approach through growth diagrams, *Journal of Algebraic Combinatorics*, Vol. 36(1), pp 67-102, 2012.

3. J. Araujo and N. Cohen and F. Giroire and F. Havet, Good edge-labelling of graphs, Discrete Applied Mathematics, Vol. 160(18), pages 2502–2513, 2012.
4. A. Abouelaoualim, K. Ch. Das, W. Fernandez de la Vega, M. Karpinski, Y. Manoussakis, C. A. Martinhon and R. Saad, Cycles and Paths in Edge-Colored Graphs with Given Degrees. J. of Graph Theory 64(1) 63–86, 2010.
5. F. Magniez, C. Mathieu, A. Nayak. "Recognizing well-parenthesized expressions in the streaming model". In: Proceedings of 42nd ACM Symposium on Theory of Computing (STOC), 261–270, 2010.

5 (max) documents majeurs (autres que publications)

1. Participation au développement du logiciel Sage : l'équipe a contribué plus de 30000 lignes de code à Sage.
2. L'équipe coordonne le projet Sage-Combinat qui vise à améliorer le système Sage comme boîte à outils extensible pour l'exploration informatique en combinatoire, en fédérant et mutualisant les efforts de développements des chercheurs dans ce domaine. Sage-Combinat regroupe une cinquantaine de contributeurs internationaux (Europe, Amérique du Nord, Australie, Japon, Corée, etc.).
3. Rapports d'expertise (AERES, AERES Greque, NSF (USA), NSERC(Canada)).

5 (max) faits illustrant le rayonnement ou l'attractivité académique

1. Insigne de chevalier dans l'ordre national du mérite et prix Femme en or de la recherche, en 2010, pour J. Kempe.
2. Cofinancement National Science Foundation, USA, grant OCI-1147247, 2012-2015, Collaborative Research: SI2-SSE: Sage-combinat: Developing and Sharing Open Source Software for Algebraic Combinatorics \$500k.
3. Coorganisation du semestre thématique "Automorphic Forms, Combinatorial Representation Theory and Multiple Dirichlet Series" à l'Institute for Computational and Experimental Research in Mathematics (ICERM), Brown University, Providence, Rhode Island, USA (<http://icerm.brown.edu/sp-s13>). Coorganisation des conférences internationales "Sage Days 45", February 11 - 15, 2013, ICERM, Brown University, Providence, Rhode Island, USA et "Sage Days 49", June 17th-21st, Orsay, France et de l'atelier AIM "Online databases: from L-functions to combinatorics", January 21 to January 25, 2013 at the International Centre for Mathematical Sciences, Edinburgh, Scotland, UK.
4. Co-Chair of the 8th french combinatorial conference Orsay 2010 (350 participants), Co-Chair of the Workshop JGA 13-15 Novembre 2013, Orsay; organisation de la deuxième conférence IEEE "Computational Complexity", 2009, Paris.
5. Editorial boards: Applied and Computational Mathematics, Open Journal on Discrete Mathematics, ISRN Discrete Mathematics, Scientific committees: ICGT2014, Grenoble June 30-July 4, 2014, international workshop on discrete structures, University of Islamabad from March 5-7, 2014, FPSAC 2012.

5 (max) faits illustrant les interactions de l'équipe avec son environnement socio-économique ou culturel

1. Organisation de la Fête de la Science 2013.
2. Invitation exposé "Jonglerie Automate et Combinatoire" 24ème congrès MATH.en.JEANS 5 au 7 avril 2013.
3. S. Laplante. "Le plus grand des hasards : Surprises quantiques". In: ed. by J.-F. Dars and A. Papillaut. Belin, 2010. Chap. L'influence de l'informatique, pp. 152-154.
4. participation au GdR Informatique Mathématique.

Principales contributions de l'équipe à des actions de formation

1. Chapitres d'ouvrages pédagogique: A. Casamayou, N. Cohen, G. Connan, T. Dumont, L. Fousse, F. Maltey, M. Meulien, M. Mezzarobba, C. Pernet, N. M. Thiéry, P. Zimmermann : Calcul mathématique avec Sage, Licence libre : Creative Commons, France, 468 pages, publié le 30 mai 2013, ISBN: 1481191047.
2. Écoles pour jeunes chercheurs: Thierry Monteil, Nathann Cohen, Vincent Delecroix, Samuel Lelievre, Cours sur Sage dans le cadre de l'École Jeunes Chercheurs en Informatique Mathématique, 8-12 Avril 2013, Perpignan; Nicolas Thiéry : Cours et TP invités lors de l'École d'automne Mathématiques discrètes : aspects combinatoires, dynamiques et algorithmiques, Bobo-Dioulasso, Burkina Faso. <http://www.ragaad.org/bobo2012/>; École des Jeunes Chercheurs en Informatique Mathématique (2009, co-organisation) Participation à deux écoles thématiques sur l'informatique quantique à Montréal (2010)
3. Porteur du projet de création du parcours MIFOSA (parcours informatique théorique) dans le cadre de la création d'un master2 recherche mention informatique à l'Université Paris Saclay
4. Responsable du master Franco-Hellénique, master international commun entre les universités Paris-Sud, Joseph Fourier de Grenoble et université de Crète.

Research Group Members and evolution since 2008

Permanent Members (June 30th, 2013)

Name	First name	Position	Institution
COHEN	Nathann	CR2	CNRS
FIORENZI	Francesca	MCF	PARIS SUD
GOUYOU-BEAUCHAMPS	Dominique	PR1	PARIS SUD
HIVERT	Florent	PR1	PARIS SUD
MANOUSSAKIS	Yannis	PREX	PARIS SUD
THAPPER	Johan	ECC	PARIS SUD
THIÉRY	Nicolas	PR2	PARIS SUD

Doctoral Students (June 30th, 2013)

Name	First name	Funding	Institution
ANGLES D'AURIAC	Jean-Alexandre	Alloc. Ministère	PARIS SUD
PRIEZ	Jean-Baptiste	Alloc. Ministère	PARIS SUD
VIRMAUX	Aladin	Digiteo	PARIS SUD

Post Doc & Engineers (June 30th, 2013)

Name	First name	Position	Institution
HARUTYUNYAN	Ararat	Post-doc	Digiteo
MONTERO	Leandro Pedro	ATER Post-doc	PARIS SUD

Visitors (2008-2013)

Name	First name	Position	Institution	Arrival	Departure
FRAGOPOULOU	Paraskevi	PR	Techn. Educational Institute of Crete	1/09/2012	28/02/2013
AKIYAMA	Jin	PR	Tokyo Univ. of Science	1/10/2012	30/10/2012
TOLLIS	Yannis	PR	University of Crete	1/05/2012	30/05/2012
KARPINSKI	Marek	PR	University of Bonn	1/04/2012	30/04/2012
RAFIEY	Arash	Res	Simon Fraser University	1/11/2011	30/12/2011
GROSHAUS	Marina	PR	Univ. of Buenos Aires	1/09/2011	30/09/2011
DEZA	Antoine	PR	McMaster University	1/09/2010	30/09/2010
PATT-SHAMIR	Boaz	PR	Tel Aviv University	1/07/2010	30/07/2010
REGEV	Oded	PR	New York University	1/07/2010	30/07/2010
AGUEDA	Raquel	MCF	University of Toledo	1/02/2010	30/06/2010
NAYAK	Ashwin	PR	University of Waterloo	1/02/2008	28/02/2008
VAN MELKEBEEK	Dieter	PR	Univ. of Wisconsin	1/06/2008	30/06/2008
MISHNA	Marni	PR	Simon Fraser University	1/01/2008	30/01/2008

Post-Doc and Temporary personnel (2008-2013)

Name	First name	Position	Institution	Arrival	Departure
SADYKOV	Ruslan	Post-doc	PARIS SUD	01/09/2007	31/08/2008
RICHTER	Peter	Post-doc	PARIS SUD	10/10/2007	24/12/2008
VIEILLERIBIERE	Adrien	Post-doc	PARIS SUD	15/09/2007	31/12/2008
KIM	Jang Soo	Post-doc	PARIS SUD	03/03/2009	31/10/2009
MUTHU	Rahul	Post-doc	PARIS SUD	01/12/2008	30/11/2009
XIAO	David	Post-doc	PARIS SUD	01/09/2009	31/10/2010
KULKARNI	Raghar	Post-doc	PARIS SUD	01/06/2011	31/08/2011
STROZECKI	Yann	ATER Post-Doc	PARIS SUD	01/09/2011	31/08/2012
BOROZAN	Valentin	ATER Post-Doc	PARIS SUD	04/09/2007	31/08/2012
NARAYANAN	Narayanan	Post-doc	PARIS SUD	01/11/2011	31/10/2012

Group evolution

Since 2009, the group witnessed a lot of movement:

Departures: In September 2009 Sylvie Corteel left the LRI for the LIAFA, followed by Jean-Paul Allouche in September 2010, thereby weakening the Combinatorics activity of the LRI.

In November 2010, the head of the team, Miklos Santha, left the LRI for the LIAFA with all the researchers working on classical and quantum algorithms: Frédéric Magniez, Jordanis Kerenis, Julia Kempe, Adi Rosen and Michel de Rougemont. Sophie Laplante joined them in September 2012, thereby ending the quantum algorithms activity at LRI.

Hiring: To maintain a strong activity on combinatorics, the LRI hired two professors: Florent Hivert in September 2011 and Nicolas Thiéry in September 2012. Nathann Cohen was hired in October 2012 as a CNRS researcher to strengthen the research on Graph algorithms.

In September 2013, two more researchers arrived: Johanne Cohen (CR1 CNRS moved from PRISM) and Antoine Deza (hired as DR2 CNRS with a DIGITEO chair).

Reorganization: Since June 2013, the Algo team was joined by Selma Djelloul, Evelyne Flandrin, David Forge, Hao Li and Reza Naserasr from the former GraphComb team, and Lin Chen, Sylvie Delaët, Fabio Martignon (Junior member at IUF, 2013-2018) from the former Réseaux and Parall teams to build a new team called GALaC for Graphs, ALgorithms and Combinatorics.

4/ Algorithms

Research Description

The Algorithmic and Complexity team is an historic team of the LRI. The work is centered on the theoretical foundations of computation: study of algorithms, complexity theory and combinatorics.

The scientific program is organized in three activities: Graphs algorithms, Combinatorics, and Complexity of classical and quantum algorithms. The work on graphs is mainly concentrated on edge-colored graphs and graph colorings, with important applications to biology, web technologies and social networks. In combinatorics, various algebraic and enumerative aspects (combinatorial Hopf algebras, representation theory, partitions and q -series, combinatorics on words) are studied in relation to dynamical systems, numeration, and complexity analysis. The third activity covered mainly Property Testing, Streaming and Online Algorithms, Cryptography and Game Theory, Query and Communication Complexities as well as Quantum algorithms.

The research work is strongly supported by computer experiments, which in turn requires an important software development effort. Therefore, the team is strongly involved in the development of the open source SAGE mathematical system, and is the leader of the SAGE-COMBINAT project which regroups 50 contributors around the world.

Graph algorithms

Since 2008, we basically worked on three extensions to the basic structural and algorithmic graph theory. First, to handle edge-colored graphs, i.e. graphs whose edges are colored by a given number of colors. Second, to study some interesting applications of such graphs to social networks. Third, to study non repetitive vertex-colorings of graphs.

Algorithmic and structural study of edge-colored graphs. Studies of spanning subgraphs with specified color patterns in edge-colored graphs has witnessed significant developments over the last decade. The

most natural pattern in such a context is that of a proper coloring, which entails adjacent edges/vertices having different colors.

Our first aim in respect of such proper colorings is to deal with *proper cycles and paths*. Petersen's famous works on graphs seem to be the first place where one can find applications of properly colored trails. Besides a number of applications in graph theory and algorithms, the concept of proper trails and its special cases, paths and cycles, appears in various other fields including genetics, VLSI applications and social sciences. In our recent works (1, 71), we investigate sufficient degree conditions on the number of edges for the existence of properly edge-colored cycles and paths in edge-colored graphs, multigraphs and random graphs. In particular, we prove that an edge-colored multigraph of order n on at least three colors and with minimum colored degree greater than or equal to $\frac{n+1}{2}$ has properly edge-colored cycles of all possible lengths, including hamiltonian cycles. Longest properly edge-colored paths and hamiltonian paths between given vertices are considered as well.

Our second aim was to extend the graph theoretic fundamental concept of *connectivity* to colored graphs with a view to gaining some insight into our problem from Menger's basic theorem. In other words, we intend to define some sort of local color-connectivity for edge-colored graphs. Difficulties arose, however, from local connectivity being not polynomially characterizable in edge-colored graphs (70). Thus, there can be no counterpart to Menger's Theorem as such, and even the notion of a connected component as an equivalence class does not carry over to edge colored graphs since the concatenation of two properly edge colored paths is not necessarily properly edge colored. In (70), the authors settled then for some practical and theoretical results which deal with the existence of vertex-disjoint paths/trails between given vertices in c -edge colored graphs. In particular, given two vertices s and t in a c -edge colored graph G^c , they proved that deciding whether there exist or not k pairwise vertex/edge disjoint properly edge-colored $s - t$ paths/trails in G^c is NP-complete even for $k = 2$ and $c = O(n^2)$, where n denotes the number of vertices in G^c and c the number of used colors. These problems remain NP-complete for c -colored graphs containing no properly edge colored cycles and $c = O(n)$. In another approach of connectivity, we deal with the proper connection problem. More precisely, an edge-colored graph G is k -proper connected if every pair of vertices is connected by k internally pairwise vertex-disjoint proper colored paths. The k -proper connection number of a connected graph G , denoted by $pc_k(G)$, is the smallest number of colors that are needed to color the edges of G in order to make it k -proper connected. In (10) we prove several upper bounds for $pc_k(G)$. We state some conjectures for general and bipartite graphs, and we prove them for the case $k = 1$. In particular, we prove a variety of conditions on G which imply $pc_1(G) = 2$.

It seemed also useful to work on some other generalizations of the classical connectivity, for instance, the *k-linking problem*. More precisely, for some positive non zero integer k , a graph is said to be k -linked (k -edge-linked), if for each k ordered pairs of vertices $(x_1, y_1), \dots, (x_k, y_k)$, there exist k pairwise vertex-disjoint (respectively edge-disjoint) paths, one per pair $x_i - y_i$. Clearly, the 1-linking problem is equivalent to the classical connectivity. The investigation of k -linkings for non colored graphs gave some important and interesting results both from a mathematical and algorithmic point of view (for a synthesis, see (143)). Here we wish to deal with the colored version of the k -linked problem in edge-colored multigraphs. In (8), we give conditions on colored degrees and/or number of edges, sufficient for an edge-colored multigraph to be k -linked (k -edge-linked). However, as the k -linking problem is trivially NP-hard, it should be interesting to establish approximation algorithms in the general case.

Our last aim is to study the existence of *spanning proper trees* in edge colored graphs. In graph theory, there exist many important problems related to trees with different levels of difficulty depending on the properties of the tree we are looking for. For example, although there are many polynomial algorithms for finding spanning trees in simple graphs, the problem becomes NP-hard for spanning trees with bounded degrees or for spanning trees maximizing the number of leafs. In the case of colored graphs, we focus on spanning trees with properties based on coloring. Namely, we deal with proper and weak proper spanning trees, denoted PST and WST, respectively, first defined in (92, 2, 136). More precisely, a proper spanning tree is a spanning proper subgraph, whose uncolored version is connected and acyclic. A weak proper spanning tree is rooted to some fixed vertex r , such that all root-to-leaf paths are properly colored. While these concepts seem very close and some ideas are common for PST and WST, the proofs and results differ dramatically. Both problems PST and WST, as well as their optimization versions, are proved to be NP-Complete and some nonapproximability bounds are established (5a). Some earlier related work was with rainbow spanning trees, i.e., spanning trees in which each pair of edges differ in color. However the rainbow spanning tree problem is polynomial. Various degree conditions guaranteeing the existence of PST and WST in edge colored graphs can be found in (136, 2).

Applications of Edge-Colored graphs to Social networks. Within the rapid growth of the Internet and the Web, and in the ease with which global communication now takes place, connectedness took an important place in modern society. Global phenomena, involving social networks and the behavior of people based on the links that connect us, appear in a regular manner. Motivated by these developments, there is a growing multidisciplinary interest to understand how highly connected social systems operate. Here we study a rich part of social network theory that involves taking a network and annotating its links (i.e., its edges) with positive and negative signs. Positive links represent friendship, while negative links represent antagonism. Thus a signed graph is one in which relations between entities may be of various types, in contrast to an unsigned graph where all relations are of the same type.

In the study of the behavior of such social antagonist environments, an important problem is to understand the tension between these two, positive and negative, opposite forces. The notion of structural balance Heider (1946) is one of the basic frameworks for such studies asserting that a social system is balanced if there is no tension and that unbalanced social structures exhibit a tension resulting in a tendency to change in the direction of balance. Since this first work of Heider, the notion of balance has been extensively studied by many mathematicians and psychologists. A cornerstone result (the so called « the balance theorem ») by Cartwright and Harary (1956) asserts that a signed graph is balanced if and only if its vertex set can be partitioned into two classes so that every edge joining vertices within a class is positive and every edge joining vertices between classes is negative.

Here we are interested in randomness and balance in random social systems (16). More precisely, we defined a probabilistic model where relations between individuals are assumed to be random. A good mathematical model for representing such random social structures is the so called random signed graph $G_{n,p,q}$ on n vertices, where we suppose that between each pair of distinct individuals there is either a positive edge with probability p or a negative edge with probability q , or else there is no edge with probability $1 - (p + q)$. Having this random graph in hands, we proved that for n arbitrarily high, almost always, a population on n individuals is unbalanced. Subsequently we estimate the maximum order of a balanced induced subgraph in $G_{n,p,q}$, and show that its order achieves only a finite number of values. Next, we study the asymptotic behavior of the degree of m -relative balance (i.e., the ratio of the number of positive cycles of length at most m to the total number of cycles of length at most m). We also give upper and lower bounds for the frustration Index of balance (i.e., the smallest number of edges whose inversion of signs results in a balanced graph). Finally, we study the threshold function of balance, e.g., a function $p_0(n)$ such that if $p \gg p_0(n)$, then almost always the random signed graph $G_{n,p,q}$ is unbalanced, else it is almost always balanced.

We also investigate on the concept of *weakly balanced networks*. More precisely, a signed graph is weakly balanced if and only if there is no set of three nodes such that the edges among them consist of exactly two positive edges and one negative edge. Since weak balance imposes less restrictions on what the network can look like, we should expect to see a broader range of possible structures for weakly balanced networks than for normal balance. In that context, very recently, we studied the weak balance of the random graph $G_{n,p,q}$ (134). In particular, we established bounds for the order of the maximum weakly balanced component of $G_{n,p,q}$, the threshold of weak balance for the case of $p = q$ as well as the weak frustration-index. We concluded the work with a study of the degree of the relative m -weak balance (i.e., the number of cycles of length m that contain exactly one negative edge over the number of cycles of length m that have odd number of negative edges).

Nonrepetitive vertex-coloring of graphs The question whether the Thue choice number of trees are bounded by a constant was asked by Grytczuk, Przybyto and Zhu in 2011. We gave a negative answer to this question (20), by proving that for any positive integer ℓ , there is a tree T with $\pi_{\text{ch}}(T) > \ell$. So, the tree-width of a graph does not provide an upper bound on its Thue choice number. On the other hand, the graphs of bounded tree-depth have bounded Thue choice number. We proved a more general class of graphs have bounded Thue choice number: for any integers Δ, z , there is a constant $c(\Delta, z)$ for which the following holds: if G is obtained from a graph G' of maximum degree at most Δ by attaching to each vertex v of G' a connected graph of tree-depth at most z , then $\pi_{\text{ch}}(G) \leq c(\Delta, z)$.

Combinatorics

Combinatorics is a traditional research theme of the Algo team. It currently groups together Francesca Fiorenzi, Dominique Gouyou-Beauchamps, Florent Hivert, and Nicolas M. Thiéry. The former members were Sylvie Corteel, Jean-Paul Allouche and Pascal Ochem.

The combinatorics theme is grounded in theoretical computer science. The two main subjects are algebraic and enumerative combinatorics, on the one hand, and combinatorics on words and dynamical systems on the other hand. It is a multidisciplinary theme whose main computer science application is the analysis of algorithms, but with strong links with mathematics, in particular number theory and algebra, as well as physics and specifically statistical physics. We highlight here some important results:

Algebraic and enumerative Combinatorics

Algebraic combinatorics aims at exploring the links between algorithms, combinatorial objects and algebraic identities.

Combinatorial Hopf algebras Generating series are at the core of combinatorics. By encoding a sequence of numbers into a single algebraic expression, properties like recurrence relations typically translate into functional equations. This opens the door for using algebraic (if not analytic) tools to tackle enumeration problems (how many objects of a given kind are there of size n ?) or complexity problems (how many steps will my algorithm take for an input of size n ?). However, one often requires more sophisticated inductions involving not only integers but objects such as trees, relations, grammars, or graphs. Combinatorial algebra are algebraic objects generalizing power series which permit to manipulate algebraically those induction. The main results in this theme are generalization of the Hook length formula for trees (62) and the study of the so called transformation of alphabet which are analogs of change of variables (28, 61, 129). This work takes place within the ANR Carma project, under the lead of Jean-Yves Thibon in Marne-la-Vallée.

Representation theory of sorting monoids This subject is related to combinatorial Hopf algebras and language theory. Indeed, several Combinatorial Hopf algebras are constructed from the representation theory of towers of monoids. Recall that the idea of representation theory is to encode a monoid as a matrix monoid allowing to use the arsenal of linear algebra in its study. The seminal example is the Hopf algebra of Symmetric functions which encodes the representation theory of the symmetric groups. Until now, few Hopf algebras were constructed this way, by lack of appropriate technology for studying the representation theory of monoids. Indeed, even though the representation theory of groups is well known since over a century ago, at least in the non-modular case, until recently, only the first elements of the theory were known for monoids.

An important barrier was the class of aperiodic monoids; introduced by Schützenberger, these monoids are in correspondence with rational languages without stars. The results of Hivert and Thiéry in collaboration with Anne Schilling from UC Davis on biHecke Monoids (27) seem to have opened a breach. Inspired by them, Thiéry indeed showed how to exploit the well known properties of the Cayley graph of an aperiodic monoid to reduce the calculation of its Cartan matrix (an important invariant of its representation theory) to the calculation of the characters of some small modules (90). The complexity improvement allowed to treat in an hour a monoid size $31\ 103$, whereas hitherto the treatment of similar monoids of size 500 could take weeks.

Recently, Thiéry together with international collaborators has been applying this technology to the study of discrete Markov chains (128) and statistical physics models, among which directed versions of sandpile models.

Tableaux and partitions combinatorics Tableaux and partitions are among the most important objects in algebraic combinatorics thanks to their connection with the symmetric group. The results obtained here concern three of their generalizations: *overpartitions*, *Permutation tableaux* and *ribbon tableau*.

The first set of results concerns the classical links between combinatorics of Partition and q -series. The importance of *overpartitions* was highlighted, especially in Rogers-Ramanujan (one of the most important in partition theory and q -series) identities (13) and the q -Bailey identity (59). More results were obtained on lecture hall partitions introduced by Mireille Bousquet-Mélou and Kimmo Eriksson in 1997 (5).

Permutation tableaux are new objects that come from the enumeration of the totally positive Grassmannian cells. They are also connected to a statistical physics model called the Partially ASymmetric Exclusion (PASEP). We have proposed two bijections between permutation tableaux and permutations (14). These bijections show how natural statistics on the tableaux are equidistributed to classical statistics on permutations: descents, RL-minima and pattern enumerations.

For *ribbon tableaux*, where ribbons are allowed to be of different sizes, we gave an extension of the

famous Robinson-Schensted correspondence by extending Fomin's growth diagram approach of the classical correspondence, in particular by allowing signs in the enumeration (26).

Combinatorics and Statistical Physics Alternating sign matrices (ASMs) are generalization of permutations which currently witness a considerable research effort in statistical physics, in particular around the (now proven) Razumov-Stroganov conjecture on the Temperley-Lieb algebra.

The enumeration formula for ASMs was first proved by Doron Zeilberger in 1996 by showing that monotone triangles (called also Gog triangle) naturally associated to them are equinumerous to Magog triangles associated to totally symmetric self-complementary plane partitions. We demonstrate a natural bijection between a sub-class of alternating sign matrices defined by a condition on the corresponding monotone triangle which we call the gapless condition and a subclass of totally symmetric self-complementary plane partitions defined by a similar condition on the corresponding fundamental domains or Magog triangles (57). We prove that, when restricted to permutations, this class of ASMs reduces to 312-avoiding permutations.

Many interesting enumerative quantities can be expressed in terms of products of matrices satisfying certain relations. In such a situation, a *Matrix Ansatz* can be useful for a variety of reasons: having explicit matrix expressions gives rise to explicit formulas for the quantities of interest; finding combinatorial objects which obey the same relations gives rise to a combinatorial formula for the quantities of interest; finding two combinatorial solutions to the same set of relations identifies the generating functions for the two sets of combinatorial objects. This approach can be applied to various domains like moments of orthogonal polynomials, permutations, signed permutations, and tableaux (75) (139).

Dynamical system and combinatorics on words

Cellular automata, groups and Cayley graphs We study cellular automata defined on the Cayley graph of a finitely generated group (19) or monoid (96), (104).

In the case of a residually finite group and in that of a group shift space on an abelian group, we proved that the periodic configurations are dense. In the one-dimensional case we proved the density for irreducible sofic shifts. In connection with this, we studied the surjectivity of cellular automata and local selfmappings. Some related decision problems for shift spaces of finite type are also investigated (19).

The Cayley graph of a finitely generated free monoid is a regular rooted tree. Our investigation on cellular automata on regular rooted trees included the characterization of sofic tree shifts in terms of unrestricted Rabin automata and the decidability of the surjectivity problem for cellular automata between sofic tree shifts (96). In the same context we proved that for $k \geq 2$ there do not exist positively expansive cellular automata defined on the full k -ary tree shift (104). Moreover, we investigated some topological properties of these automata and their relationships, namely permutivity, surjectivity, preinjectivity, right-closingness and openness.

Combinatorics on words The first kinds of results concern pattern avoidance. In 2005, Ilie, Ochermann, and Shallit generalized the notion of repetition threshold, which is the object of Dejean's conjecture. This generalization consisted in taking into account the length of the avoided words. We gave a lower and an upper bound on this generalized repetition threshold (58, 21, 105). More results classify the infinite words over the two-letter alphabet $\{0, 1\}$ that avoid the pattern AABBCABBA (45) and approximate square avoidance (67).

Words, fractals and number theory The second set of results on combinatorics on words concerns the connections between formal languages and words, on one hand, and number theory, symbolic dynamic on the other hand.

Sturmian sequences are in some sense the "least complicated" aperiodic sequences on a binary alphabet. We generalize a result of Niu and al. by proving, using a work of Cosnard and al. (1982-1983), that a large class of Thue-Morse-like sequences belong to the sets of binary sequences introduced by Erdős, Joó, and Komornik (1990). The case of alphabets of size larger than 2 yields similar results (119). Starting from a study of Y. Bugeaud and A. Dubickas (2005) on a question in distribution of real numbers modulo 1 via combinatorics on words, we survey some combinatorial properties of (epi)Sturmian sequences and distribution modulo 1 in connection to their work (53). We focus on extremal properties of (epi)Sturmian sequences, some of which have been rediscovered several times.

In the line of research related to the *combinatorics of representations of real numbers in non-integer bases*, one can define univoque numbers are real numbers $\lambda > 1$ such that the number 1 admits a unique expansion in base λ . We show that the smallest univoque number belonging to the interval $(b, b + 1)$ is transcendental, where b is any positive integer. An avatar of the Thue-Morse sequence, namely the fixed point beginning in 3 of the morphism $3 \rightarrow 31, 2 \rightarrow 30, 1 \rightarrow 03, 0 \rightarrow 02$, occurs in a “universal” manner (3). We study (purely) periodic unique β -expansions and show that for each $n \geq 2$ there exists $\beta_n \in [\frac{1+\sqrt{5}}{2}, 2)$ such that there are no unique periodic β -expansions of smallest period n for $\beta \leq \beta_n$ and at least one such expansion for $\beta > \beta_n$ (52).

Classical and Quantum algorithms and complexity

The results described here were developed by the part of the team that moved to LIAFA (de Rougemont, Kempe, Kerenidis, Laplante, Magniez, Rosen and Santha). They cover mainly Property Testing, Streaming and Online Algorithms, Cryptography and Game Theory, Query and Communication Complexities, Quantum algorithms.

Classical algorithms and complexity In the area of *Property Testing* (a statistics based approximation technique to decide whether an input satisfies a given property, or is far to any input satisfying the property), we initiated the study for the edit distance with moves in the contexts of words (22), XML databases (101) and Markov Decision Processes (116). For *streaming and online algorithms* we have defined a novel model of online computation with advice, where online algorithms have some partial information about the future. We also gave online algorithms, and sometimes offline approximation algorithms, for various problems in communication networks and adjacent fields (39). We also initiated the study of memory space complexity of language recognition (85) with application to large XML databases. Concerning *cryptography and game theory*, one of the challenges brought on by the new pervasive nature of data is the question of trust. Trust can come in the form of cryptographic protocols, which ensure secrecy and authenticity, or it can come in the form of game-theoretic mechanisms that use money and utility to incentivize individuals to behave truthfully. Here we have studied the robustness of the computational problems underlying modern cryptography (77, 86), the optimal efficiency of various cryptographic protocols such as Zero Knowledge and bit commitment (107), and the efficiency of analyzing their behavior as in computing equilibria (78). We have also studied the “converse” of cryptography, relating the complexity of various models of machine learning (91). In the area of *query and communication complexities* we developed the study of the limitations of the models described above. In particular, we developed general methods to prove lower bounds based on Kolmogorov arguments (32). Motivated by streaming algorithms applications, we also provided new lower bounds to explicit problems (85).

Quantum algorithms and complexity Concerning *quantum computing*, one of the main purposes was to design, for specific problems, faster quantum algorithms than any known classical procedure. In that aim, we have conceived fast quantum algorithms for group theoretic questions, often related to the paradigmatic hidden subgroup problem (29). Our research has also concentrated on quantum query complexity of search algorithms via quantum walks. We have obtained several generic results about the quantization of classical Markov chains (84, 111, 117). A second purpose was to consider *communication complexity* with the aim to study the classical and quantum models side-by-side in order to understand the similarities and differences between them. We have shown exponential gaps between classical and quantum models for the Hidden Matching problem (7). We have also studied the complexity of entangled games (34) and shown hardness results on approximating the quantum value of a game. In quantum *cryptography*, one of the main goals is to study the optimal security parameters for specific fundamental primitives. Moreover, it is important to extend the security proofs in realistic conditions that take into account the imperfections of the quantum devices. First, we have found the optimal parameters for coin flipping and bit commitment (74) and we have studied a number of other cryptographic primitives, including oblivious transfer, zero knowledge and computational bit commitments (73, 99, 100). Second, we have studied security in the device independent model and in the presence of losses and errors. (98).

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Collaborations

Participation to national and international collaborative research projects

- Coorganization (with Anne Schilling and Daniel Bump) of the thematic semester “Automorphic Forms, Combinatorial Representation Theory and Multiple Dirichlet Series” at the Institute for Computational and Experimental Research in Mathematics (ICERM), Brown University, Providence, Rhodes Island, USA (<http://icerm.brown.edu/sp-s13>).
- Collaborative Research: SI2-SSE: “Sage-combinat: Developing and Sharing Open Source Software for Algebraic Combinatorics”, NSF, 2012-2015, Coordinator: Dan Bump, Gregg Musiker, Anne Schilling, William Stein (and Nicolas M. Thiéry).
- The team is involved in several european and national research projects, including a very large number of scientific contacts, listed in the “Contracts and Grants” section.

Collaborations with other laboratories

- Anne Schilling, Tom Denton, University of California at Davis, USA: representation theory of monoids (60, 27, 128)
- Benjamin Steinberg, City College of New York, USA: (128)
- Arvind Ayyer, Indian Institute of Science, Bangalore, India: (128)
- Vic Reiner, University of Minnesota, USA: (62)
- University of Crete (Franco-Hellenic Master)
- Gervais Mendy, University of Dakar, Graph Theory (two visits) (8, 71, 143, 2)
- Raquel Agueda, University of Toledo, Graph Coloring, (two visits) (71, 2)
- Antoine Deza, MacMaster Univ, Combinatorial Geometry.
- Jean Christophe Novelli (IGM, Univ. Marne-la-Vallée), Frédéric Chapoton (Institut Camille Jordan, CNRS), ANR Carma (129)
- Hivert and Thiéry are both associated members of the Laboratoire International Franco-Québécois de Recherche en Combinatoire (LIRCO), Quebec, UQÀM.

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Volunteer Professional Service

Management Positions in Scientific Organisations

- LRI: Manoussakis, Vice Director (Since January 2012).
- GdR-IM: Hivert, Coordinator of the CombAlg group (until 2009).
- European Mathematical Society: Allouche, Member of the Ethic Committee (Since 2010).
- Société Mathématique de France: Allouche, Publication director (until 2010).
- Comité National Français des Mathématiciens: Allouche, Member (until 2010).
- University Paris-Sud: Manoussakis, Elected Member of scientific council (2006-2008).
- LRI: Manoussakis, Elected Member of laboratory council (2001-2009).
- University Paris-Sud: Manoussakis, Member of the research council, UFR Sciences (2007-2008).

Organisation of Conferences and Scientific Events

- 8th french combinatorial conference Orsay 2010 (350 participants): Manoussakis, Co-Chair.
- Workshop JGA 13-15 Novembre 2013, Orsay: Manoussakis, Co-Chair;
- Organisation de la deuxième conférence IEEE “Computational Complexity”, 2009, Paris, Laplante, Co-Chair.
- ICERM, Coorganisation of the thematic semester «Automorphic Forms, Combinatorial Representation Theory and Multiple Dirichlet Series» at the Institute for Computational and Experimental Research in Mathematics (ICERM), Brown University, Providence, Rhodes Island, USA (<http://icerm.brown.edu/sp-s13>).
- Sage Days 49, Free and Practical Software for (Algebraic) Combinatorics (satellite of the FPSAC conference), Paris, France, 2013: Thiéry, local organizer.
- Sage Days 45: Multiple Dirichlet series, combinatorics, and representation theory, ICERM, Brown, RI, 2013: Thiéry, coorganizer.

- Online databases: from L-functions to combinatorics, Edinburgh, Scotland, UK, 2013: Thiéry, coorganizer
- «Sage-Combinat Days in Cernay», 6–10 février 2012, Cernay-la-Ville: Hivert, organizer.
- Organizer and Chair of the “Séminaire parisien de combinatoire Philippe Flajolet”, Monthly seminar, IHP, Paris: Hivert, organizer.

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Honors

Prizes and Awards

- J. Kempe, Insigne de chevalier in the “ordre national du mérite” and award «Femme en or de la recherche», 2010.
- A. Chailloux, Gilles Kahn PhD prize, 2011

Keynote Addresses

International

- Hivert: 22nd International Conference on Formal Power Series and Algebraic Combinatorics (FPSAC’10), San Francisco State University, August 2-6, 2010, USA.
- Hivert: LACIM 2010, 2010 August 29-31, UQAM, Quebec, The 1-E transform in combinatorial Hopf Algebras.
- Allouche: Groups generated by automata, Centre Stefano Franscini, Ascona, Monte Verità, SUISSE, 2009 February 11-15.
- Allouche: CNTA 2008 (Canadian Number Theory Association X Meeting), Fields Institute and University of Waterloo, Waterloo, CANADA, 2008 July 13-18
- Allouche: p -adic differential equations: a conference in honor of Gilles Christol, Bressanone (Université de Padoue), ITALIE, 2008 September 6-9;
- Workshop on Dynamical Systems and Symbolic Dynamics, Bielefeld, 2010, Germany, May 17-19.
- Allouche: Mini-Workshop : Combinatorics on Words, MFO, Oberwolfach, Germany, August 23-28, 2010

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Evaluation of Research

Editorial Boards

International

- Journal de Théorie des Nombres de Bordeaux, Allouche, *Director of publication*
- Advances in Applied Mathematics: Allouche
- Journal of Integer sequences: Allouche
- Mathématiques et Sciences Humaines: Allouche, *Redaction committee*
- Journal of Mathematics and Music: Allouche
- Pure Mathematics and Applications: Allouche
- Uniform Distribution Theory: Allouche
- Open Journal on Discrete Mathematics: Manoussakis
- ISRN Discrete Mathematics: Manoussakis
- Applied and Computational Mathematics: Manoussakis
- International Journal of Mathematics and Statistics: Manoussakis

Program Committees

Member (international events)

- "JAC 2008", Journées Automates Cellulaires 2008, Uzès, April 2008: Allouche.
- "CanaDAM 2009", Canadian Discrete and Algorithmic Mathematics Conference 2009, CRM, Montréal, Canada, May 2009: Allouche.
- 7th International Conference on Words, Université de Salerno, Fisciano, Italie, 14–18 September 2009: Allouche.
- Formal Power series and Algebraic Combinatorics FPSAC 2012, Nagoya, Japan, at Nagoya University, July 30–August 3: Hivert.
- "9th International colloquium on graph theory and combinatorics", Grenoble, June 30–July 4, 2014, Manoussakis, Scientific committee.
- International Workshop on Discrete Structures (IWODS) March 5-7, 2014 Islamabad, Pakistan, Manoussakis, Scientific committee.

Evaluation Committees and Invited Expertise

International

- Greek AERES Agency: Manoussakis.
- Greek national projects, Manoussakis, grant evaluation expert.
- National Science Foundation (NSF), USA: Hivert, grant evaluation expert.
- Natural Sciences and Engineering Research Council of Canada (NSERC), Canada: Hivert, grant evaluation expert.

National

- ANR, Hivert, grant evaluation expert.
- ANR, Thiéry, grant evaluation expert.
- Regional, Manoussakis, grant evaluation expert.

Other evaluation activities

Hiring Committees

- Hivert: Prof (Calais 2013), Mdc (Rouen 2010, Marne-la-Vallée 2009);
- Fiorenzi: Mdc (Paris-Sud 2009, Marne-la-Vallée 2009, Paris-Sud 2010)
- Thiéry: Mdc (Paris-Sud 2009), PRAG (Paris-Sud 2010, 2011)
- Manoussakis: President Prof (Paris-Sud 2009, 2010), Prof (Paris-Sud 2011, 2012, 2013), MdC (Paris-Sud 2013, Versailles 2012, Évry 2012)

PhD and Habilitation Juries

- Manoussakis: Habilitation referee for the conseil scientifique de l'Université Paris SUD 11 for applications in physics, economy, mathematics (roughly 60-80 files per year: Manoussakis, 2006-2008)
- Manoussakis: president (9), reviewer (5), examiner (10)
- Hivert: HdR reviewer (2), president (3), reviewer (2), examiner (2)
- Thiéry: reviewer (2), examiner (4)

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Interactions with the social, economic and cultural environment

Popularisation of Research Results

- Organizer of the "Fête de la Science 2013".
- Hivert, Invitation to give the plenary talk "Jonglerie Automate et Combinatoire", 24ème congrès MATH.en.JEANS, April 5-7, 2013.
- S. Laplante. Chapter "Le plus grand des hasards : Surprises quantiques". In: ed. by J.-F. Dars and A. Papillaut. Belin, 2010. Chap. L'influence de l'informatique, pp. 152-154.

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)

Type	Name	Managing Institution	Start / Duration	Amount
ANR	ICOMB	Université Paris XI	07.2008 / 60 mo.	71.00 k€
Subvention	GT CMF	CNRS	01.2007 / 36 mo.	8.00 k€
ANR	VERAP	CNRS	01.2008 / 36 mo.	121.68 k€
Subvention	AAP 2013	Université Paris XI	01.2013 / 12 mo.	10.40 k€
DIGITEO	SAGE	Université Paris XI	01.2012 / 2 mo.	1.50 k€
ANR	CRYQ	CNRS	01.2009 / 57 mo.	196.00 k€
Subvention	GT IQ	CNRS	01.2006 / 48 mo.	8.00 k€
Subvention	JST-ICT	CNRS	01.2008 / 48 mo.	90.00 k€
Contrat européen	QCCC	Université Paris XI	05.2006 / 24 mo.	80.00 k€
ANR	ALGOQP	CNRS	12.2005 / 42 mo.	280.00 k€
ANR	DIQIP	Université Paris XI	09.2011 / 36 mo.	24.44 k€
DIGITEO	QNLCC	autre	09.2011 / 36 mo.	102.20 k€
Contrat européen	CSQIP	Université Paris XI	10.2008 / 39 mo.	138.00 k€
Subvention	MAGNIN L	Université Paris XI	06.2009 / 46 mo.	7.50 k€
ANR	QRAC	Université Paris XI	01.2009 / 48 mo.	420.00 k€
DIGITEO	ASSECGA	Université Paris XI	10.2012 / 12 mo.	51.30 k€
Subvention	MENDY G.	Université Paris XI	04.2008 / 46 mo.	7.50 k€
Subvention	HSP	CNRS	01.2008 / 24 mo.	6.80 k€
Contrat européen	QAP	Université Paris XI	11.2005 / 48 mo.	158.40 k€

Software Licensing and Distribution

Sage - a free open-source mathematics software system

<http://www.sagemath.org/>

Contact: Hivert-Thierry

SAGE is a free open-source mathematics software licensed under GPL. It is similar to MAPLE, MuPAD, MATHEMATICA, MAGMA, and up to some point MATLAB. It combines the power of many open-source packages GAP4, Linbox, Singular, Symmetrca, etc.) into a common interface and is based on the popular Python programming language.

It is developed by an international community of 300 teachers and researchers. The development process include a public referring process. Each line of code must be validated before being integrated into SAGE.

Sage-Combinat - to improve the open source mathematical system Sage

<http://combinat.sagemath.org>

Contact: Hivert-Thiéry

The mission of SAGE-COMBINAT itself is to improve SAGE as an extensible toolbox for computer exploration in combinatorics, and to foster code sharing between researchers in this area. Sage-Combinat is developed under the lead of the LRI (Thiéry-Hivert) and groups now approximatively 50 contributors all over the worlds (Europ, North America, Australia, Japan, Korea, ...). In practice, Sage-Combinat is a collection of experimental extension on top of Sage, which are developed by a community of researchers. Those extension are progressively intergrated to SAGE as soon as they are stable enough. The code volume is around 120 000 lines of codes integrated into Sage. The combinat team participated in more that 700 Tickets (=modification, bug fix, enhancement...). The team also have 150 000 lines of experimental line of codes which are in stabilization process.

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Training and Education

Book

1. Book chapters: A. Casamayou, N. Cohen, G. Connan, T. Dumont, L. Fousse, F. Maltey, M. Meulien, M. Mezzarobba, C. Pernet, N. M. Thiéry, P Zimmermann : Calcul mathématique avec Sage, Licence: Creative Commons, France, 468 pages, published in May 30, 2013, ISBN: 1481191047.

School for graduate students and young researchers

1. School for young researchers: Thiery Monteil, Nathann Cohen, Vincent Delecroix, Samuel Lelievre, Sage Cours within the École Jeunes Chercheurs en Informatique Mathématique, April 8-12, 2013, Perpignan;
2. Nicolas Thiéry : Invited cours and laboratory within the École d'automne "Mathématiques discrètes : aspects combinatoires, dynamiques et algorithmiques", Bobo-Dioulasso, Burkina Faso, October 2012. <http://www.ragaad.org/bobo2012/>;
3. «Ecole des Jeunes Chercheurs en Informatique Mathématique» (2009, co-organization);
4. Two thematic schools on "Quantum Computing", Montréal (2010);

Graduate Courses

- The team is the leader of projet MIFOSA which aims to create a research Master 2 at the Paris Saclay University (opening in September 2015).
- Coordinator of the international Franco-Hellenic master, common to the University Paris-Sud, Joseph Fourier at Grenoble and the University of Crete.
- Coordinator of the Master 2 «Compétences Complémentaires en Informatique», Paris-Sud University.

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Thesis

Habilitation à Diriger des Recherches	
Name	Defense
Sylvain PEYRONNET	07.12.2010
Iordanis KERENIDIS	03.12.2010
Julia KEMPE	14.09.2010

Defended thesis				
<i>Name</i>	<i>Start</i>	<i>Defense</i>	<i>Funding</i>	<i>Advisor</i>
Valentin BOROZAN	01.10.2007	30.09.2011	Alloc. Ministère	MANOUSSAKIS
André CHAILLOUX	15.09.2007	24.06.2011	ENS	SANTHA
Claudia HESS	15.12.2005	25.01.2008	ETR	DE ROUGEMONT
Mathieu JOSUAT-VERGES	09.01.2007	25.01.2010	Alloc. Ministère	CORTEEL
Marc KAPLAN	01.10.2005	28.09.2009	Alloc. Ministère	LAPLANTE
Gervais MENDY	20.11.2006	28.09.2011	ETR	MANOUSSAKIS
Leandro Pedro MONTERO	01.12.2009	13.12.2012	Alloc. Ministère	MANOUSSAKIS
Luc SANSELMÉ	14.10.2004	10.12.2008	Alloc. Ministère	SANTHA
Mathieu TRACOL	01.10.2007	15.06.2010	Alloc. Ministère	DE ROUGEMONT
Adrien VIEILLERIBIÈRE	01.10.2004	22.09.2008	Alloc. Ministère	DE ROUGEMONT
Xavier ZEITOUN	01.10.2009	13.06.2013	Alloc. Ministère	DE ROUGEMONT

Thesis in progress			
<i>Name</i>	<i>Start</i>	<i>Funding</i>	<i>Advisor</i>
Jean-Alexandre ANGLES D'AURIAC	01.10.2011	Alloc. Ministère	MANOUSSAKIS
Michele MANGILI	01.10.2012	Alloc. Ministère	MARTIGNON
Jean-Baptiste PRIEZ	01.10.2012	Alloc. Ministère	HIVERT
Aladin VIRMAUX	01.10.2012	Digiteo	THIÉRY

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Self Assessment

Strengths

- Very high quality in research production;
- High international visibility;
- High attractivity;
- Leader in development of combinatorics software (Sage-Combinat).

Weaknesses

- Lots of movements, the team is in stabilization process;
- Very few young researchers (1 CR CNRS), a large part of the researchers are Professor or Research director;
- Few industrial contact.

Risks

- Integration of the team: The team is in complete reorganization (lots of hiring) as well as its environment (plateaux de Saclay);
- The team is currently missing some access to Master courses.

Opportunity

- The team is a funding member of the Fédération d'Algorithmique du plateau de Saclay and the associate Seminar;
- The team is the coordinator of the newly created master MIFOSA (Master d'informatique fondamentale du plateau de Saclay).

Graphs: Synthetic presentation

Nom du responsable de l'équipe : **Abdel LISSER**

Effectifs de l'équipe

Au premier janvier 2008: 9 permanents dont 8 enseignants-chercheurs : 3 PRs, 4 MDC et un DR CNRS.

Personnels ayant quitté l'équipe pendant le contrat en cours

- Didier Fayard, Professeur IUT Orsay, départ à la retraite 2012.
- Mekkia Kouider, Maître de conférences université de Paris Sud, départ à la retraite 2010.
- Charles Delorme, Maître de conférences université de Paris Sud, départ à la retraite 2011.
- Jean-François Saclé, Maître de conférences université de Paris Sud, départ à la retraite 2012.
- Evelyne Flandrin, Professeur université de Paris Descartes et chercheuse au LRI, départ à la retraite 2012.
- 13 doctorants ont soutenus leur thèse durant cette période.

Nombre de recrutements réalisés au cours de la période considérée et origine des personnels

- Céline Gicquel, Maître de conférences IUT Orsay, recrutée en 2011.

Production scientifique au cours de la période écoulée

- En considérant les théorèmes de Ramsey et de Turán; Li Hao a introduit une nouvelle classe de problèmes Ramsey-Turán qui fait partie des 15 nouvelles questions et conjectures proposées par Shelp.
- Li Hao a montré que si G est un graphe élémentaire tel que $|V(G)| \geq 3r + 4s$ sommets dont le degré minimum est $\geq 2r + 3s$, alors G contient $r + s$ cycles sommets disjoints dont chaque cycle contenant s a soit deux cordes, soit un cycle de longueur 4 ayant une corde. Ce résultat montre que la conjecture de Bialostochi, Finkel et Gyrfas est vraie.

Bilan quantitatif des publications de l'équipe

- Articles de revue : internationales majeures 80 ; autres revues 70

5 publications majeures

- H. Li, V. Nikiforov and R.H. Schelp, A new class of Ramsey-Turán problems, *Discrete Mathematics* 310 (2010) 3579-3583.
- Mahdad Khatirinejad, Reza Naserasr, Mike Newman, Ben Seamone, Brett Stevens: Vertex-colouring edge-weightings with two edge weights. *Discrete Mathematics & Theoretical Computer Science (DMTCS)* 14(1):1-20 (2012).
- E. Flandrin, A. Marczyk, J.F. Saclé, M. Wozniak "Neighbor sum distinguishing index" *Graphs and Combinatorics*, (DOI) 10.1007/S00373-012-1191-X, May 2012.

5 (max) faits illustrant le rayonnement ou l'attractivité académique

- Hao Li, *Changjiang Lectureship Chair Professor* (by Changjiang Scholar Award Program of Chinese Minister of Education and the Li Ka-Shing foundation)

Principales contributions de l'équipe à des actions de formation

- Cours au Master Recherche en Informatique de l'université de Paris Sud (https://www.dep-informatique.u-psud.fr/formation/lmd/M2R_NSI)

Research Group Members and evolution since 2008

Permanent Members (June 30th, 2013)

Name	First name	Position	Institution
DJELLOUL	Selma	MCF	PARIS EST
FLANDRIN	Evelyne	PREM	PARIS 5
FORGE	David	MCF	PARIS SUD
LI	Hao	DR2	CNRS
NASERASR	Réza	CR1	CNRS

Group evolution

- Mekkia Kouider, Charles Delorme, Jean-François Saclé and Evelyne Flandrin are retired

Research Description

Graph theory

Participants: Hao Li, Réza Naserasr, David Forge, Odile Favaron, Charles Delorme, Evelyne Flandrin, Mekkia Kouider, Jean-François Saclé, Maryvonne Maheo, Selma Djelloul

Most of our works focus on fundamental problems in graph theory. We also work on matroids and some problems of graph theory that have practical background in energy conservation in wireless sensor networks and social networks.

The theory of hamiltonian graphs and various cycles structures are one of the core topics in graph theory. Li and Yang obtained partial results on an important conjecture of Thomassen on hamiltonian line graphs. Li *et al.* developed new definitions of implicit-degrees that generalize the degree of a vertex and in a series of 10 papers, we show new theorems on hamiltonian cycles, pancyclic, cyclability, dominating cycles, etc, that are stronger than classical theorems. Invited by an editor, Li wrote a survey on generalizations of the Dirac theorem which is the base of the hamiltonian extremal graph theory. Li *et al.* proved in 2009 a result on partitions of a graph into cycles with chords. This result is stronger than a conjecture of Bialostocki, Finkel, and Gyárfás and is a generalization of well known results of Pósa and Corrádi and Hajnal. Flandrin and Li studied cyclability of given vertex subsets or edge subsets, some of these works are specially related with claw-free graphs, bipartite graphs and the (generalized) prisms of graphs.

Developing theory of homomorphism of signed graphs, Naserasr proved that while the size of largest planar signed clique is 8, the largest signed-chromatic number of a planar signed graph is somewhere between 10 and 48. Naserasr *et al.* have managed to introduce a new reformulation of the Hadwiger's conjecture. Using this reformulation we have proved an essential difference between the cases where the conjecture is proved and unproved cases. Results are also obtained in homomorphisms of planar signed graphs to signed projective cubes.

Extremal graph theory is an important topic that has potential applications. Ramsey theory and Turán's extremal graph theorem are both among the most basic theorems in graph theory. Li *et al.* introduced and studied a new class of Ramsey-Turán problems. Based on a conjecture we made and a partial result obtained, Schelp proposed a series of new conjectures that generalize many classical conjectures in

Ramsey theory. Delorme studied large graphs, that is, given degree, diameter and some other conditions, like being bipartite, or planar or Cayley, what the largest order of a graph is subject to these conditions. Many tools are used either to build “large graphs” and therefore provide lower bounds or improve, (that is decrease) upper bounds. Erdős stated several conjectures in extremal graph theory related to triangles and pentagons. Bollobás and Győri studied the problem: what can we say about the number of triangles in a graph not containing any pentagon? Upper and lower bounds are proved by Li et *al.* for the number of triangles in C_{2k+1} -free graphs. The bounds involve extremal numbers related to appropriate even cycles.

Favaron studied various domination parameters. For most of them, the subdivision number of a graph is the minimum number of edges to subdivide in order to increase the parameter. She got with some Iranian colleagues many results on this well-studied topic. They also proved a conjecture of Alon and Bollobás on the game domination number of a graph, improving the previously known result by a coefficient $2/3$.

Kouider defined the quasi-monotonous property that is related to dominating colorings and she showed that chordal graphs are not quasi-monotonous in general whereas graphs in a subclass of chordal graphs are quasi-monotonous. Kouider has different results on the existence of factors with prescribed degrees. On the other hand she has several results on the conjecture El Sahili-Kouider on the b -coloring of regular graphs.

Forge’s research is on matroid theory with basic links to graphs. He studied arrangements of hyperplanes in terms of graphs with gains. Many questions can be asked and they of course correspond to questions on the arrangement like finding the combinatorial invariants such as characteristic or Tutte polynomials. Forge has a series of articles on finding such polynomials for gain graphs and sometime some special gain graphs like the braid, the Shi or the Linial gain graphs.

Delorme also adressed some questions concerning algorithmic (domination by edges) and extremal (generalised cages) theory of graphs, as well as spectral (in relation with existence of homomorphisms questions) or algebraic or even geometric aspects.

Djelloul obtained results for graph products about treewidth and its connections with graph grammars and with logical definability of graph properties. She designed an algorithm that, given a tree-decomposition of a graph G and a tree-decomposition of a graph H , provides a tree-decomposition of the cartesian product of G and H . In the context of graph grammars and graph logic, S. Djelloul proved that the cartesian product of a class of graphs by a finite set of graphs preserves the property of being a context-free set, and that the cartesian product by a finite set of connected graphs preserves MS_1 -definability and MS_2 -definability.

We have also worked on graph theory problems that have strong practical background. Results have obtained by Li et *al.* on energy conservation in wireless sensor networks and connectivity of graphs. In collaboration with John Hopcroft who received the Turing Award in 1986, Li et *al.* obtained results on labeling vertices and edges in social networks.

4/ Graphs

Collaborations

Participation to national and international collaborative research projects

- PEPS project on homomorphisms of signed graph, coordinator: Reza Naserasr

Collaborations with other laboratories

- Pr. E. Sopena and other members of the team including students, LaBRI Bordeaux, Signed graph homomorphisms.
- Pr. P. Hell and Pr. B. Mohar, Simon Fraser University, Vancouver Canada, tropical homomorphisms and orthogonality graphs.

- Dr. L. Beaudou, LIMOS, Clement-Ferrand. Homomorphism to projective cubes.
- Pr. R. Skrekovski, Slovenia, discharging methods for homomorphisms problems.
- Pr. S. Fujita Tokyo, Japan. Longest path problems
- Pr. H. Hajiabolhassan, Tehran, Iran. Homomorphism via topology
- Dr. N. Narayanan, k-intersection edge-colorings.
- PR. El Sahili , University of Beyrouth, colouring of graphs
- DR. Valencia-Pabon, University of Nancy, colouring of graphs
- Pr Volkmann, University of Aachen, Germany. k-domination.
- Prs Cockayne and Mynhardt, University of Victoria, Canada. Open irredundance.
- Pr Blidia and Chellali, Universities of Alger and Blida. k-independence.
- Pr Arumugam, Kalasalingam university, India. Irredundance saturation.
- Pr Henning, Universities of Pietermaritzburg and Johannesburg, South Africa. Paired domination.
- Pr Hansen, Gerad, University of Montreal, Canada. Girth, independence and irredundance.
- Prs Karami, Sheikhholeslami et al., Azerbaijan University, Tabriz, Iran. Subdivision domination parameters.
- Pr. John Hopcroft, Cornell University, USA, Graph Theory Problems in Social Networks.
- Pr. Herbert Fleischner, Vienna University of Technology, Austria, Cycles in Graph.
- Pr. Hajo Broersma, University of Twente, Netherlands, Cycles in Graph.
- Pr. Mirka Miller, University of Newcastle, England, Graph Theory in Networks.
- Pr. Wozniak, AGH, Poland, Cycles in Graph.
- Pr. Guantao Chen, Georgia State University, USA, Cycles in Digraph.
- Pr. Michael D. Plummer, Vanderbilt University, USA, Cycles in Graph.
- Pr. Bing Wei, University of Mississippi, USA, Hamilton cycle.
- Pr. Ralph Faudree, Richard Schelp, Paul Balister and Vlado Nikiforov, University of Memphis, USA, Hamilton cycle and Ramsey-Turan problems.
- Pr. Ervin Gyori, Alfred Renyi Institute of Mathematics, Hungary, Cycles in Graph.
- Pr. Xiaoya Zha, Middle Tennessee State University, USA, Cycles in Graph.
- Pr. Heping Zhang, Lanzhou University, China, Graph Theory in Networks.
- Pr. Jinlong Shu, East China Normal University, China, Cycles in Graph.
- Pr. Guizhen Liu, Shandong University, China, Colouring in Graphs.
- Pr. Guiying Yan, Chinese Academy of Sciences, China, Cycles in Graph.
- Pr. Xueliang Li, Nankai University, China, Cycles in Graph.

Other Collaborations

Participation to national and international networks

4/ Graphs

Volunteer Professional Service

Organisation of Conferences and Scientific Events

- Organizing Bordeaux workshop on identifying codes, Nov. 2011 Bordeaux.
- Autumn school on signed graphs, at Thézac, Aquitaine. October 2012.
- Autumn school on signed graphs, at Thézac, Aquitaine. October 2013.
- Journée graphs et Algorithm, organizer (co-chair), Nov. 2013.
- The 8th French Combinatorial Conference, Orsay, France, Jun. 2010: Hao Li and Yannis Manoussakis are co-Chairs and Organizers.

4/ Graphs

Honors

Prizes and Awards

- Jiangiang Cheng, *Best student paper at ICORES Conference* (2012)
- Chen Wang, *Best student paper at ICORES Conference* (2013)

Keynote Addresses

International

- <Favaron>, *CombinaTexas 2013*, invited plenary speaker

France

Other Honors

- Hao Li, *Changjiang Lectureship Chair Professor* (by Changjiang Scholar Award Program of Chinese Minister of Education and the Li Ka-Shing fondation)

4/ Graphs

Interactions with the social, economic and cultural environment

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
ANR	DOPAGE	Université Paris XI	10.2009 / 36 mo.	60.00 k€
ANR	TEOMATRO	Université Paris XI	12.2010 / 36 mo.	20.28 k€
Subvention	ALPAGE	Université Paris XI	12.2005 / 42 mo.	70.00 k€
Subvention	PEPS-INS2I	CNRS	01.2012 / 12 mo.	8.00 k€
CNRS	CCAS	CNRS-Chinese Academy of Sciences	2013 / 3.2 mo.	

4/ Graphs

Thesis

Defended thesis				
Name	Start	Defense	Funding	Advisor
Lech ADAMUS	01.12.2006	06.11.2008	ETR	FLANDRIN
Ailian CHEN	01.09.2005	26.08.2008	ETR	LI
Haiyan KANG	01.11.2008	25.05.2010	ETR	FLANDRIN
Li LIU	27.11.2006	04.12.2008		LI
Huifang MIAO	01.09.2005	23.05.2008	ETR	LI
David SOGUET	01.10.2004	02.07.2008	Alloc. Ministère	DJELLOUL
Yi YANG	01.09.2005	25.08.2009		LI
Shan ZHOU	30.11.2005	30.05.2008	Etranger	LI
Yan ZHU	01.09.2006	25.05.2010		LI

Thesis in progress			
Name	Start	Funding	Advisor
Yandong BAI	14.09.2011	ETR	LI
Weihua HE	14.09.2011	ETR	LI
Qiang SUN	01.10.2012	ETR	LI
Weihua YANG	24.01.2011	ETR	LI

4/ Graphs

Self Assessment

The main criticisms addressed to GraphComb team after the former evaluation are the high number of small impact published papers and lack of industrial real world applications. During the last period, we continue our scientific production with high impact for some of our papers in graph theory. Reza Naserasr joined our team as CNRS researcher and developed new topics, organized our seminars and different schools on graph theory.

4/ GALaC

Strategy and five-year project

The research work of the “**A**lgorithms, **G**raphes and **C**ombinatoire” team, **GALaC**, is concentrated on several highly competitive fields in Theoretical and Applied Computer Science.

Driven by the common goal of developing the theory of efficient algorithms, our group was born as the result of the federation of several autonomous researchers and research groups from the previous Algo, Graph, Networks and Parall teams of LRI.

Rooted in the common ground of algorithmics, multiple research directions are *jointly investigated* by our group, which is structured by the following activities: combinatorics, graph theory, and the design of algorithms tailored for networked and distributed systems.

Research on networked systems, for example, needs the theoretical tools developed in the graph activity, in order to model networking problems, while combinatorics is necessary to evaluate the complexity of the developed (often distributed) algorithms.

The strong involvement in the development of the open source Sage mathematical software represents another key example of the synergies between the research activities developed in GALaC, and in particular between the combinatorics and graph theory ones. Indeed, the experimental research and development which characterizes this project, based on the mutualization of software development, is a federating factor for the research efforts of several members of these two activities (namely, F. Hivert, N. Thiéry, and N. Cohen).

More in depth, the main focus of our research activities is as follows: the combinatorics activity studies the strong interactions and relations that exist between algorithms and algebraic structures. At the same time, graph structures constitute the core of the research of the graph theory activity, which is mainly focused on both structural and algorithmic approach. Finally, algorithms for networked systems are developed in the third activity, using theoretical tools like algorithmic game theory and distributed computing, with the aim of designing efficient modeling, control and performance optimization algorithms especially tailored for networked and distributed systems, as well as their applications.

Our group is well integrated in the international scientific community. The number of high level publications, recognitions and research grants are witnesses of the high scientific quality of the work of the members of GALaC. Scientific excellence is and will remain in the future our main and highest aspiration.

Specifically, several common directions, detailed in the following, are present in the research conducted by the members of GALaC, and these form the federating factors of our group. We plan to develop our research within these areas.

The Combinatorics activity

Combinatorics is a research activity that takes place within the “**A**lgorithms, **G**raphes and **C**ombinatoire” team **GALaC**. It has four permanent members, namely Francesca Fiorenzi, Dominique Gouyou-Beauchamps, Florent Hivert and Nicolas Thiéry, and a number of non-permanent members including postdoctoral fellows, ATER, graduate students, interns and international visiting researchers.

Combinatorics is historically an important research topic of the former **Algo** team of the LRI. It was very weakened by the departure of Jean-Paul Allouche and Sylvie Corteel, but the LRI decided to maintain a strong combinatorics activity by recruiting two professors (Hivert in September 2011 and Thiéry in September 2012). As a consequence, the research subject of the Combinatorics activity recently shifted toward more algebraic aspects.

The main focus of this activity is the interrelation between algebraic structure and algorithms. We plan to work on the following subjects:

- Algebraic structures (Combinatorial Hopf Algebras, Operads, Monoids, ...) related to algorithms;
- Enumerative combinatorics and symbolic dynamic.
- Object oriented software design for modeling mathematics and development of SAGE-COMBINAT;

More precisely, the research project takes place in effective algebraic combinatorics, at the interface of enumerative combinatorics and analysis of algorithms on one hand and symbolic and algebraic computation on the other hand. The objective is twofold: firstly, thanks to vast generalization of the notion of generating series, we hope to give a theoretical framework allowing to study the fine behavior of various algorithms. Reciprocally, the study of those very same algorithms gives a new mean to discover algebraic identities. Those identities have many applications in mathematics, in particular in representation theory but also in physics (mainly statistical physics).

The research relies deeply on computer experimentation and contains as a consequence an important software development part within the SAGE-COMBINAT software project. However, the required level of sophistication, flexibility, and breath of computational tools is reaching a point where large scale collaborative development is critical. The design and collaborative development of such a software is raising research-grade computer science challenges around the modelling of mathematics, the management of large hierarchy of (object oriented) classes, etc.

Those very specific questions also raise more general combinatorial questions. We therefore plan to work on enumerative combinatorics and cellular automaton, in particular on trees.

This activity is conducted with close collaborators in France, Germany, North America, and India.

The Graph Theory activity

The Graph Theory activity involves eight permanent members: Johanne Cohen, Nathann Cohen, Antoine Deza, Selma Djelloul, Evelyne Flandrin, David Forge, Hao Li, Yannis Manoussakis and Reza Naserasr, and a number of non-permanent members including postdoctoral fellows, ATER, graduate students, interns and international visiting researchers.

The main focus is on structural and algorithmic point of views.

The team established expertise includes problems such as finding large cycles in a given graph, graph colorings, covering problems, and extremal graph theory. For example, some team members are particularly interested in Thomassen’s conjecture: Every 4-connected line graph is Hamiltonian. Finding sufficient and computationally tractable conditions for a graph to be Hamiltonian is of significant importance from both theoretical and algorithmic viewpoints as Hamiltonicity is an NP-hard problem.

Generalization of such problems has also been recently considered for edge- or vertex-colored graphs. For example, one may look for properly colored spanning trees in an edge- or a vertex-colored graph. Alternatively, one may look for a dominating set in a vertex colored graph having at least one vertex from each color. Beside their theoretical interest, these extensions have applications in areas including biocomputing and web problems.

The recent inclusion of new members to the team has further broadened our research expertise. Signed graphs, which are half way between graphs and 2-edge colored graphs, have proven to be an efficient tool to investigate some of the core problems of graph theory. While we consider extending or relaxing a number of classical problems from graphs and 2-edge colored graphs to signed graphs, we consider some of the most challenging problems in graph theory through the broader perspective of signed graphs. Most of these problems are connected to the celebrated four-color Theorem including (odd) Hadwiger's conjecture and Seymour edge-coloring conjecture of planar graphs. Signed graphs play a special role there by revealing relations between (signed) minors and (signed) homeomorphisms. Furthermore, random signed graph is a notion that has not received much of attention yet, and through this window we strengthen our use of probabilistic methods. In addition, we have recently started an international collaborative research project on homomorphism of vertex-colored graphs with an algorithmic viewpoint.

Many of the questions we consider can be stated in terms of (integer) linear optimization that is an expertise of new members of the team with research interests focusing on the combinatorial, computational, and geometric aspects of linear optimization. In this regard the aim would be to investigate recent results illustrating the significant interconnection between the most computationally successful algorithms for linear optimization and its generalizations, and the geometric and combinatorial structure of the input. Ideally, the deeper theoretical understanding will ultimately lead to increasingly efficient algorithms.

Most of our research collaborations involve French research groups including LaBRI, LIRMM, LIAFA, and LIMOS as well as research groups in Europe, North America, China, Japan, India and South America.

Algorithms for Networked Systems

Algorithms for Networked Systems (ANS) is a research activity that takes place within the **GALaC** team. It has four permanent members, namely Lin Chen, Johanne Cohen, Sylvie Delaët, Fabio Martignon, and a number of non-permanent members including postdoctoral fellows, ATER, graduate students, interns and international visiting researchers.

The research goal of the ANS group is to design efficient modeling, control and performance optimization algorithms especially tailored for networked and distributed systems, as well as their applications. The scientific contributions we expect are therefore both *theoretical*, with the development of new mathematical modeling techniques and proofs, and *applied*, with the development of innovative tools for the optimal planning and resource allocation in cognitive, opportunistic wireless and content-centric networks.

Specifically, the objectives of the ANS group for the next 5 years are:

- To establish theoretical building blocks for the design and optimization of networked systems, including: Control Theory, Game Theory, Distributed Algorithms (Self-stabilization, Fault Tolerance), Discrete Event Simulation systems.
- To design novel, efficient algorithms and protocols based on the developed theoretical framework, and evaluate their performance in practical networking scenarios. This includes: Opportunistic Wireless systems (including, among others, Cognitive Radio, Sensor and Robot networks), Future Internet infrastructures and protocols (Information, Content-Centric Networks), Security in Cyber-physical systems.

More specifically, the challenges we will address are related to *dynamic spectrum aggregation*, which has just emerged in the cognitive radio network field, with many important theoretical and technical problems waiting to be solved. In this context, we plan to (1) develop a theoretical framework characterizing the tradeoff between spectrum and energy efficiencies in spectrum aggregation, and (2) design green dynamic spectrum aggregation mechanisms that jointly optimize the spectrum sensing, spectrum aggregation and access so as to achieve a desired balance from both spectrum and energy perspectives. This research work will be conducted in the framework of an ongoing research project, the Green-Dyspan project (ANR Blanc International II, March 2013-Sep. 2016), in cooperation with Zhejiang University.

Another interesting research field is related to content-centric networks (CCNs), which constitute one of the most promising paradigms for the future Internet. In this field, several research issues are still open, and we plan to (1) devise efficient algorithms to foster resource sharing between network nodes, (2) design optimal resource allocation schemes to plan and manage efficient CCNs in a time-varying context, (3) game theoretical models to address security/privacy issues arising in mobile CCNs, as a basic building block to further support cooperative behaviors. This work will be conducted within the framework of the IUF 5-year project (2013-2018).

We will also study self-stabilization and fault-tolerance properties of different networked systems, like mobile robot networks, wireless inter-networked systems and sensor networks. Common criteria of those systems are the hardness of formal analysis due to huge non-determinism, and likeliness of fault occurrence. Unlike classical fault-tolerance techniques that rely on redundancy and replication (and are hence costly both in terms of memory, computation, and communication usage), self-stabilization is an optimistic way to recover from system faults, and is likely to enable lightweight solutions that are suited to those constrained emerging networks.

4/ GALaC

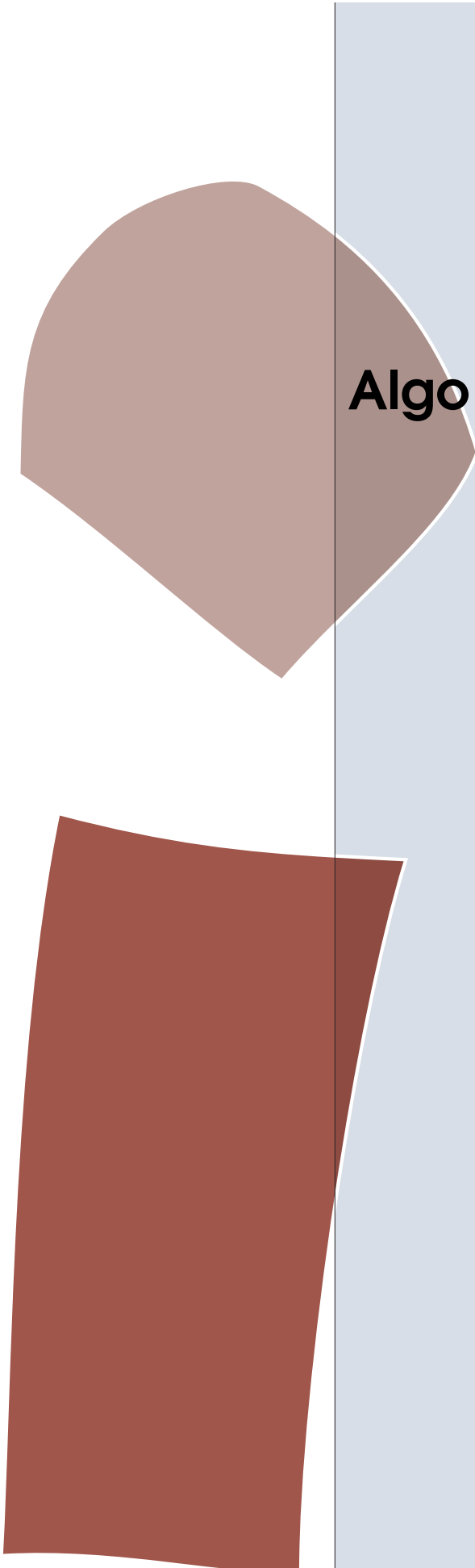
Strategy

Our strategy to stabilize the team within its environment and in particular the creating of the Université Paris-Saclay is based on three ongoing actions: the hiring of new young researchers, the creation of the ‘Séminaire d’algorithmique et de complexité du plateau de Saclay’ and the creation of the “MIFOSA” master.

Recruitment The team is expected to recruit a new associate professor (Maître de conférences) in June 2014. The new member is supposed to work in combinatorics and graphs thus further strengthening the synergy between these two activities. Moreover, the LRI decided to hire more young researchers in the GALaC Team within the next five years. We proactively are looking for young researchers (CR CNRS/Maître de Conférences/Postdoc) to hire in order to reinforce all research areas of the GALaC team. Among other things, our involvement in the Sage project gives us access to a regular source of international candidates.

Séminaire d’algorithmique et de complexité du plateau de Saclay The séminaire was founded in October 2011 by the Algorithmic and Complexity team of the LRI, LIX, PRISM and Supélec. It occurs every two weeks and gather usually more than 20 people. It was initially decided that the hosting will change every years (LRI in 2011, LIX in 2012 and Supélec in 2013). By gathering all the teams working around algorithms, we hope to create a large synergy on the plateau de Saclay. The precise program is available on www.lix.polytechnique.fr/~bodirsky/seminaire/.

Master MIFOSA The team leads the creation of the Master 2 MIFOSA which will start in 2015. The goal is to create a Master in theoretical computer science on the “Plateau de Saclay” involving 3 Universities (Evry, Orsay, Versailles) and 5 “Grandes Écoles” (Centrale, Supélec, ENSTA, Télécom ParisTech, Télécom SudParis), with the support of INRIA, Alcatel and EDF. We expect students from all components of the Paris-Saclay university as well as from other international universities. The team will be involved in several courses in Combinatorics, Graphs theory, Algorithms, and Distributed Network Algorithms. We expect that our involvements in this project will let us find and hire future outstanding PhD students.



Algo team publications

Journal articles

Major international journals

- (1) A. Abouelaoualim, K. C. Das, L. Fernandez de la Vega, M. Karpinski, C. A. Martignhon, Y. Manoussakis, and R. Saad. Cycles and paths in edge-colored graphs with given degrees. *Journal of Graph Theory*, 64(1):63–86, 2010.
- (2) R. Agueda, V. Borozan, Y. Manoussakis, G. Mendy, and R. Muthu. Sufficient conditions for the existence of spanning colored trees in edge-colored graphs. *Discrete Mathematics*, 312(17):2694–2699, 2012.
- (3) J.-P. Allouche and C. Frougny. Univoque numbers and an avatar of thue-morse. *Acta Arithmetica*, 136:319–329, 2009.
- (4) J.-P. Allouche, N. Rampersad, and J. Shallit. Periodicity, repetitions, and orbits of an automatic sequence. *Theoretical Computer Science*, 410(27-29):2795–2803, 2009.
- (5) G. E. Andrews, S. Corteel, and C. D. Savage. On q -series identities arising from lecture hall partitions. *International Journal Number Theory*, 5(2):327–337, 2009.
- (6) J. Araujo, N. Cohen, F. Giroire, and F. Havet. Good edge-labelling of graphs. *Discrete Applied Mathematics*, 160(18):2502 – 2513, 2012.
- (7) Z. Bar-Yossef, T. S. Jayram, and I. Kerenidis. Exponential separation of quantum and classical one-way communication complexity. *SIAM Journal on Computing*, 38(1):366–384, 2008.
- (8) J. Becu, M. Dah, Y. Manoussakis, and G. Mendy. Links in edge colored-graphs. *European Journal of Combinatorics*, 31(2):442–460, 2010.
- (9) O. V. Borodin, A. O. Ivanova, M. Montassier, P. Ochem, and A. Raspaud. Vertex decompositions of sparse graphs into an edgeless subgraph and a subgraph of maximum degree at most k . *Journal of Graph Theory*, 65(2):83–93, 2010.
- (10) V. Borozan, S. Fujita, A. Gerek, C. Magnant, Y. Manoussakis, L. P. Montero, and Z. Tuza. Proper connection of graphs. *Discrete Mathematics*, 312(17):2550–2560, 2012.
- (11) T. Ceccherini-Silberstein, M. Coornaert, F. Fiorenzi, and P. E. Schupp. Groups, graphs, languages, automata, games and second-order monadic logic. *European Journal of Combinatorics*, 33(7):1330–1368, 2012.
- (12) J. Chalopin, D. Gonçalves, and P. Ochem. Planar graphs have 1-string representations. *Discrete and Computational Geometry*, 43(3):626–647, 2010.
- (13) S. Corteel, J. Lovejoy, and O. Mallet. An extension to overpartitions of the Rogers-Ramanujan identities for even moduli. *Journal of Number Theory*, 128(6):1602–1621, 2008.
- (14) S. Corteel and P. Nadeau. Bijections for permutation tableaux. *European Journal of Combinatorics*, 30(1):295–310, 2009.
- (15) J. Degorre, M. Kaplan, S. Laplante, and J. Roland. The communication complexity of non-signaling distributions. *Quantum Information and Computation*, 11(8):0649–0676, 2011.
- (16) A. El Maffouhi, Y. Manoussakis, and O. Megalakaki. Balance in random signed graphs. *Internet Mathematics*, 8(4):364–380, 2012.
- (17) L. Esperet, A. Labourel, and P. Ochem. On induced-universal graphs for the class of bounded-degree graphs. *Information Processing Letters*, 108(5):255–260, nov 2008.
- (18) L. Esperet and P. Ochem. On circle graphs with girth at least five. *Discrete Mathematics*, 309(8):2217–2222, 2009.
- (19) F. Fiorenzi. Periodic configurations of subshifts on groups. *International Journal of Algebra and Computation (IJAC)*, 19(3):315–335, 2009.

- (20) F. Fiorenzi, P. Ochem, P. Ossona de Mendez, and X. Zhu. Thue choosability of trees. *Discrete Appl. Math.*, 159(17):2045–2049, 2011.
- (21) F. Fiorenzi, P. Ochem, and E. Vaslet. Bounds for the generalized repetition threshold. *Theoret. Comput. Sci.*, 412:2955–2963, 2011.
- (22) E. Fischer, F. Magniez, and M. D. Rougemont. Approximate satisfiability and equivalence. *SIAM Journal on Computing*, 39(6):2251–2281, 2010.
- (23) K. Friedl, G. Ivanyos, M. Santha, and Y. F. Verhoeven. On the black-box complexity of Sperner’s lemma. *Theory of Computing Systems*, 45(3):629–646, 2009.
- (24) K. Friedl, F. Magniez, M. Santha, and P. Sen. Quantum testers for hidden group properties. *Fundamenta Informaticae*, 91(2):325–340, 2009.
- (25) D. Goncalves and P. Ochem. On star and caterpillar arboricity. *Discrete Math.*, 309(11):3694–3702, 2009.
- (26) D. Gouyou-beauchamps and P. Nadeau. Signed enumeration of ribbon tableaux: an approach through growth diagrams. *Journal of Algebraic Combinatorics*, 36:67–102, 2012.
- (27) F. Hivert, A. Schilling, and N. M. Thiéry. The biHecke monoid of a Coxeter group and its representation theory. *Algebra and Number Theory*, 7(3):595–671, January 2013. 64 pages, arXiv:1012.1361 (math.CO).
- (28) F. Hivert, J.-G. Luque, J.-C. Novelli, and J.-Y. Thibon. The $(1-E)$ -transform in combinatorial hopf algebras. *J. Algebraic Combin.*, 33:277–312, 2011.
- (29) G. Ivanyos, L. Sanselme, and M. Santha. An efficient quantum algorithm for the hidden subgroup problem in nil-2 groups. *Algorithmica*, 62(1-2):480–498, 2012.
- (30) R. Jain, H. Klauck, and M. Santha. Optimal direct sum results for deterministic and randomized decision tree complexity. *Information Processing Letters*, 110:893–897, 2010.
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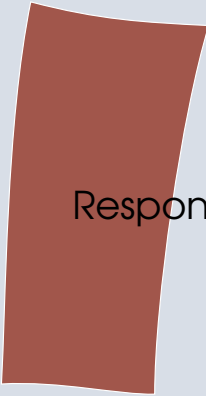
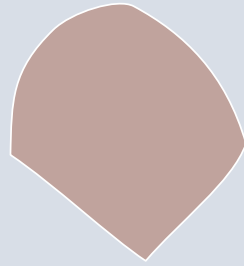
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5/ HCC

Human-Centered Computing



équipe Informatique Centrée sur l'Humain

Responsable: Michel Beaudouin-Lafon, Olivier Chapuis

L'équipe HCC du LRI coïncide avec l'équipe InSitu commune avec Inria. L'équipe explore de nouvelles formes d'interaction homme-machine et développe la notion d'*interaction située*, pour prendre en compte explicitement le rôle critique du contexte dans la conception de systèmes interactifs. Le but est de permettre aux utilisateurs de mieux comprendre et contrôler l'environnement informatique. Les recherches d'InSitu sont organisées en quatre thèmes complémentaires :

Paradigmes d'interaction et de visualisation : optimiser le compromis entre puissance et simplicité pour améliorer la performance des utilisateurs, notamment par l'étude des interfaces multi-échelles (zoomables), de la visualisation interactive et des interfaces tangibles.

Communication médiatisée : explorer des applications multimedia permettant aux utilisateurs de rester en contact à distance tout en respectant leur vie privée, en testant des prototypes en environnement réel.

Méthodes de conception : développer et tester des techniques participatives qui impliquent les utilisateurs tout au long du cycle de conception, à travers une approche pluridisciplinaire combinant ingénierie, sciences humaines et design.

Ingénierie des systèmes interactifs : développer des outils avancés de construction de systèmes interactifs pour permettre aux chercheurs d'InSitu ou d'ailleurs d'imaginer, de concevoir et de développer des systèmes interactifs nouveaux.



Human-Centered Computing

Head: Michel Beaudouin-Lafon, Olivier Chapuis

The LRI HCC group corresponds to the InSitu group joint with Inria. The group explores advanced forms of Human-Computer Interaction and places particular emphasis on *situated interaction*, acknowledging the critical role of context in the design of interactive systems. The goal is to empower users, enhancing their understanding and control of computer environments. InSitu's research is organized into four inter-related themes:

Interaction and visualization paradigms optimize the trade-off between power and simplicity to enhance the user's performance and understanding. This work includes multi-scale (zoomable) interfaces, interactive information visualization and tangible interfaces.

Mediated communication explores innovative multimedia applications that help users maintain peripheral awareness at a distance, while maintaining privacy and control. This work includes longitudinal field tests of working prototypes with users in real-world settings.

Research methods develop and test novel participatory design techniques that include users throughout the design process. This work integrates engineering, social science and design methods to create a multi-disciplinary approach to interaction design.

Engineering of interactive systems develops advanced tools for building libraries, exploratory toolkits and platforms. This work enables researchers, both within and outside of InSitu, to imagine, design and implement advanced interactive systems.

Synthetic presentation

Head of InSitu: **Wendy MACKAY**

Members of the group

As of January, 2008, the group had 3 university faculty (1 PR, 2 MC), 2 Inria researchers (1 DR, 1 CR) and 1 CNRS research scientist (CR), as well as 12 Ph.D. students, 1 post-doctoral student and 2 research engineers.

Permanent members who left the group

N. Roussel (MC) left in October 2009 to join Inria-Lille as Research Director; C. Puech (PR) left in February 2012 to found the Inria-Chile lab; E. Pietriga (Inria CR) left in July 2012 to join Inria-Chile.

Permanent members who joined the group

C. Appert, Ph.D. Univ. Paris-Sud, joined in September 2008 as CNRS research scientist; T. Tsandilas, Ph.D. Univ. Torontot, joined in September 2010 as Inria research scientist; C. Puech, Inria's director of research, joined in September 2010 as full professor; A. Bezerianos, assistant professor at Ecole Centrale, joined in September 2011 as assistant professor.

Highlights of the scientific activity

1. InSitu was recognized at the highest international level with many prizes (3 best papers and 4 honorable mentions in the top conferences in the field), an ERC Advanced Grant, an appointment with Institut Universitaire de France, and the organization in Paris of the largest conference in the field, ACM CHI (1000 presentations, 3500 attendees).
2. The WILD project (Wall-Size Interaction with Large Datasets), a world-class platform for collaborative interaction featuring a 140-million pixels wall-size display and full-room motion tracking system, provided a unique testbed to conduct research on off-the-desktop interaction, including fundamental studies of pointing and visualization, participatory design with expert users and implementation of advanced software toolkits, leading to the DIGISCOPE Equipment of Excellence.
3. InSitu continued its successful line of research on on-the-desktop interaction, including basic research on understanding and improving pointing, such as the DynaSpot pointing facilitation technique, advanced visualization, such as the JellyLens adaptive lenses, and gesture-based interaction, such as the OctoPocus dynamic guide or Rhythmic Interaction.
4. Our work on interactive paper has focused on creativity by studying extreme users, namely contemporary music composers at IRCAM and McGill, to create interactive systems mixing paper and computer that users can re-interpret and adapt to their needs, such as MusInk for interactive musical composition and PaperTonnetz for musical exploration.
5. InSitu has continued its tradition of developing advanced toolkits that explore novel interactive computation paradigms, such as SwingStates and FlowStates, which combines state-based and dataflow models, Substance, which introduces a novel data-oriented paradigm for distributed interfaces, and jBricks, to deploy applications on cluster-based wall-size displays.

Number of publications

- Articles in major international journals: 11 - Other journals: 3
- Articles in major international conferences: 40 - Other conferences: 40
- Books and book chapters: 11

Top five publications

- Anastasia Bezerianos and Petra Isenberg (2012) Perception of Visual Variables on Tiled Wall-Sized Displays for Information Visualization Applications. *IEEE Trans. on Visualization and Computer Graphics* (IEEE InfoVis'12), 18(12), pp. 2516-2525.
- Emilien Ghomi, Guillaume Faure, Stéphane Huot, Olivier Chapuis and Michel Beaudouin-Lafon (2012) Using Rhythmic Patterns as an Input Method. *Proc. Human factors in Computing Systems* (CHI '12). ACM, pages 1253-1262. (Best Paper Award).
- Mathieu Nancel, Julie Wagner, Emmanuel Pietriga, Olivier Chapuis and Wendy Mackay (2011) Mid-air Pan-and-Zoom on Wall-sized Displays. In *Proc. Human Factors in Computing Systems* (CHI'11). ACM, pages 177-186. (Best Paper Award).
- Theophanis Tsandilas, Catherine Letondal and Wendy Mackay (2009) Musink: Composing Music through Augmented Drawing. *Proc. Human Factors in Computing Systems* (CHI '09). ACM, pages 819-828. (Best Paper Award).

- Caroline Appert and Michel Beaudouin-Lafon (2008) SwingStates: Adding State Machines to Java and the Swing Toolkit. *Software: Practice and Experience*, 38(11):1149-1182

Top five software packages

- TouchStone, a software platform to design, run and analyze controlled experiments, is used in our research and for teaching at the Masters level.
- SwingStates, a toolkit extending the Java Swing toolkit with state machines and a structured drawing canvas, is used in our research, as well as for teaching at Paris-Sud and other French universities.
- jBricks, a toolkit to develop applications for cluster-based multi-surface environments, is used in our WILD (Wall-sized Display) platform as well as in the control room of the ALMA radio-telescope in Chile.
- Substance, a middleware based on a novel programming model called data-oriented programming, was used in combination with our other software Scotty and the WILD Input Server to develop several applications for the WILD room, showcasing the notion of multi-surface interaction.

Top five facts illustrating the scientific visibility

- Wendy Mackay was awarded an Advanced Grant from the ERC that started June, 1, 2013, entitled "CREATIV: Creating Human-Computer Partnerships".
- Michel Beaudouin-Lafon was appointed as senior member of the Institut Universitaire de France for 5 years (October 2011).
- InSitu received three best paper awards at CHI (2009, 2011, 2012), three honorable mention awards at CHI (2009, 2012 et 2013), one honorable mention award at UIST 2011, one best paper award at MobileHCI 2012 and one best paper award at IHM 2009.
- Caroline Appert (coordinator) and Fanis Tsandilas were awarded an ANR Jeunes Chercheuses / Jeunes Chercheurs grant to study multidimensional gestures.
- InSitu created the SIRIUS associated team as part of Inria Silicon-Valley, associated with HCI labs at Stanford, UC Berkeley and UC San Diego, with 6 joint publications and multiple cross visits and exchanges, including Wendy Mackay and Michel Beaudouin-Lafon two-year sabbatical at Stanford.

Top five facts illustrating the interactions with the socio-economic and cultural environment

- Wendy Mackay (General Chair) and Michel Beaudouin-Lafon (Technical Program Co-Chair) organized CHI 2013 in Paris, ACM's flagship conference in Human-Computer Interaction with almost 3500 attendees and 1000 presentations over six days. CHI'13 anchored the first ECRC (European Computer Research Congress) series of ACM conferences, with Michel Beaudouin-Lafon on the organizing committee.
- The WILD platform (experimental high-resolution, interactive platform for conducting research on collaborative human-computer interaction and the visualization of large datasets) was demonstrated to numerous audiences: K-12 students, university students (IUT, Polytech, Supélec, etc.), visitors from academia and industry, government representatives (both French and foreign).
- EquipEx Digiscope - a 22Meuro project to create a high-performance visualization infrastructure for collaborative interaction with extremely large data sets and computation - is coordinated by InSitu and is a collaboration between 9 academic institutions of the Saclay Campus (FCS Campus Paris-Saclay, Univ. Paris-Sud, CNRS, CEA, Inria, Institut Mines-Telecom, Ecole Centrale Paris, Univ. Versailles - Saint-Quentin, ENS Cachan, Maison de la Simulation), with high interest from large companies and SMEs.
- Inria Chile - Emmanuel Pietriga joined Inria Chile in July 2012 where he is heading the Massive Data project, continuing the close collaboration with the ALMA radio-observatory on the design and implementation of interactive visualization components for the telescope's control room, and working on new industrial transfer projects related to the visualization of massive datasets.
- "Fête de la Science" organization for LRI in 2010 (C. Appert) and 2011 (T. Tsandilas).
- ICI-TV (an OMTE project with the CEA start-up, Praesto) led to technology transfer to create private social networks based on a multi-scale communication band, with hardware patented by Inria.

Top five contributions to teaching and training

- Founding of the second-year Research Master Specialty in Interaction (M2R Interaction), the only such program in France (taught in English).
- Founding and participation in the Human-Computer Interaction and Design (HCID) major of the EIT ICT Labs Master School.
- Use of InSitu software to teach students in both Masters programs, including the Touchstone platform for designing and running controlled experiments, and the SwingStates toolkit for developing graphical user interfaces.
- Creation of a human-computer interaction teaching lab featuring desktop computers, tablets and smartphones with associated software and development tools.
- InSitu supervised 16 research Masters students and 17 Ph.D. students (11 defended theses).

Research Group Members and evolution since 2008

Permanent Members (October 1st, 2013)			
Name	First name	Position	Institution
APPERT	Caroline	CR2	CNRS
BEAUDOUIN-LAFON	Michel	PREX	PARIS SUD
BEZERIANOS	Anastasia	MCF	PARIS SUD
CHAPUIS	Olivier	CR1	CNRS
FLEURY	Cédric	MCF	Paris-Sud
HUOT	Stéphane	MCF HDR	PARIS SUD
MACKAY	Wendy	DR1	Inria
TSANDILAS	Theophanis	CR1	Inria

Doctoral Students (October 1st, 2013)			
Name	First name	Funding	Institution
BONNET	David	Alloc.	PARIS SUD
GARCIA	Jérémie	ATER	PARIS SUD
JALAL	Ghita	Contract	Inria
LIU	Can	Digicosme	PARIS SUD
MATHEW	Justin	CIFRE	DMS
PINDAT	Cyprien	Alloc.	PARIS SUD
STRAZZULLA	Daniel	Cordi	Inria
ZINENKO	Oleksandr	Contract	Inria

Temporary Personnel (2008-2013)					
Name	First name	Position	Institution	Arrival	Departure
TSANDILAS	Theophanis	Post-doc	Inria	09.2007	02.2009
CARDONA	Rémi	Engineer	Inria	09.2007	08.2009
LUONG	The Nhan	Engineer	Inria	10.2007	09.2008
LETONDAL	Catherine	Engineer	Inria	06.2008	05.2009
EAGAN	James	Post-doc	PARIS SUD	02.2009	02.2011
PRIMET	Romain	Engineer	Inria	03.2009	06.2013
PILLIAS	Clément	Engineer	Inria	03.2009	09.2012
HUSSON	Julien	Engineer	Inria	10.2009	09.2011
KLOKMOSE	Clemens	Post-doc	PARIS SUD	11.2009	10.2010
LICCARDI	Ilaria	Post-doc	Inria	03.2010	12.2011
TSANDILAS	Theophanis	Post-doc	Inria	04.2010	10.2010
DE ALMEIDA	Rodrigo	Post-doc	Inria	02.2011	01.2012
GUPTA	Arijit	Engineer	Inria	03.2011	02.2012
SPELMEZAN	Daniel	Post-doc	Inria	09.2011	08.2012
TEZIER	Gabriel	Engineer	CNRS	06.2012	05.2013
OEHLBERG	Lora	Post-doc	Inria	12.2012	04.2013
OLAFSDOTTIR	Halla	Post-doc	PARIS SUD	01.2013	12.2013
SANAEI	Monireh	Engineer	Inria	02.2013	01.2015
THORPE	Jonathan	Engineer	CNRS	10.2013	05.2015
KOOLI	Amani	Engineer	CNRS	10.2013	05.2015

Visitors for 3 months or more (2008-2013)					
Name	First name	Position	Institution	Arrival	Departure
KLOKMOSE	Clemens	PhD	U. Aarhus	11.2007	04.2008
JACOB	Robert	Professor	Tufts Univ.	01.2008	06.2008
LOTTIRIDGE	Danielle	PhD	U. Toronto	2008	2009
SHENGQIONG	Yuan	Other	Wuhan IT	2008	2008
GJERLUFSEN	Tony	PhD	U. Aarhus	11.2009	05.2010
SOARES DE OLIVEIRA NETO	João	PhD	U São Paulo	2009	2010
FIGUEIRA FILHO	Fernando	PhD	UC Irvine U São Paulo	05.2010	07.2010

Group evolution

- Caroline Appert joined in September 2008 as CNRS Research Scientist
- Nicolas Roussel (MCF) left in October 2009 to join Inria-Lille as Research Director
- Theophanis Tsandilas joined in September 2010 as Inria Research Scientist
- Claude Puech joined between September 2010 and February 2012 as Full Professor and left to found the Inria-Chile lab
- Anastasia Bezerianos joined in September 2011 as Assistant Professor
- Emmanuel Pietriga (CR1 Inria) left in July 2012 to join Inria-Chile
- Cédric Fleury (MCF) joined in September 2013 as Assistant Professor
- Wendy Mackay and Michel Beaudouin-Lafon were Visiting Professors at Stanford University between September 2010 and August 2012
- Stéphane Huot was on leave at Inria from September 2011 to August 2013
- Three Inria administrative assistants supported the group over the period: Marie-Carol Lopes, Hélène Milome and Alexandra Merlin

5/ InSitu

Research Description

The focus of the InSitu project is to create innovative interactive systems that truly meet the needs of their users. For us, context is critical: we need to provide designers with tools and methods that actively take context into account. This requires a deeper understanding of the complementary characteristics of humans and computers as well as an analysis of specific situations of use. Our goal is to develop and facilitate the creation of such situated interfaces, which take optimal advantage of context to provide users with the particular tools they need to address the problems at hand. Our approach both expands today's graphical user interfaces and explores new possibilities, addressing the following goals:

- *Flexibility* to support end-user customisation and programming as well as adaptation to physical context;
- *Integration of physical and electronic worlds* through the exploration of mixed reality and tangible interfaces;
- *Scalability* with respect to the quantity of data being managed, through the development of multi-scale interfaces and information visualisation techniques;
- *Cooperation and collaboration support* in order to study new forms of person-to-person mediated communication;
- *Integration* of varied interaction styles and techniques into a single coherent environment, using appropriate interaction models and architectures.

The overall goal of InSitu is to develop situated interfaces, i.e. interfaces that are adapted (or adaptable) to their contexts of use by taking advantage of complementary aspects of humans and computers. Our very ambitious longterm goal is to move beyond the current generation of desktop environments and envision the next generation of interactive environments.

Our research strategy is to develop case studies and development tools, in parallel. The case studies allow us to study specific users, in particular application domains, and explore innovative interaction approaches in real-world contexts. The development tools, consisting of architectures and toolkits, allow us to create a development environment for creating novel types of interaction and facilitate the creation of innovative applications. We have identified four research themes, each with separate deliverables, to achieve this objective: Interaction and Visualization Paradigms, Mediated Communication, Research Methods and Engineering of Interactive Systems.

Interaction and visualization paradigms focuses on the trade-off between power and simplicity in interactive systems, both in terms of interaction and in managing and visualizing data. Rather than accepting one or the other, our objective is to shift the trade-off curve, creating systems that provide more power while retaining simplicity. We are investigating both on-the-desktop and off-the-desktop interaction, including multi-scale and multi-surface interaction, interactive information visualization, gesture-based and

tangible interfaces, and multimedia (video and audio). Our goal is to not only explore these paradigms individually but also to investigate how to integrate them into real-world applications.

Mediated communication focuses on how to help people to maintain peripheral awareness of each others' activities at a distance (to "stay in touch"), while maintaining privacy and ensuring that users stay in control of their communication channels. Our objective is to generate a design space for alternative forms of communication, developing and testing new communication applications that illustrate different dimensions of the design space. We develop communication appliances for home settings, including support for the elderly, children, remote couples and families.

Research methods focuses on how multi-disciplinary teams can create effective interactive systems that take context into account. Our objective is to create new research methods that include users throughout the design process, to test these methods in real-world settings and to disseminate these methods to researchers and designers. We investigate participatory design techniques that actively involve users throughout the design process and multidisciplinary design techniques that facilitate communication among researchers from engineering, social science and design disciplines.

Engineering of interactive systems focuses on creating effective tools for building interactive systems. Our objective is to generate libraries, exploratory toolkits and platforms that enable us to quickly implement and work with new concepts, while also enabling researchers within and outside of InSitu to benefit from our research. We are investigating tools that facilitate the design and adoption of effective interaction techniques and paradigms and component-based architectures to facilitate dynamic management of interactive systems, especially in distributed environments. Our goal is to develop open source toolkits that enable us and our research colleagues to design and implement advanced interactive systems.

Although we articulate each theme separately, we often intermix them within actual projects. We also work across disciplines, providing us with research breadth, and at the same time, seek to obtain depth in particular projects. We apply our own research methods to the design of new interaction techniques, develop our own tools for developing these techniques and integrate these techniques in the design of innovative interactive systems, which we test in real-world settings. Our long-term goal is to create a new generation of interactive environments that provide a compelling alternative to the current generation of desktop computers.

Interaction on the Desktop



Figure 5.1: From left to right: DynaSpot, JellyLens, OctoPocus and Dwell-and-Spring

InSitu has a long tradition of studying basic tasks performed on the desktop such as pointing, navigation, command activation and window management. Since users rely on these interactions hundreds of times a day, any improvement can have a huge impact on the user experience. We have continued our work on pointing, navigation and window management, and have also studied issues related to command activation such as learning shortcuts and repairing errors.

Target acquisition (or pointing) is the most common basic task on the desktop, e.g., to select a menu item or push a button. We have improved the state of the art in understanding target acquisition by developing performance models that better capture the underlying phenomenon. For example, we have identified which factors affect pointing performance when targets are located on screen edges, e.g., a menu bar, and we have refined the well-known Fitts' pointing model to quantify the gain due to the presence of an edge (16). We have also extensively studied the acquisition of very small targets (6). In particular we have confirmed a strong departure from Fitts' Law and we have shown that Welford's 1969 model is better suited to these difficult pointing cases. These findings have informed the design of new and efficient pointing techniques. *TorusDesktop* (36) lets the mouse cursor wrap around screen edges to

quickly reach targets on the other side of the screen, but uses a “dead zone” to conserve the potential benefits of screen edges. It has shown clear benefits in several conditions. *DynaSpot* (23) (honorable mention at CHI 2009) couples the cursor’s activation area with its speed. This technique outperforms the traditional point cursor and achieves the same level of performance as the best target-aware techniques, most notably the Bubble Cursor. However, unlike the Bubble Cursor, it also lets users select any pixel on the screen, not just the predefined targets.

Zoomable (or multi-scale) interfaces have become the standard representation for navigating large information spaces such as geographical maps and networks. InSitu has conducted extensive research on focus+context techniques that provide in-place magnification of a region without requiring users to zoom the whole representation and consequently lose context. With *Sigma Lenses* (44) we investigated how such techniques can be built within a framework defined along three dimensions: space, translucency and time. We have identified the most promising points in this design space through empirical studies and have shown how to address issues of quantization that arise with high magnification factors (17). Our representation-independent implementation of *Sigma Lenses* for both 3D graphics and rich 2D graphics (8) makes it easy to use them in a wide variety of applications. In contrast, taking the representation into account allowed us to design *JellyLenses* (45) that dynamically adapt to the shape of the objects of interest in order to optimize which regions fall into the focus, context and transition regions. A multi-scale visual search task experiment demonstrated that *JellyLenses* consistently perform better than regular circular fisheye lenses. We have also designed two new content-aware techniques, *Bring & Go* and *Link Sliding* (41), for navigating large networks. *Bring & Go* moves adjacent nodes nearby while *Link Sliding* guides panning along the links. These techniques improve the state of the art for exploration and node revisiting tasks.

Interaction on the desktop often involves managing different views, windows and moving objects. Users need to organize their views so as to be able to switch their focus of attention among them and perform operations such as copy-paste across them. *Glimpse* (26) is a quick preview technique that smoothly transitions between document markup code (HTML, wiki markup or $\text{\LaTeX}$) and its visual rendering. It provides an efficient alternative to classical preview windows by supporting rapid overviews of code-to-document mappings and by saving screen real-estate. To facilitate operations across windows, we also introduced new techniques (31, 114) that improve the state of the art: a selection, copy-and-drag history manager; two techniques for exposing the user’s desk and leafing through stacks of overlapping windows; and a technique that integrates the previous two techniques with conventional drag-and-drop. Finally, we studied interaction with pop-up targets, such as the items in popup menus, and with animated targets, such as the windows that move when using Mac OS X Exposé. We conducted empirical studies that model how pointing is affected by the delay before a target pops up and by the duration of the animation (30).

Gesture-based input is becoming a common alternative to buttons and menus to invoke commands. We conducted an extensive survey and empirical studies in collaboration with Google Research and the University of Saint Andrews to assess the cognitive and motor benefits of using gestures as command shortcuts (10, 19). To address the well-known problem of gesture-based interfaces not being self-revealing, we developed *OctoPocus* (21), a dynamic guide that combines on-screen feedforward and feedback to help users learn, execute and remember gesture sets (112). Controlled experiments showed that *OctoPocus* is significantly faster than conventional help techniques and improves learning of arbitrary gesture sets. To ensure this approach works with gestures drawn at different sizes, we developed a scale-independent algorithm that incrementally recognizes incomplete gestures (15).

We also continued to improve the traditional point-and-click, press-drag-release and menu selection interactions. With *UIMarks* (24), users can associate actions to on-screen targets using a graphical marking language. For example, a *UIMark* can be used to quickly access a tool in a palette, click it and move back to the starting point. *Dwell-and-Spring* (18) lets users undo commands issued with a press-drag-release interaction. Desktop interfaces use this interaction heavily but do not usually offer an undo mechanism. *Dwell-and-Spring* uses a spring widget that pops up whenever users dwell during a press-drag-release interaction, giving them the opportunity to either cancel or undo the current manipulation. Our morphological analysis of menu techniques (63) introduced a design space to facilitate the analysis of existing menu techniques and the exploration of novel menu designs, in particular to increase menu capacity without sacrificing performance. We demonstrated its generative aspect by introducing four new menu designs based on poorly explored combinations of input dimensions: pressure, distance, stylus azimuth and finger touches combined with hand rotation.

Interaction off the Desktop

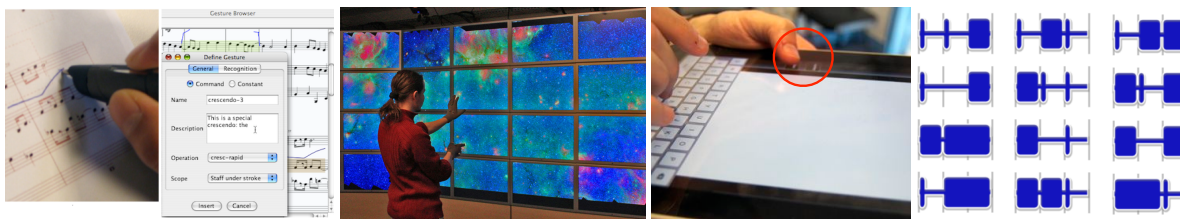


Figure 5.2: From left to right, *Musink*, *WILD* pan-and-zoom, *BiPad*, and rhythmic interaction

Computer input and output technology has evolved from traditional desktop environments to more diverse environments ranging from augmented paper and small mobile displays to very large digital tabletops and wall-size displays. This evolution has prompted new interaction paradigms, such as on-body interaction and multi-surface interaction. InSitu investigates new forms of interaction for these environments and seeks to better understand how it fundamentally changes user practices. Our work in this area has received numerous awards at international venues.

Although interaction with mobile devices is becoming more and more common, many techniques do not take into account the context of use of these devices. For example, single-handed use of mobile devices is very common, but many techniques require both hands. We investigated thumb-based interaction for mobile devices such that holding the device and interacting with it can be done with one hand. We introduced *TapTap* and *MagStick* (47), two techniques that use the thumb for target acquisition without occluding the content of mobile displays. We also designed *ThumbRock* (70), a new micro gesture that consists of rolling the thumb back and forth on the touchscreen. This micro gesture can be used as a new gesture event, such as a flick or a pinch, to increase the vocabulary of touch-based interaction on mobile devices. Finally the *Swiss Army Menu* (SAM) (58) is a radial menu that makes a very large number of functions accessible via small thumb movements. All these techniques were evaluated through user studies that demonstrated their advantages over the state of the art.

We also studied novel uses of hand-held devices. *Mobile AR* (39) (honorable mention at CHI 2012), uses the mobile device's camera and touchscreen to create mobile augmented reality, and significantly helped users to interact with everyday physical objects, such as door codes and home appliances. With *BiPad* (53), we examined how users hold their mobile tablets and introduced a design space that characterizes bimanual interaction on multitouch tablets. We created several bimanual interaction techniques for tablets and implemented a toolkit that makes it easy to integrate them into applications.

WILD (Wall-Size Interaction with Large Datasets) is InSitu's experimental ultra-high-resolution interactive platform for studying collaborative interaction and the visualization of very large datasets (3). It features a wall-sized display with 32 monitors, a multitouch table, a motion-tracking system and various mobile devices. Our goal is to explore the next generation of interactive systems by distributing interaction across these diverse computing devices, enabling multiple users to easily create, share and manipulate digital content.

We first conducted a set of user studies using wall displays to better understand their fundamental characteristics. In *Mid-air Pan-Zoom* (43) (best paper at CHI 2011), we studied how people navigate information using a variety of input technology and identified three key factors for the design of mid-air pan-and-zoom techniques: uni- vs. bimanual interaction, linear vs. circular movements, and level of guidance to accomplish the gestures in mid-air. We also investigated how information is visually perceived (4) in these environments when people are able to move freely. We found a severe and unpredictable distortion at locations that are far away and below the viewer's field of view, requiring the development of appropriate interaction and visualization techniques.

To improve interaction with large displays, we also combined novel interaction techniques with information about the user's location near the wall display. In *GridScape* (25), the content of the display moves as people move in front of the wall so as to reveal content that is hidden behind the bezels of the monitors, as if looking through French doors. *GridScape* was tested using different search tasks, and was extended to multi-user collaboration. In *HeadPad* (42) a viewer's head orientation was used to determine their focus in order to improve pointing accuracy. Finally, we are investigating how to best combine the different devices present in the *WILD* room to aid users. For example *Combinatorix* (87) combines a digital tabletop and other screens with physical tokens to help students work collaboratively to solve probability problems.

With the recent start of the Digiscope project we are now extending our work on the WILD platform to remote collaborative interaction across multiple sites equipped with high-end visualization and interaction capabilities.

Another major focus includes user interfaces that mix traditional media such as paper with computers. We conducted a number of studies with composers of contemporary music at IRCAM and designed user interfaces that enhance their creative process. *Musink* (51) (best paper at CHI 2009) lets composers transition smoothly between paper and OpenMusic, a flexible music composition tool. *Musink* supports semi-structured, delayed interpretation of the user's written marks. Its customizable gesture browser gives composers significant freedom to create their own, individualized composition languages and to experiment with music, on-paper and on-line. We ran a series of participatory design sessions with music composers at IRCAM to explore the concept of "paper substrates" (32). These design sessions resulted in augmented paper interactions, such as drawing and modifying specialized data over formatted paper, exploring variations by superimposing handwritten data, linking them together, overlaying them, and archiving them into physical folders. We also explored new forms of musical representation that are particularly appropriate for pen-based interaction. For example, *PaperTonnetz* (69) lets musicians explore and compose music using a spatial representations by drawing on interactive paper, creating re-playable patterns that represent pitch sequences and/or chords.

In paper-based interfaces, the lack of feedback makes menu navigation and command selection difficult. *Knotty gestures* (52) combines the best qualities of paper buttons and marks, providing users with a subtle, in-the-flow-of-writing technique for tagging and structuring handwritten data and subsequently interacting with the paper. We also combined the use of portable touch-screen devices with pen and paper to help users direct and refine the interpretation of their strokes on paper (50). We demonstrated both techniques through a mobile interface for writing music.

Finally, we investigated novel interaction paradigms that break previous expectations about the future of interaction. In *Rhythmic Interaction* (33, 115) (best paper at CHI 2012) we use rhythm and temporal structures to enter information, in particular in situations where the visual channel is overloaded or not available. We have also investigated how the entire human body plays a central role in interaction. With the *BodyScape* design space (55) (honorable mention at CHI 2013) we explored the relationship between users and their environment, specifically how different body parts enhance or restrict movement for specific interactions. *BodyScape* can be used to analyze existing techniques or suggest new ones, such as on-body touch interactions (124). Full body interaction was also used to help snowboarders learn correct positions (48) (best paper at MobileHCI 2012) by wearing vibration motors attached to the thighs and shoulders to remind the snowboarder of the correct posture.

Mediated Communication

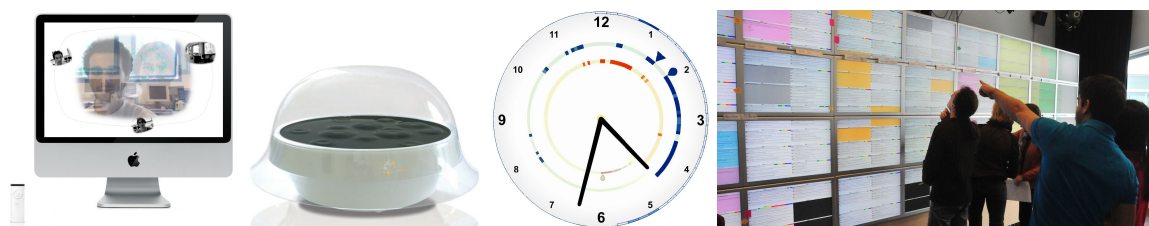


Figure 5.3: From left to right, *Pêlè-Mêlè*, *WeMe*, *MarkerClock*, and CHI'13 scheduling

Our work in mediated communication involves both theoretical work on multiscale communication (116) and participatory design studies of communication appliances in domestic settings. Multiscale communication allows users to vary their degree of engagement. *Pêlè-Mêlè* (61) provides gradual attention management mechanisms that support transitions between background and foreground communications and lets users control information pace and salience. We also considered the role of peripheral displays for interpersonal communication (35) and investigated cross-media applications that mix digital and non-digital media (73).

We conducted a series of participatory design studies to create *communication appliances* to help remote family members stay in touch (119). The *WeMe* system (82) offers peripheral awareness across households. *WeMe*'s ferrofluid bubbles move in response to ambient sounds, both local and distant,

but family members can also generate patterns intentionally, by moving their hands around the surface. *WeMe* acts as a stand-alone sculpture, a passive indicator of remote activity and a source of shared interaction. We also studied remote couples and developed the *MissU* (40) technology probe to help them communicate during “empty moments”, the time when users most needed communication technology.

Our studies of the elderly focused on how to help them successfully “age in place”. Our approach centered around *peer care* (9): instead of “big brother”-style monitoring of their activities, we instead emphasize inter-personal communication. *Marker Clock* (122) captures activity levels, both local and remote, and displays it on a clock face. The ICI-TV technology maturation project (financed by Digiteo and completed in 2009) transferred our mediated communication technology to Praesto, a CEA startup that provides services to the elderly. We created dedicated communication channels, via a settop box on a television, to connect the elderly with remote family members. ICI-TV led to a second technology transfer project, called Buena Vista, which worked with a startup, SDS (Splitted-Desktop Systems), that creates complete solutions (end-user terminals, software stack and server back-end) for simple access to the internet.

The Digiscope project is currently exploring the problem of mediated communication within and across wall-sized displays and other immersive environments. Our initial prototyping sessions with users (57, 3) sparked a number of follow-on projects and influenced the design of the CHI 2013 interactive schedule (86).

Research Methods



Figure 5.4: From left to right, *Generative Deconstruction*, *TouchStone*, *Inkspace*, and *Prism*

Conducting empirical research is a fundamental part of In Situ’s research activities and includes observation of users, in field and laboratory settings, controlled laboratory experiments, longitudinal field studies and participatory design. We also conduct research on design methods, to explore and test new ways of conducting HCI research.

We explored the paradigm of *Research through Design* (101) in which the end goal is not to produce an artifact, but rather to frame an alternative future and uncover unmet human needs, desires, emotions, and aspirations. We also examined participatory design engagement in fieldwork (46) and developed techniques for sketching design spaces (79) to help developers generate and analyze new ideas. *Generative Walkthroughs* (80) support the *redesign* phase of an iterative design process, helping designers generate new design alternatives informed by social science principles.

We developed a Java-based version of our *TouchStone*¹ platform, an experiment design platform that provides a strong empirical foundation for comparing and evaluating interaction and visualization techniques. We used *TouchStone* to design and conduct controlled laboratory experiments to validate new algorithms and interaction techniques, including: high precision magnification lenses (17), *UIMarks* (24), scale detection for incomplete gesture input (15) and several studies on the WILD wall-size display (120). We also conducted studies of the perception of visual variables that encode information (4) and found that perception is affected differently at different locations on the screen, depending on the vertical and horizontal positioning of this information.

We conducted a series of participatory design workshops with biologists and astrophysicists and also ran a quasi-experiment with researchers that offered new insights into the sustainable use of interactive paper (54). We studied communication on the web, including a longitudinal study of authoring wiki-books (38) and the role of addressing internal redundancy for creating high quality books. We also interviewed Wikipedia contributors and administrators as well as sociologists who study Wikipedia, which led

¹<http://code.google.com/p/touchstone-platforms>

to the development of *WikipediaViz* (72), a set of visual indicators to keep Wikipedia readers aware of important meta-information about the articles they read.

The *ReActivity* project explored how people interact with temporal data. We ran the CHI'09 workshop on "Interacting with Temporal Data" (81), which generated both research papers and a set of five developed video prototypes. We conducted longitudinal field studies with biologists at INSERM and Institut Pasteur, investigating how biologists use our hybrid notebooks (62) and *Prism* (49, 123). We developed *InkSplorer* (75) as a technology probe that connects users' hand-written gestures on paper to Max/MSP and OpenMusic. Composers appropriated *InkSplorer* according to their preferred composition styles, emphasizing its ability to help them quickly explore musical ideas on paper as they interact with the computer. We also analyzed the role that annotations play in visual analysis and record-keeping, specifically on visualization dashboards (28) that link collections of visualizations, focusing on business intelligence analysis.

We also created the *UIST 2.0 20th Anniversary Celebration* archive², which includes 20 years of archived proceedings and videos, video interviews with seven UIST pioneers, a video of the ZUIST zoomable interface for browsing the UIST archives, a timeline illustrating the history of interaction techniques, a social network graph of UIST authors, and the results of the two *interactive thread* exercises, which identified 150 of most influential UIST research over the past 20 years and several hundred novel design ideas for future technologies, inspired by images collected from the past 10 years of UIST.

Engineering of Interactive Systems



Figure 5.5: From left to right, *FlowStates*, *jBricks*, and *Substance*

InSitu has a long tradition of developing software tools and user interface toolkits to facilitate the creation of interactive systems. These tools allow us to better experiment with our ideas and are therefore an integral part of our research methodology. Most of them are freely available and some are used outside InSitu for research or teaching.

We developed a first set of tools to support zoomable user interfaces (ZUIs). Our *ZVTM* toolkit was extended to support lenses modeled after our Sigma-lenses framework (44) as well as our new high-precision magnification lenses (17). It is also used in the context of our collaboration with the ALMA radio-telescope on the design and implementation of user interfaces for operations monitoring and control (83).

We developed another set of tools to experiment with programming models for interactive systems. The traditional approach, based on callbacks (or listeners) is well-known for being cumbersome and error-prone. With *SwingStates* (1), we revived the use of state machines to program interaction, and successfully integrated it with the popular Java Swing toolkit. *SwingStates* is used for various research projects, but also for teaching at Paris-Sud and other Universities.

With *FlowStates* (56) (best paper at IHM 2009) we integrated *SwingStates*' state-based model with ICon's data flow model to significantly increase the range of innovative interaction techniques that we can quickly prototype. *FlowStates* is used extensively in our WILD platform, in particular in the *WILD Input Server* which allows us to combine a variety of input devices and change their mapping at run-time.

We also explored the use of communicating processes and reactive behaviors for programming interaction. Combined with our work on the *VIGO* architectural model (37) for instrumental interaction, this eventually led to the *Substance* framework (34). *Substance* is based on a novel programming model called *data orientation* and supports distributed environments where components can be added, removed and reconfigured at run-time. It was developed specifically to explore the concept of *multi-surface interaction* on our WILD platform.

²<http://uistf.org/archive>

WILD (Wall-Size Interaction with Large Datasets) is InSitu's experimental ultra-high-resolution interactive platform for studying collaborative interaction and the visualization of very large datasets (3). It features a wall-sized display with 32 monitors, a multitouch table, a motion-tracking system and various mobile devices. We developed software architectures and toolkits that enable developers to run applications on such multi-device, cluster-based systems, including the *Substance* framework introduced above.

jBricks (84) is a Java toolkit for exploratory prototyping of interaction techniques and rapid development of post-WIMP applications on cluster-driven interactive visualization platforms. It integrates a high-quality 2D graphics rendering engine based on ZVTM and a versatile input configuration module (the *WILD Input Server*) into a coherent framework. We use it for many of our studies of interaction techniques on WILD.

Scotty (27) (notable mention at UIST 2011) introduces the notion of user interface programming at run-time to create more malleable software. We have used *Scotty* to distribute the user interface of an application over multiple devices, e.g. to teleport a window running on a laptop to the WILD wall display.

We have also developed toolkits for bimanual interaction with a tablet (53), for creating adaptable pointing techniques (24), for adding stroke shortcuts to Java Swing applications (19) and for improving gesture recognition in *SwingStates* (15).

In summary, InSitu has made significant progress towards mature toolkits that support post-WIMP and distributed user interfaces, based on novel and effective programming models. These toolkits, in turn, have enabled us to experiment with novel interaction techniques using rapid prototyping, including, in some cases, during participatory design sessions involving end users. Conversely, our work on novel interaction techniques and mediated communication has often led to the development of software toolkits that embody their underlying principles, facilitating further exploration. This back-and-forth between techniques, methods and tools is a defining feature of InSitu, captured by the *Designing Interaction* (117) framework. As the focus of our research on interaction techniques has shifted from on-the-desktop to off-the-desktop, this approach has proven more valid than ever: improving interaction in such environments requires more complex software architectures and tools; in turn, these tools and architectures are a key step to getting these technologies outside the lab.

5/ InSitu

Collaborations

Participation to national and international collaborative research projects

A table and more detailed description of all the group's contracts is available in the Appendix.

International:

- *EDGE - Evaluation methods, Design Guidelines and Environments for Virtual Reality and Information Visualization Techniques*, Inria & CNPq, Brazil (2005-2008). Coordinator for InSitu: Nicolas Roussel. Partners: InSitu, Inria MERLIN, Inria AVIZ, CS Institute of the Federal University of Rio Grande do Sul, CS Department of PUC-Rio University
- *HolyRisk - Scientific Uncertainty and Food Risk Regulation*, ANR Blanc (2009-2013), Coordinator: Emmanuel Pietriga. Partners: InSitu, INRA, Agro ParisTech, Univ. Maryland
- *VCoRE - Next-Generation Visual Computing Platform*, Inria (2011-2014), Coordinator for InSitu: Stéphane Huot. Partners: Inria (Grenoble, Lille, Rennes, Saclay, Sophia Antipolis), IGD Fraunhofer Institute
- *BayScope - Architectures and Interaction Paradigms for Multi-surface Environments*, NSF (2012-2013), Coordinator: Wendy Mackay. Partners: InSitu, Berkeley Institute of Design (BiD)
- *DRAO - Interactive Graphics Tools to Support Sketching*, ANR (2012-), Coordinator: Adrien Bousseau (Inria Sophia). Partners: InSitu, Inria-Sophia, UC Berkeley

National:

- *DISCODOM - Experimental communication systems for the home environment*, France Telecom (2008), Coordinator: Nicolas Roussel. Partners: InSitu, FT R&D
- *WebContent - the Semantic Web Platform*, RNTL (2008-2009), Coordinator for InSitu: Emmanuel Pietriga. Partners: InSitu, Inria Gemo, EADS, CEA, INRA, Thalès, LRI IASI, LIP6, Inria Mostrare, and more
- *iStar - Multi-language interaction engine*, ANR (2008-2010), Coordinator for InSitu: Michel Beaudouin-Lafon. Partners: InSitu, ENAC (Toulouse), IntuiLab, Anyware Technologies

- ICI-TV - *Inria-CEA Interactive Television*, Digiteo (2008-2009), Coordinator: Wendy Mackay. Partners: InSitu, CEA
- WILD - *Wall-Sized Interaction for Large Datasets*, Digiteo / Région Île-de-France (2008-2011), Coordinators: Michel Beaudouin-Lafon & Emmanuel Pietriga. Partners: InSitu, LIMSI-CNRS, Inria AVIZ
- REACTIVITY - *Interacting with Temporal Data*, Joint Microsoft Research-Inria Lab (2008-2011), Coordinator: Wendy Mackay. Partners: InSitu, Inria-AVIZ, MSR Redmond
- MLSN - *Multi-Level Social Networks*, ANR VERSO (2009-2012), Coordinator: Emmanuel Pietriga. Partners: InSitu, Univ. Paris-Sud, Univ. Paris-Dauphine, BasicLead
- ENSCI Digiteo action (2010), Coordinator: Wendy Mackay. Partners: InSitu, ENSCI (Paris)
- WILD-PCRI - *WILD extension*, Digiteo (2010-2011), Coordinator: Michel Beaudouin-Lafon. Partners: InSitu, LIMSI-CNRS, Inria AVIZ
- DigiPods - *Remote Collaborative Interaction Among Heterogeneous Visualization Platforms*, Région Île-de-France (2012-2015), Coordinator: Stéphane Huot. Partners: Digiteo/FCS Campus Paris-Saclay, Univ. Paris-Sud, Inria, CNRS, CEA, Telecom ParisTech

Collaborations with other laboratories

- Atau Tanaka, Sony CSL, Paris (2008): *Mobile devices for sound-mediated communication* (67). InSitu members: Olivier Bau, Wendy Mackay
- Carlos Agon & Nicolas Donin, IRCAM, Paris (2008): *Paperoles, an analysis of paper use by music composers*. InSitu members: Catherine Letondal, Wendy Mackay, Aurélien Tabard, Theophanis Tsandilas (joint publication in 2007)
- Thierry Rose, Florence Hantraye & Denise Ogilvie, Institut Pasteur and Victoria Bohler, INRA, France (2008): *Prism, a hybrid laboratory notebook* (49). InSitu members: Catherine Letondal, Wendy Mackay, Aurélien Tabard, Yuan Shen-quiong
- Shumin Zhai, Google Inc, Mountain View, USA, Per Ola Kristensson, University of St Andrews, Scotland, Tue Haste Andersen, university of Copenhagen, Denmark, & Xiang Cao, Microsoft Research Asia, China: *Foundational Issues in Touch-Surface Stroke Gesture Design — An Integrative Review* (10). InSitu member: Caroline Appert
- Pourang P. Irani, associate professor at the University of Manitoba, Canada, and Xing-Dong Yang Ph.D. Student at University of Alberta, Canada: *High-precision pointing on large wall displays using small handheld devices* (42). InSitu members: Mathieu Nancel, Olivier Chapuis, Emmanuel Pietriga, Michel Beaudouin-Lafon
- Ravin Balakrishnan, Univ. Toronto (2006-2009): *MUSE, Multi-Scale Environments* (40, 80). Joint lab ("Equipe Associée") between Inria and U. Toronto
- Scott Klemmer, Stanford Univ. and Jim Hollan, UC San Diego (2009-2012): *SIRIUS, Situated Interaction Research* (87, 86). Joint lab ("Equipe Associée") between Inria, Stanford Univ. and UC San Diego
- Clemens Klokrose and Kim Halskov, Univ. Aarhus, Denmark (2011-): Multi-surface interaction and interaction with large surfaces (3, 86), Creative design in education. InSitu members: Michel Beaudouin-Lafon, Wendy Mackay
- Eric Lecolinet and James Eagan, Telecom ParisTech (2008-): techniques for mobile devices (47), multi-surface interaction (27, 3), ongoing Ph.D. thesis funded by the Digicosme Labex. InSitu members: Stéphane Huot, Michel Beaudouin-Lafon, Olivier Chapuis
- AVIZ Inria-Saclay team (2008-): visual perception (5, 4, 93), visualization and navigation techniques (29, 7, 41, 59, 72), animation (26), pointing (6, 36) and toolkits (56). InSitu members: Anastasia Bezerianos, Stéphane Huot, Olivier Chapuis, Caroline Appert, Michel Beaudouin-Lafon

Other Collaborations

- SKA, South Africa and CNAM, France (2010): Collaboration on the design of user interfaces for the MeerKAT radiotelescope, one of the precursors of the Square Kilometer Array (SKA). Principal Investigator: Emmanuel Pietriga
- Atacama Large Millimeter/submillimeter Array (ALMA), Chile - European Southern Observatory (ESO), National Astronomical Observatory of Japan (NAOJ) and National Radio Astronomy Observatory (NRAO)/NSF (2009-2012): Collaboration to redesign the graphical user interfaces of the ALMA observatory's operations monitoring and control software. Principal investigator: Emmanuel Pietriga
- Communication and Information Research and Innovation Center (CIRIC), Chile (2012): Emmanuel Pietriga joined Inria Chile in July 2012 and is now heading the Massive Data project.
- VENISE (LIMSI-CNRS): Stéphane Huot co-supervises a thesis with Nicolas Ferey and Patrick Bourdot from LIMSI on the manipulation of mobile targets in large wall-size and immersive displays, with an application to molecular dynamics simulation.

Participation to national and international networks

- “Equipe d’Excellence” Digiscope - *Collaborative Interaction with Complex Data and Computation*, Coordinator: Michel Beaudouin-Lafon. Partners: Digiteo/FCS Campus Paris-Saclay, Univ. Paris-Sud, CNRS, CEA, Inria, Telecom ParisTech, Ecole Centrale, Univ. Versailles-Saint-Quentin, Ecole Normale Supérieure de Cachan, Maison de la Simulation.
- “Laboratoire d’Excellence” Digicosme - *Distributed data, programs and architectures*, Coordinator for the Interaction and Visualization task of the DataSense theme: Michel Beaudouin-Lafon. Members of this task: InSitu, Inria AVIZ, LIMSI-CNRS, Telecom ParisTech VIA, CEA LIST.

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Volunteer Professional Service

Management Positions in Scientific Organisations

- Université Paris-Sud: Michel Beaudouin-Lafon, Director of LRI, Laboratoire de Recherche en Informatique (2002-2009)
- Université Paris-Sud: Wendy Mackay, Vice-President for Research, Computer Science Dpt. (2007-2010)
- Inria: Wendy Mackay, elected representative at “Commission d’Evaluation” (2007-2010)
- LRI: Caroline Appert, President of the space allocation committee (2010-)

Organisation of Conferences and Scientific Events

- CHI 2013, *ACM Conference on Human Factors in Computing Systems*, Paris, 2013: Wendy Mackay (General Chair), Michel Beaudouin-Lafon (Technical Program Co-Chair)
- ECRC 2013, *First ACM European Computer Research Congress*, Paris, 2013: Michel Beaudouin-Lafon (Organizing Committee member)
- CSCW 2010, *ACM Conference on Computer Supported Cooperative Work*, Savannah (USA), 2010: Ilaria Liccardi (Student Volunteers Co-Chair)
- VL/HCC 2008, *IEEE Symposium on Visual Languages and Human-Centric Computing*, Herrsching am Ammersee (Germany), 2008: Emmanuel Pietriga (Publicity chair)
- IHM 2009, *Conférence Francophone d’Interaction Homme-Machine*, Grenoble, 2009: Michel Beaudouin-Lafon (Doctoral Consortium Co-Chair)
- IHM 2011, *Conférence Francophone d’Interaction Homme-Machine*, Nice, 2011: Stéphane Huot (Demonstrations Co-Chair)
- Graduate Consortium “Expanding end user control in socio-technical systems”, in conjunction with VL/HCC, 2011: Emmanuel Pietriga (Submission Coordinator, 2011)
- ACM CHI 2009 Workshop *Interacting with Temporal Data*, 2009: Wendy Mackay (Co-Chair), Aurélien Tabard (Co-Chair)
- ACM CHI 2011 Workshop *Ethics, Logs and Videotape*, 2011: Wendy Mackay (Co-Organizer)
- Mensch & Computer 2011 Workshop *Interaktive Displays in der Kooperation: Herausforderung an Gestaltung und Praxis*, 2011: Julie Wagner (Workshop Co-Chair)
- “RepliCHI” Panel, *ACM Conference on Human Factors in Computing Systems*, 2011 & 2012: Wendy Mackay (Co-Organizer)

Working Groups

- Alliance des Sciences et Technologies du Numérique (ALLISTENE), Working group “Knowledge, Content and Interaction”: Wendy Mackay and Michel Beaudouin-Lafon, members (2010-2013)
- Alliance des Sciences et Technologies du Numérique (ALLISTENE), Working group “Interactions des mondes physiques, de l’humain et du monde numérique” for the National Research Strategy agenda: Michel Beaudouin-Lafon, co-chair (2013)
- Inria Evaluation Committee Working Group “Evaluating researchers activities”: Wendy Mackay, member (2008-2009)

- Inria Evaluation Committee Working Group "Mobility": Wendy Mackay, organizer (2008-2009)
- Université Paris-Sud Working Group "Plan campus": Wendy Mackay, member (2009)
- "Commission Petit", CNRS working group to organize the Science and Technology of Information area within CNRS, Member: Michel Beaudouin-Lafon (2009)

Participation to editorial committees

Editorial boards:

- International Journal of Human-Computer Study (IJHCS), Elsevier: Michel Beaudouin-Lafon (Member of the Advisory Board, 2009-2012)
- Journal of Computer Supported Cooperative Work (JCSCW), Springer: Michel Beaudouin-Lafon (Member of the Advisory Board, 2010-2012)
- IEEE Symposium on Visual Languages and Human Centric Computing: Emmanuel Pietriga (Steering Committee member, and chair since September 2011)
- Journal d'Interaction Personne-Système (AFIHM): Nicolas Roussel (co-editor in chief, 2008-2009)
- Revue Information-Interaction-Intelligence (Revue I3), Cépaduès: Michel Beaudouin-Lafon (Member of the Advisory Board, 2010)

Scientific committees and Steering committees:

- Agence Nationale de la Recherche (ANR), Area committee for Information and Communication Science and Technology (CoSTIC): Michel Beaudouin-Lafon (Member, 2009-2011)
- Agence Nationale de la Recherche (ANR), "Contenus et Interactions" program, Steering Committee member: Michel Beaudouin-Lafon (2011-2013)
- Digiteo Steering Committee (Comité de Pilotage du RTRA Digiteo): Michel Beaudouin-Lafon (Member, 2006-2010)
- Steering Committee of the Campus Paris-Saclay Institute for Digital Society (Institut de la Société Numérique): Michel Beaudouin-Lafon (Member, 2013-)
- Inria thematic committee for the Perception, Cognition and Interaction area, member: Wendy Mackay (2010-2011)
- Inria-Saclay Scientific Commission: Michel Beaudouin-Lafon (Member, 2008-2010)
- TELECOM ParisTech Research Committee: Michel Beaudouin-Lafon (Member, 2008-)
- IRCAM (Paris) Scientific Committee: Michel Beaudouin-Lafon (Member, 2004-, Chair in 2009)
- Steering Committee (Conseil d'orientation) of Laboratoire STEF, ENS Cachan: Michel Beaudouin-Lafon (Member, 2011-)
- Club Informatique des Grandes Entreprises Françaises (CIGREF) Scientific Committee of the ISD Program (Information Systems Dynamics): Michel Beaudouin-Lafon (Member, 2009-2012)

Learned Societies:

- ACM: Michel Beaudouin-Lafon member at large of the ACM Council (2000-2008), member of the ACM Publications Board (2002-2009), member of the ACM Europe Council (since 2009)
- ACM SIGCHI: Wendy Mackay, member of ACM SIGCHI Conference Management Committee (2011-)
- ACM SIGCHI Paris Local Chapter: Emmanuel Pietriga (Chair, 2010-2011), Julie Wagner (Seminars Co-Organizer, Webmaster, 2010-2012), Anastasia Bezerianos (Treasurer, 2011, Vice-Chair, 2012)
- AFIHM (French speaking HCI association): Stéphane Huot (Executive Committee, 2005-2008, Scientific Board, 2012-), Michel Beaudouin-Lafon (Scientific Board, 2008-2012), Nicolas Roussel (Executive Committee, 2009), Olivier Chapuis (Executive Committee, 2013-).

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Honors

Prizes and Awards

- Caroline Appert: *first prize for the Gilles Kahn thesis award in Computer Science* (2008), sponsored by SPECIF and the French Académie des Sciences
- Theophanis Tsandilas, Catherine Letondal & Wendy Mackay: *Best Paper award at ACM CHI 2009* for "Musink: Composing Music through Augmented Drawing"

- Olivier Chapuis, Jean-Baptiste Labrune & Emmanuel Pietriga: *Honorable Mention award at ACM CHI 2009* for “Dynaspot: speed-dependent area cursor”
- Caroline Appert, Stéphane Huot, Pierre Dragicevic & Michel Beaudouin-Lafon: *Best Paper award at IHM 2009* for “Flowstates: Prototypage d’applications interactives avec des flots de données et des machines à états”
- Catherine Letondal & Wendy Mackay: *Best Demonstration award at IHM 2009* for “L’écriture augmentée: enregistrer des explorations interactives avec une feuille de données scientifiques”
- Mathieu Nancel, Julie Wagner, Emmanuel Pietriga, Olivier Chapuis & Wendy Mackay: *Best Paper award at ACM CHI 2011* for “Mid-air Pan-and-Zoom on Wall-sized Displays”
- James Eagan, Wendy Mackay & Michel Beaudouin-Lafon: *Notable Mention award at ACM UIST 2012* for “Cracking the Cocoa Nut: User Interface Programming at Runtime”.
- Émilien Ghomi, Guillaume Faure, Stéphane Huot, Olivier Chapuis & Michel Beaudouin-Lafon: *Best Paper award at ACM CHI 2012* for “Using Rhythmic Patterns as an Input Method”
- Can Liu, Stéphane Huot, Jonathan Diehl, Wendy Mackay, & Michel Beaudouin-Lafon: *Honorable Mention award at ACM CHI 2012* for “Evaluating the Benefits of Real-time Feed- back in Mobile Augmented Reality with Hand-held Devices”
- Daniel Spelmezan: *Best Paper award at ACM MobileHCI 2012* for “An Investigation into the Use of Tactile Instructions in Snowboarding”
- Julie Wagner, Mathieu Nancel, Sean Gustafson, Stéphane Huot & Wendy Mackay: *Honorable Mention award at ACM CHI 2013* for “A Body-centric Design Space for Multi-surface Interaction”

Keynote Addresses

International

- Wendy Mackay, *The Sixth International Conference on Creating, Connecting and Collaborating through Computing (C5’08)*, Poitiers, France, January 2008: “Participatory design within and across disciplines”
- Wendy Mackay, *SAKAI conference*, Paris, July 2008: “Participatory design: Designing for and with users”
- Wendy Mackay, *BB-Ubicomp*, London, May 2009: “InterLiving: Ubiquitous Communication Appliances”

InSitu members also gave 46 invited seminars or talks at international venues and foreign laboratories.

France

- Wendy Mackay, *Forum Systèmes & Logiciels pour les NTIC dans le transport*, Noisy le grand, March 2009: “L’Intelligence ambiante”
- Michel Beaudouin-Lafon, *Forum sur l’Interaction Tactile et Gestuelle (FITG)*, Lille, November 2012: “Du Geste à l’Instrument”

InSitu members also gave 35 invited seminars or talks at French venues and laboratories.

Other Honors

- Wendy Mackay: *Inducted into the ACM CHI Academy* (2009). The CHI Academy is an honorary group of individuals who have made substantial contributions to the field of human-computer interaction
- Michel Beaudouin-Lafon: *Inducted as senior member of the Institut Universitaire de France* (2011)
- Wendy Mackay: *Five-year Advanced Grant by the European Research Council (ERC)* (2012)
- Ilaria Liccardi: *Three-year Marie Curie grant by the European Research Council* (2012), to work with Wendy Mackay and Prof. H. Abelson at M.I.T.

Editorial Boards

International

- CACM, *Communications of the ACM*, ACM: Wendy Mackay (2008-2012)
- TOCHI, *Transactions on Computer Human Interaction*, ACM: Wendy Mackay (2008-2009), Michel Beaudouin-Lafon (2009-2012)
- IJHCS, *International Journal of Human-Computer Study*, Elsevier: Michel Beaudouin-Lafon (2008)
- JCSCW, *Journal of Computer Supported Cooperative Work*, Springer: Michel Beaudouin-Lafon (2008-2009)
- JVL, *Journal of Visual Languages and Computing*, Elsevier: Emmanuel Pietriga (Guest Editor, 2011-2012)
- IJSWIS, *International Journal on Semantic Web and Information Systems*: Emmanuel Pietriga (Editorial board, special issue on Visualisation of and Interaction with Semantic Web Data, 2011)

National

- JIPS, *Journal d'Interaction Personne-Système*, AFIHM: Michel Beaudouin-Lafon (2009-2010)

Program Committees

InSitu members chaired 12 program committees and participated in 46 program committees of international conferences and 6 program committees of national conferences.

Chair

- CHI, *ACM Conference on Human Factors in Computing*: Wendy Mackay (Subcommittee chair, 2008, 2009, 2010), Michel Beaudouin-Lafon (Subcommittee chair, 2010)
- UIST, *ACM Symposium on User Interface Software and Technology*: Michel Beaudouin-Lafon (Program Chair, 2008)
- ECAI, *IEEE European Conference on Artificial Intelligence*: Wendy Mackay (Area Chair, 2008)
- CSCW, *ACM conference on Computer Supported Cooperative Work*: Nicolas Roussel (Interactive Posters co-chair, 2008)
- VL/HCC, *IEEE Symposium on Visual Languages and Human-Centric Computing*: Emmanuel Pietriga (Program Co-Chair, 2010)
- ISMAR, *IEEE and ACM International Symposium on Mixed and Augmented Reality*: Wendy Mackay (Area chair, 2010)
- IHM, *Conférence Francophone d'Interaction Homme-Machine*: Stéphane Huot (Papers Co-Chair, 2010, 2013)
- UBIMOB, *5èmes journées Francophones Mobilité et Ubiquité*: Nicolas Roussel (Program Co-Chair, 2009)

Member (international events)

- CHI, *ACM Conference on Human Factors in Computing*: Michel Beaudouin-Lafon (2009), Catherine Letondal (2009), Olivier Chapuis (2010, 2012), Emmanuel Pietriga (2011, 2012), Caroline Appert (2012, 2013), Stéphane Huot (2013)
- UIST, *ACM Symposium on User Interface Software and Technology*: Caroline Appert (2008, 2009, 2010, 2011, 2013), Wendy Mackay (2008), Michel Beaudouin-Lafon (2010, 2011)
- CSCW, *ACM conference on Computer Supported Cooperative Work*: Nicolas Roussel (2008), Michel Beaudouin-Lafon (2010, 2011), Wendy Mackay (2011)
- DIS, *ACM Conference on Designing Interactive Systems*: Wendy Mackay (2010)
- UbiComp, *ACM International Conference on Ubiquitous Computing*: Wendy Mackay (2010)
- INTERACT *12th IFIP TC13 Conference in Human-Computer Interaction*: Olivier Chapuis (2009, 2013), Stéphane Huot (2009, 2013), Emmanuel Pietriga (2009, 2013), Caroline Appert (2013)
- NordiCHI, *ACM SIGCHI Nordic Forum for Human-Computer Interaction Research*: Emmanuel Pietriga (2012)
- WWW, *ACM International World Wide Web Conference (Tutorials)*: Emmanuel Pietriga (2012)
- SoftVis, *ACM Symposium on Software Visualization*: Emmanuel Pietriga (2008)
- VL/HCC, *IEEE Symposium on Visual Languages and Human-Centric Computing*: Emmanuel Pietriga (2008, 2009, 2011, 2012)
- PacificVis, *IEEE Pacific Visualization Symposium*: Anastasia Bezerianos (2011, 2012)
- ICEIS, *ACM SIGCHI Symposium on Engineering Interactive Computing Systems*: Michel Beaudouin-Lafon (2009)
- VINCI, *Visual Information Communications International*: Emmanuel Pietriga (2009, 2010)
- ISEUD, *Second International Symposium on End User Development*: Catherine Letondal (2009)

- *ACM/BCS Visions of Computer Science*: Michel Beaudouin-Lafon (2010)
- *Eurographics, 34th Annual Conference of the European Association for Computer Graphics*: Theophanis Tsandilas (2013)
- *SIGRAD 2012 - Eurographics Nordic forum for computer graphics and visualization*: Emmanuel Pietriga (2012)

Member (national events)

- *IHM, Conférence Francophone d'Interaction Homme-Machine*: Michel Beaudouin-Lafon (2009, 2010), Stéphane Huot (2011), Olivier Chapuis (2013).
- *UBIMOB, 5èmes journées Francophones Mobilité et Ubiquité*: Stéphane Huot (2009)
- *IHC, Simpósio de Fatores Humanos em Sistemas Computacionais de la Sociedade Brasileira de Computação*: Nicolas Roussel (2008)

Evaluation Committees and Invited Expertise

International

- European Research Council (ERC), Advanced Grants evaluation panel: Michel Beaudouin-Lafon (2008, 2009, 2010)
- European Research Council (ERC), SYNERGY Grants evaluation panel: Michel Beaudouin-Lafon (2011, 2012)
- European Commission, 7th Framework Programme (FP7), Expert reviewer: Emmanuel Pietriga (2008, 2010, 2011)
- European Science Foundation (ESF) Exploratory Workshop, Expert reviewer: Wendy Mackay (2008)
- SEE-ERA.NET PLUS Joint Call for European Research Projects, Evaluator: Emmanuel Pietriga (2009)
- Engineering and Physical Sciences Research Council (EPSRC), UK, Large grants expert reviewer: Wendy Mackay (2008)
- Engineering and Physical Sciences Research Council (EPSRC), UK, Mid-term evaluation reviewer: Michel Beaudouin-Lafon (2010)
- Natural Sciences and Engineering Research Council of Canada (NSERC), Canada, Expert reviewer: Michel Beaudouin-Lafon (2010, 2011, 2012)
- New Eurasia Foundation, Expert Reviewer: Emmanuel Pietriga (2011)
- Tenure cases and Full professor promotions, USA and Canada, Reviewer: Michel Beaudouin-Lafon (2011, 2012, 2013)

National

- Agence Nationale de la Recherche (ANR), "Contenus et Interactions" program, Reviewer: Nicolas Roussel (2008)
- Agence Nationale de la Recherche (ANR), "Réseaux du Futur et Services" program, Jury member: Wendy Mackay (2008)
- Agence Nationale de la Recherche (ANR), "Jeunes Chercheuses Jeunes Chercheurs" program, Reviewer: Wendy Mackay (2008), Caroline Appert (2013)
- Agence Nationale de la Recherche (ANR), Expert reviewer: Caroline Appert (2011, 2012), Olivier Chapuis (2011, 2012), Emmanuel Pietriga (2011, 2012), Stéphane Huot (2012), Wendy Mackay (2012)
- AERES (National Evaluation Agency) Visiting Committee for LABRI, Bordeaux, Member: Michel Beaudouin-Lafon (2009)
- Inria Assessment Committee, Member: Wendy Mackay (2009, 2010)
- Agoranov business incubator, Paris, Evaluator: Nicolas Roussel (2009)

Other evaluation activities

- Gilles Kahn thesis prize (SPECIF & Académie des Sciences), Jury member: Caroline Appert (2008-2010)
- Doctoral Consortium of ACM Symposium on User Interface Software and Technology (UIST), Jury member: Caroline Appert (2009), Wendy Mackay (2009)
- Univ. Paris-Sud committee "BQR Financier", Jury member: Wendy Mackay (2008-2010)
- Univ. Paris-Sud committee "BQR Emploi", Jury member: Wendy Mackay (2008-2010)
- Univ. Paris-Sud committee "ANR Preciput", Jury member: Wendy Mackay (2008-2009)
- Univ. Paris-Sud committee "Mutualisation des moyens de la recherche", Jury member: Wendy Mackay (2010)
- Univ. Paris-Sud committee "Bonus Attractivité", Jury member: Wendy Mackay (2010)

- Univ. Paris-Sud committee for “Habilitation à Diriger des Recherches”, Member: Wendy Mackay (2008-2010)

Hiring committees:

- Univ. Paris-Sud specialist commission (Commission Consultative des Spécialistes de l’Université 27ème section), Members: Michel Beaudouin-Lafon (2008-), Stéphane Huot (2010-), Wendy Mackay (2010-)
- Univ. Paris-Sud hiring committees, Members: Stéphane Huot (2009, 2010, 2011), Olivier Chapuis (2010), Michel Beaudouin-Lafon (2010, 2012)
- Univ. Paris-Sud Promotion committee, Member: Wendy Mackay (2010)
- Inria junior researcher hiring committees, Member: Wendy Mackay (Lille, 2009, Sophia Antipolis, 2009, Rennes 2010)
- Inria senior researcher hiring committees, Member: Wendy Mackay (2010)
- Inria promotion committee, Member: Wendy Mackay (2010)
- Univ. Lille hiring committee, Members: Nicolas Roussel (2008), Olivier Chapuis (2010), Caroline Appert (2011)
- Univ. Nantes hiring committee, Member: Michel Beaudouin-Lafon (2010)
- ENS Cachan hiring committee, Member: Michel Beaudouin-Lafon (2010)
- Univ. Paul Sabatier (Toulouse) hiring committee, Members: Caroline Appert (2012), Stéphane Huot (2012)
- Univ. Bordeaux I hiring committee, Member: Stéphane Huot (2013)

Habilitation committees:

- Benoît Martin (Université de Metz): Michel Beaudouin-Lafon, reviewer (2008)
- Emmanuel Dubois (Univ. Paul Sabatier, Toulouse): Michel Beaudouin-Lafon, reviewer (2009)
- Yannick Prié (Univ. Claude Bernard Lyon 1, Lyon): Michel Beaudouin-Lafon, president (2011)
- Jérôme Azé (LRI, Univ. Paris-Sud, Orsay): Michel Beaudouin-Lafon, president (2012)
- Géry Casiez (LIFL, Univ. Lille 1, Lille): Michel Beaudouin-Lafon, reviewer (2012)
- Emmanuel Pietriga (Université Paris-Sud): Wendy Mackay, jury member (2012)
- Stéphane Huot (Université Paris-Sud): Michel Beaudouin-Lafon and Wendy Mackay, jury members (2012)

PhD committees (other than InSitu graduates):

- Frédéric Lemoine (Université Paris-Sud): Wendy Mackay, president (2008)
- Scott Sherwood (Glasgow University): Wendy Mackay, external examiner (2008)
- Danielle Lottridge (University of Toronto): Wendy Mackay, thesis proposal jury member (2008)
- Gilles Bailly (Univ. Joseph Fourier, Grenoble & TELECOM ParisTech, Paris): Michel Beaudouin-Lafon, reviewer (2009)
- Arnaud Blouin (ESEO, Angers): Emmanuel Pietriga, jury member (2009)
- Celine Coutrix (Univ. Joseph Fourier, Grenoble): Wendy Mackay, reviewer (2009)
- Bruno Mantel (Univ. Montpellier, Montpellier): Michel Beaudouin-Lafon, reviewer (2009)
- Scott Sherwood (Univ. of Glasgow, Glasgow): Wendy Mackay, reviewer (2009)
- Guillaume Zuffery (EPFL, Lausanne, Switzerland): Michel Beaudouin-Lafon, reviewer (2010)
- Anne Roudaut (Telecom ParisTech, Paris): Michel Beaudouin-Lafon, reviewer (2010)
- Shuo-Hsiu Hsu (Conservatoire National des Arts et Métiers, Paris): Emmanuel Pietriga, examiner (2010)
- Xu Quan (Université des Sciences et Technologies de Lille): Olivier Chapuis, examiner (2010)
- University of Melbourne, Australia: Emmanuel Pietriga, reviewer (2011)
- Sarah Alaoui (LIMSI, Univ. Paris-Sud, Orsay): Michel Beaudouin-Lafon, president (2012)
- Mathias Baglioni (Télécom ParisTech, Paris): Stéphane Huot, examiner (2012)
- Aurélie Cohé (Univ. Bordeaux 1, Bordeaux): Caroline Appert, examiner (2012)
- Simon Perrault (Télécom ParisTech, Paris): Olivier Chapuis, reviewer (2013)
- Sebastien Rufange (École de Technologie Supérieure, Canada): Anastasia Bezerianos, reviewer (2013)

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Interactions with the social, economic and cultural environment

Popularisation of Research Results

- Interviews of Wendy Mackay by France Bleu and France Inter radio stations and for the publication “*Regards sur le numérique*” (2008)
- “*Fête de la science*” at LRI, coordinators: Caroline Appert (2009, 2010), Theophanis Tsandilas (2010, 2011)
- “*L’internet pour tous : le développement est-il uniquement conditionné par l’accès au numérique*”, Forum Le Monde - La Recherche, Collège de France, Paris, July 2010. Talk and panel discussion: Wendy Mackay.

- “WILD, un mur d’images interactif au service des scientifiques”, Les Jeudis de la Recherche, Centre de Vulgarisation de la Connaissance (Université Paris-Sud & CNRS), 2010. Speaker: Emmanuel Pietriga
- “La ville participative des citoyens acteurs: de nouveaux outils pour de nouveaux usages”, Rencontres Inria-Industrie, Jouy-en-Josas, June 2010. Speaker: Wendy Mackay
- “Les Rencontres Inria-Industrie”, 2010. Demonstrations of the WILD platform by Wendy Mackay and Knotty Gestures by Theophanis Tsandilas.
- “ACM SIGCHI Paris VideoShowcase” 2011, Espace Pompidou, Paris, France. Coordinator: Caroline Appert
- “Les Dossiers de la Recherche, Entretien avec Wendy Mackay : Les tablettes seront de plus en plus interactives”, La Recherche, June 2012
- “La Plateforme WILD”, Presentation of WILD to High School students, November 2012: Michel Beaudouin-Lafon, Romain Primet
- “WILD: An interactive platform for visualizing high-resolution data” Delegation from Chile (government and academia), November 2012: Demonstration by Michel Beaudouin-Lafon & Romain Primet
- “WILD: une plateforme de visualisation interactive haute résolution” Presentation of WILD to HEC students, December 2012: Wendy Mackay, Romain Primet
- “La Plateforme WILD”, Presentation of WILD to visitors from the French Ministry of Research and Inria’s Administration Council, April 2012: Emmanuel Pietriga, Romain Primet
- Presentation of WILD to industrial visitors of LRI, Visite des Industriels, Fête de la Science, October 2012: Romain Primet
- “Who is interaction design?”, Centre Pompidou, Future en Seine, June 2012. Presenters: Theophanis Tsandilas, Julie Wagner, Émillien Ghomi

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
Europe	SOCIALPRIVACY	Inria	09.2012 / 36 mo.	268.55 k€
Europe	CREATIV	Inria	06.2013 / 60 mo.	2459.00 k€
Europe	EIT ICT LABS-KIC 2011	Université Paris XI	01.2011 / 12 mo.	19.50 k€
Europe	EIT ICT LABS-KIC 2012	Université Paris XI	01.2012 / 12 mo.	34.80 k€
Europe	EIT ICT LABS-KIC 2013	Université Paris XI	01.2013 / 12 mo.	47.30 k€
ANR	MDGest	Université Paris XI	10.2011 / 36 mo.	87.62 k€
ANR	DIGISCOPE CNRS	CNRS	03.2011 / 106 mo.	486.00 k€
ANR	DIGISCOPE Inria	Inria	01.2011 / 108 mo.	318.81 k€
ANR	DIGISCOPE UPS	Université Paris XI	03.2011 / 106 mo.	99.56 k€
ANR	IStar	Université Paris XI	12.2007 / 51 mo.	218.43 k€
ANR	HOLYRISK	Inria	10.2009 / 48 mo.	52.00 k€
ANR	MLSN	Inria	11.2009 / 36 mo.	174.01 k€
ANR	WEBCONTENT	Inria	12.2005 / 48 mo.	63.56 k€
Région IDF	DIGIPODS Inria	Inria	01.2012 / 36 mo.	236.00 k€
Région IDF	DIGIPODS UPS	Université Paris XI	01.2012 / 36 mo.	259.00 k€
DIGITEO	WILD	Université Paris XI	07.2008 / 46 mo.	267.72 k€
DIGITEO	WILD PCRI	Université Paris XI	07.2010 / 18 mo.	19.80 k€
DIGITEO	WILD	Inria	07.2008 / 46 mo.	148.73 k€
DIGITEO	WILD PCRI	Inria	07.2010 / 18 mo.	7.92 k€
DIGITEO	ICI-TV	CEPHYTEN	06.2008 / 12 mo.	60.00 k€
DIGITEO	ENSCI Design Project	Inria	10.2009 / 5 mo.	10.00 k€
DIGICOSME	DIGIZOOM	Inria	03.2012 / 48 mo.	102.20 k€
Subvention	IUF	Université Paris XI	01.2012 / 60 mo.	85.00 k€
Subvention	WILD PRECIPUT	Université Paris XI	01.2009 / 17 mo.	70.00 k€
Subvention	AAP 2012	Université Paris XI	01.2012 / 12 mo.	35.00 k€
Subvention	PLATEFORME IHM	Université Paris XI	09.2012 / 24 mo.	78.82 k€

SocialPrivacy

Partners: Inria, MIT CSAIL

Although users' right to privacy has long been protected, the rapid adoption of social media has surpassed society's ability to effectively regulate it. Today's users lack informed consent: they must make all-or-nothing decisions about on-line privacy regardless of context. The Social Privacy project will first diagnose the problem, exploring privacy issues associated with social media at the level of the individual, the enterprise and society, and then generate effective solutions, from providing users with technical safeguards and informed consent, to establishing corporate guidelines for protecting privacy, to developing and testing recommendations for public policy.

Type: Europe (Marie Curie grant)
Amount: 268.55 k€
Duration: 36 months
Scientific director for LRI:
W. Mackay

CREATIV

Partners: Inria

CREATIV explores how the concept of co-adaptation can revolutionize the design and use of interactive software. Co-adaptation is the parallel phenomenon in which users both adapt their behavior to the system's constraints, learning its power and idiosyncrasies, and appropriate the system for their own needs, often using it in ways unintended by the system designer. The initial goal of the CREATIV project is to fundamentally improve the learning and expressive capabilities of advanced users of creative software, offering significantly enhanced methods for expressing and exploring their ideas. The ultimate goal is to radically transform interactive systems for everyone by creating a powerful and flexible partnership between human users and interactive technology.

Type: Europe (ERC
Advanced grant)
Amount: 2459 k€
Duration: 60 months
Scientific director for LRI:
W. Mackay

EIT ICT Labs

Partners: U. Paris-Sud

See https://www.dep-informatique.u-psud.fr/en/formation/lmd/M1_HCID

InSitu participates in the Human-Computer Interaction and Design (HCID) major of the EIT ICT Labs European Master School. We are one of the two sites for the first year of this Master Program, and host one of the specialties for second-year students. Students in this program receive a double degree after studying in two countries.

Type: European Institute of
Technology
Amount: 101.60 k€
Duration: 36 months
Scientific director for LRI:
M. Beaudouin-Lafon

MDGest

Partners: U. Paris-Sud, Inria

Interacting with gestures is becoming increasingly more relevant since the introduction of touch-screen devices where the user can trace gestures directly on the screen (as opposed as when using an indirect input device like a mouse). Gestures, in existing solutions, are identified solely based on their geometrical shape. Unfortunately, this approach does not scale up, leading to complex gesture vocabularies that are hard to learn and hard to execute. MDGest focuses on the use of new gesture characteristics (dimensions) to discriminate different gestures (dynamics, drawing direction and orientation, distinctive drawing patterns, etc.) to propose a large vocabulary of gestures having a simple shape to be usable from both motor and cognitive perspectives.

Type: ANR Jeunes
Chercheurs
Amount: 87.62 k€
Duration: 36 months
Scientific director for LRI:
C. Appert

Digiscope

Partners: FCS Paris-Saclay, U. Paris-Sud, CNRS, CEA, Inria, Institut Mines-Telecom, Ecole Centrale Paris, U. Versailles - Saint-Quentin, ENS Cachan, Maison de la simulation

See <http://digiscope.fr>

DIGISCOPE is a high-performance visualization infrastructure for collaborative interaction with extremely large data sets and computation. The project will create nine room-size interactive visualization platforms interconnected by a high-performance telepresence network for remote collaboration, and a digital fabrication lab (FabLab). These facilities will be accessible to users outside the project. M. Beaudouin-Lafon is the scientific director of the project, which received 6.9M€ from ANR and has a total budget of 22M€.

Type: ANR Equipex
Amount: 904.37 k€
Duration: 106 months
Scientific director for LRI:
M. Beaudouin-Lafon

IStar

Partners: ENAC Toulouse, U. Paris-Sud, IntuiLab, Anyware Technologies

The IStar project will develop a new generation of programming tools for developing interactive applications, supporting interoperability among components developed on different platforms as well as multi-surface / multi-device applications. It will be

Type: ANR Contint
Amount: 218.43 k€
Duration: 51 months
Scientific director for LRI:
M. Beaudouin-Lafon

based on a run-time kernel (virtual machine or server) that will execute programs developed according to a semantic model suited to describe interactive components. The run-time kernel will use platform-dependent rendering modules, such as OpenGL for graphics or embedded resources such as the Flash or SVG plug-ins of a web browser, therefore supporting Web 2.0 applications.

HOLYRISK

Partners: Inria, INRA, Agro ParisTech, U. Maryland

Scientific knowledge has become one of the most important prerequisites for making regulatory decisions. For instance, food risk policies are based on the framework of risk analysis which has been an effort to apply universal and formal methods of science to risk assessment and to place societal response to hazards on a scientific footing. This project is proposing a US/EU comparative empirical study that investigates the ways uncertainties are perceived, handled and expressed by experts throughout the food risk analysis process. The project is interdisciplinary, involving scientists from sociology, economics, risk analysis and computer science. It relies on the building of a database to store risk assessment and management documents. The database will provide computer scientists with a unique testing environment where researchers and risk professionals will help calibrate the system. Sociologists will address the substantive questions framing the research using mixed method analysis. Computer scientists will participate in developing 1. the database based on structure and semi-structured information, 2. a coding aid based on machine learning, 3. an interactive visual interface that allows efficient multi-scale navigation in a large corpus of annotated documents, and 4. a case-based reasoning system aiding risk managers.

Type: ANR
Amount: 52 k€
Duration: 48 months
Scientific director for LRI: E. Pietriga

MLSN

Partners: Inria, U. Paris-Sud, U. Paris-Dauphine, Basic Lead

This project aims at designing an innovative demonstrator that can be implemented on social networking platforms to do real-time visualization of multiplex social interactions. This demonstrator is a generic decision support tool which can potentially be applied in many industrial contexts. MLSN is based on recent findings in academic research on graph drawing techniques and on network analysis. From these points of view, MLSN contributes to three topics: - Social networks theory - New clustering techniques to qualify the centrality of networks' members and to analyze their similarities. - visualization of the manner people interact to exchange resources in a multi-level context MLSN associates researchers in human-computer interaction, sociology of networks and economics of the Internet (ADIS), and an industrial partner.

Type: ANR
Amount: 174 k€
Duration: 36 months
Scientific director for LRI: E. Pietriga

WebContent

Partners: Inria, INRA, CNRS, CEA, U. Paris 6, U. Rouen, EADS, Thalès, Xylème

The WebContent project is creating a software platform to accommodate the tools necessary to efficiently exploit and extend the future of the Internet: the Semantic Web. Its objective is to produce a flexible and generic platform for content management and to integrate Semantic Web technologies in order to show their effectiveness on real applications with strong economic or societal stakes. In Situ and LIMSI collaborate on the design and implementation of the platform's visualization components.

Type: ANR
Amount: 63.56 k€
Duration: 48 months
Scientific director for LRI: E. Pietriga

DigiPods

Partners: FCS Paris-Saclay, U. Paris-Sud, CNRS, CEA, Inria Institut Mines-Telecom

The goal of DIGIPODS is to design new interactive equipments and devices for collaborative interaction in immersive and high-resolution visualization platforms, connected through a high-end telepresence infrastructure. Beyond the usual interactive devices of such platforms (motion capture, interactive surfaces, haptic devices, audio and video systems), all the platforms will be augmented with new devices to facilitate co-located or remote interaction and collaboration: telepresence robots and the Digicarts, a new kind of interaction devices specifically

Type: Région IdF SESAME
Amount: 495 k€
Duration: 36 months
Scientific director for LRI: S. Huot

designed for these needs. These equipments will be used by researchers in Human-Computer Interaction to explore the visualization and manipulation of large datasets, interaction in virtual reality, remote collaboration among heterogeneous platforms; but also by researchers from other fields and by professionals in order to explore and manipulate their complex data.

WILD

Partners: U. Paris-Sud, CNRS, Inria

See <http://insitu.lri.fr/Projects/WILD>

Type: DIGITEO RTRA
Amount: 514.17 k€
Duration: 46 months
Scientific director for LRI:
M. Beaudouin-Lafon

The goal of the WILD project is to create a very high resolution platform for interactive visualization. It will be used both by researchers in human-computer interaction to study interactive visualization of large data sets, and by researchers from other disciplines to explore their complex data. The platform will consist of a unique interactive wall display made of thirty-two 30" LCD screens, i.e. a 5m50 x 1m80 (18' x 6') wall displaying 20 490 x 6 400 = 131 million pixels, and a camera-based gesture tracking system supporting interaction with the wall as well as within the surrounding space. The platform will also include one or more interactive tables and other interaction devices will in order to facilitate collaborative work, therefore creating a unique experimental environment for interactive visualization.

ICI-TV

Partners: Inria, CEA, PRAESTO

Type: DIGITEO OMTE
Amount: 60 k€
Duration: 12 months
Scientific director for LRI:
W. Mackay

The goal of the ICI-TV project is to help seniors remain independent while living at home by staying in touch with close family, friends and care-givers. ICI-TV will provide a range of communication services on a home television, via a set-top box. Elderly users will use an intuitive, easy-to-use interface to access channels devoted to specific people: accessing that person is a simple matter of changing to the appropriate channel. Users may choose three levels of interaction, from low-level indicators of presence, to exchanges of photos and messages, to live audio-video chat. ICI-TV plans to transfer this technology to a CEA-based startup, called Praesto, by September 2009.

DigiZoom

Partners: U. Paris-Sud, Inria, Institut Mines-Telecom

Type: DIGICOSME Labex
Amount: 102.20 k€
Duration: 48 months
Scientific director for LRI:
O. Chapuis

Design, modeling and empirical evaluation of multi-scale navigation techniques depending on the input channels and output characteristics of the devices, in particular the size, in single-user and collaborative contexts.

IUF

Partners: U. Paris-Sud

Type: IUF fellowship
Amount: 85 k€
Duration: 60 months
Scientific director for LRI:
M. Beaudouin-Lafon

The goal of this 5-year fellowship is to develop a new paradigm for interacting with computers based on the concept of Instrumental Interaction. Tools or instruments are a natural way to interact with the real world, and will serve as a powerful metaphor to interact with on-line information. At the empirical level, the project will study why and how instruments can be natural and efficient, based on the psychological theory of affordances. At the conceptual level, it will create a general framework for interaction in distributed environments featuring multiple devices, interactive surfaces and users. At the engineering level, it will develop the appropriate programming abstractions and software architecture to develop a full-scale prototype validating the key ideas of the project.

AAP 2012

Partners: U. Paris-Sud

We investigate what information is best shown and explored in large display environments and how humans perceive, understand and interact with visual information differently depending on their position and distance from such displays. The end goal is to propose better visualization and interaction alternatives and decide when users should transition their work to such environments.

Type: U. Paris-Sud
Amount: 35 k€
Duration: 12 months
Scientific director for LRI:
A. Bezerianos

Plateforme IHM

Partners: U. Paris-Sud

This project is creating a pedagogical platform for teaching Human-Computer Interaction (HCI). The teaching environment will be accessible to all formations having an HCI component (L1, M1, M2 at "UFR des Sciences") to make students able to develop innovative projects in an environment providing timely pieces of hardware and software. This platform will consist of about twenty Apple workstations and mobile devices (both tablet and smartphone-sized). The goal is not only to provide HCI application classes that are up to date with current trends but also (and mainly) make the teaching staff able to focus on HCI practical and theoretical concepts by saving time thanks to these easy to learn and use technologies.

Type: U. Paris-Sud
Amount: 78.82 k€
Duration: 24 months
Scientific director for LRI:
C. Appert

Private contracts and grants (jan 2008 - jun 2013)

Type	Name	Managing Institution	Start / Duration	Amount
CIFRE	CIFRE THALES	Université Paris XI	06.2004 / 50 mo.	12.54 k€
Industriel	ReActivity	CEPHYTEN	01.2008 / 36 mo.	400.00 k€
Industriel	DISCODOM	CEPHYTEN	12.2005 / 36 mo.	221.13 k€

CIFRE THALES

Partners: U. Paris-Sud, Thales

The CIFRE program funded the Ph.D. of Jérôme Lard conducted at Thales on novel software architectures for interactive systems.

Type: CIFRE
Amount: 12.54 k€
Duration: 50 months
Scientific director for LRI:
M. Beaudouin-Lafon

ReActivity

Partners: Inria, Inria-Microsoft joint lab

The ReActivity project focuses on the fundamental problem of how to capture researchers' work processes in a form that enables them to observe their past and current activity, to reflect upon it and to improve their own future activity. Our goals are to identify appropriate levels of data capture and to create sophisticated tools for logging and storing records of user activity, including their interactions with the physical world and across computer platforms. We are also interested in developing efficient algorithms for visualizing the resulting multi-media temporal data and in developing interactive applications that allow scientists to explore, reuse and improve successful strategies. We use participatory design to identify real-world work patterns and needs and we evaluate our work via benchmarks and field tests with practicing scientists.

Type: Industry
Amount: 400 k€
Duration: 36 months
Scientific director for LRI:
W. Mackay

DISCODOM

Partners: U. Paris-Sud, France Telecom

See <http://insitu.lri.fr/discodom/>

Type: Industry
Amount: 221.13 k€
Duration: 36 months
Scientific director for LRI:
N. Roussel

The goal of this project is to design innovative communication systems for the home environment. In this context, we are particularly interested in supporting smooth transitions between alternative forms of communication involving different media combination.

FlowStates Toolkit - Programming Interactive Applications with Data Flow and State Machines

<http://www.lri.fr/~appert/FlowStates/>

Contact: *Caroline Appert*

FlowStates is a user interface toolkit compatible with Java Swing that combines two models for managing events: dataflow and state machines. The dataflow model makes it easy to support non-standard input devices and to reconfigure interactions according to the available devices, while state machines support the programming of complex interactions. This hybrid approach provides power and expressivity. It also provides flexibility by explicitly not setting strict limits between the roles of each model.

jBricks - Java toolkit for interactive visualization platforms

Contact: *Emmanuel Pietriga*

jBricks is a Java toolkit that integrates a high-quality 2D graphics rendering engine and a versatile input configuration module into a coherent framework, enabling the exploratory prototyping of interaction techniques and rapid development of post-WIMP applications running on cluster-driven interactive visualization platforms. It is based on our ZVTM and WILD Input Server toolkits.

JFresnel - A Java library that implements the Fresnel specification

<http://jfresnel.gforge.inria.fr/>

Contact: *Emmanuel Pietriga*

Fresnel is a presentation vocabulary for Semantic Web data designed to be application and representation paradigm independent. JFresnel is a Java library that implements the Fresnel specification for various RDF APIs, such as Jena and Sesame.

Metisse - Windowing System to explore innovative window management techniques

<http://insitu.lri.fr/metisse/>

Contact: *Olivier Chapuis*

Metisse is an X-based window system designed with two goals in mind. First, it should make it easy for HCI researchers to design and implement innovative window management techniques. Second, it should conform to existing standards and be robust and efficient enough to be used on a daily basis, making it a suitable platform for the evaluation of the proposed techniques. Metisse is not focused on a particular kind of interaction (e.g. 3D) and should not be seen as a new desktop proposal. It is rather a tool for creating new types of desktop environments.

Nucleo - Video toolkit

<http://insitu.lri.fr/~rousseau/projects/nucleo/>

Contact: *Olivier Chapuis*

Núcleo is a toolkit for exploring new uses of video and new human-computer interaction techniques. Núcleo supports rapid prototyping and incremental development of video applications. This approach contrasts with many of the research themes usually associated to video in the Multimedia or Network communities such as compression, transport or synchronization. Núcleo runs on Apple Mac OS X and Linux and is freely available under the GNU Lesser General Public License (LGPL).

Scotty - User Interface Programming at Run Time

<http://insitu.lri.fr/Projects/Scotty>

Contact: *Michel Beaudouin-Lafon*

The goal of Scotty is to support “malleability”, i.e. interfaces that can be modified at run-time in ways not anticipated by the designers. Scotty is a toolkit that allows a programmer to extend an existing Mac OS X application without access to its source code. Scotty provides the following abstractions: hooks to alter the appearance of windows and widgets, event funnels to alter their behavior, glass sheets to overlay graphics and add new interaction methods, dynamic code loading and object proxies to redefine and

extend existing objects. Scotty also provides a higher-level interface based on instrumental interaction.

Substance - Programming framework and middleware for developing distributed interactive application

<http://substance-env.sourceforge.net/>

Contact: Michel Beaudouin-Lafon

Substance is a novel middleware for developing flexible interactive multi-surface applications. Substance is based on a data-oriented framework that decouples functionality from data. Shared Substance is a middleware implemented in Substance that provides powerful sharing abstractions to develop distributed applications.

SwingStates - An extension to the Java Swing toolkit based on state machines

<http://swingstates.sourceforge.net/>

Contact: Caroline Appert

SwingStates is an extension to the Java Swing user interface toolkit that facilitates the creation of interactive applications by providing state machines to specify interactions. SwingStates also provides a powerful Canvas to create new widgets and a flexible input system to use non-standard input devices. State machines are specified directly in Java by taking advantage of the syntax of inner classes. The combinatorial explosion of the number of states is controlled by allowing multiple state machines to run in parallel.

Touchstone - Software platform for designing and running controlled experiments

<http://code.google.com/p/touchstone-platforms/>

Contact: Caroline Appert

Touchstone is an open-source platform designed to help establish a solid research foundation for HCI in the area of novel interaction techniques. Touchstone includes a design platform for exploring alternative designs of controlled laboratory experiments and a run platform for running subjects. Designed for HCI researchers and their students, Touchstone facilitates the process of creating new experiments, as well as replicating and extending experiments in the research literature.

WIS - WILD Input Server

Contact: Stéphane Huot

The WILD Input Server (WIS) is part of the jBricks framework and helps prototyping, developing, testing and debugging interactive applications on cluster-based visualization platforms such as WILD. The WIS is a multi-device environment, enabling users to gather input data from a large variety of heterogeneous resources, including standard input devices, multi-touch devices such as tablets, motion trackers and standard communication protocols (OSC, TUIO, VRPN). WIS uses the ICon data-flow visual editor to create and edit input configurations that connect input devices and interaction techniques to applications at runtime. An extension API and a dynamic plugin architecture also allows to extend WIS functionalities at runtime.

WMTRACE - Logging and visualizing user's window management activity

<http://www.lri.fr/~chapuis/software/wmtrace/>

Contact: Olivier Chapuis

WMtrace includes two tools that help study an individual user's window management activity. The first tool runs in the background of an X Window session and continuously logs information about windows and how they are being manipulated. The second uses a VCR-like interface to replay the resulting logs and analyze the entire session.

ZGRViewer - A GraphViz/DOT Viewer

<http://zvtm.sourceforge.net/zgrviewer.html>

Contact: Emmanuel Pietriga

ZGRViewer is a 2.5D graph visualizer implemented in Java and based on the Zoomable Visual Transfor-

mation Machine (ZVTM). It is specifically designed to display graphs expressed using the DOT language from AT&T GraphViz and processed by programs dot, neato or others such as twopi.

ZVTM - Zoomable Visual Transformation Machine

<http://zvtm.sourceforge.net/index.html>

Contact: Emmanuel Pietriga

The ZVTM is a Zoomable User Interface (ZUI) toolkit implemented in Java, designed to ease the task of creating complex visual editors in which large amounts of objects have to be displayed, or which contain complex geometrical shapes that need to be animated. It is based on the metaphor of universes that can be observed through smart movable/zoomable cameras, and offers features such as perceptual continuity in object animations and camera movements.

5/ InSitu

Training and Education

Graduate Courses

Master in Computer Science, Univ. Paris-Sud:

- *Interfaces and Interactive Systems* (first year): Theophanis Tsandilas, Cyprien Pindat
- *Programming of Interactive Systems* (first year): Anastasia Bezerianos, Mathieu Nancel, David Bonnet
- *Formation à la Recherche* (second year, all research specialties): Wendy Mackay
- *Technical Writing in English* (second year): Wendy Mackay

Master Interaction, Second-year Research Specialty of the Master in Computer Science, Univ. Paris-Sud:

- Organization: Michel Beaudouin-Lafon (chair, 2010, 2011), Anastasia Bezerianos (chair, 2012, 2013), Caroline Appert (Internships, 2010-2012)
- *Fundamentals of Human-Computer Interaction*: Michel Beaudouin-Lafon, Anastasia Bezerianos, Caroline Appert, David Bonnet
- *Mixed-Reality and Tangible Interaction*: Anastasia Bezerianos
- *Design and Evaluation of Interactive Systems*: Wendy Mackay, Anastasia Bezerianos
- *Mixed Reality and Tangible Interaction*: Anastasia Bezerianos
- *Groupware and Collaborative Interaction*: Michel Beaudouin-Lafon

Master HCID, European Master School of EIT ICT Labs, Major in Human-Computer Interaction and Design, Univ. Paris-Sud:

- Organization: Michel Beaudouin-Lafon (chair, 2012, 2013)
- *Introduction to Human-Computer Interaction*: Michel Beaudouin-Lafon, David Bonnet
- *Programming of Interactive Systems*: Anastasia Bezerianos, David Bonnet
- *Design and Evaluation of Interactive Systems*: Wendy Mackay, Anastasia Bezerianos
- *Evaluation of interactive systems*: Caroline Appert
- *Human-Computer Interaction project*: Anastasia Bezerianos, Wendy Mackay, Michel Beaudouin-Lafon

Master IAC, Second-year Research Specialty of the Master in Computer Science, Univ. Paris-Sud:

- *Human-Computer Interaction*: Theophanis Tsandilas, Olivier Chapuis
- *HCI and Information Visualization*: Caroline Appert (Coordinator), Olivier Chapuis, Stéphane Huot, Theophanis Tsandilas

Master Pro, Second-year Professional Specialty of the Master in Computer Science, Univ. Paris-Sud:

- *Design and Evaluation of Interactive Systems*: Wendy Mackay, Anastasia Bezerianos

Stanford University:

- *CS477 Reinventing Interactive Systems*: Michel Beaudouin-Lafon, Wendy Mackay

- CS377 *Prototyping Interactive Systems*: Wendy Mackay
- CS294h *Design of Interactive Systems*: Wendy Mackay

Other courses:

- IFIPS Engineering school continuous training program, Univ. Paris-Sud, *Interaction Homme-Machine*: Michel Beaudouin-Lafon, Olivier Chapuis
- DMKM Erasmus Mundus (M2), Polytech'Nantes, *Introduction to Human-Computer Interaction*: Theophanis Tsandilas

Internship supervision:

- David Bonnet, Univ. Paris-Sud: Caroline Appert (2011)
- Can Liu, RWTH Aachen, Germany: Stéphane Huot (2011)
- Pierre Rossinés, Univ. Paris-Sud: Theophanis Tsandilas (2011)
- Julien Altieri, Ecole Polytechnique: Olivier Chapuis (2011)
- Stelios Frantzeskakis, Univ. Paris-Sud, "Navigating large information spaces on wall displays using mobile devices": Anastasia Bezerianos & Olivier Chapuis (2012)
- Jéronimo Barbosa, Universidade Federal de Pernambuco (CIn/UFPE), Recife, Brazil, "Linking digital tabletops with physical paper for creative interactions": Theophanis Tsandilas & Anastasia Bezerianos (2012)
- Lei Chen, Telecom Brest, "Focus+Context Navigation and Interaction on Graphical Tablets": Olivier Chapuis & Caroline Appert (2012)
- Stéphan Delarue, Univ. Toulouse 3, "Interaction gestuelle et propriétés physiologiques". Caroline Appert & Theophanis Tsandilas (2013)
- Jessalyn Alvina, Univ. Paris-Sud, "RouteLens: Efficient Route Following for Map Applications": Caroline Appert & Olivier Chapuis (2013)
- Evanthia Dimara, Univ. Paris-Sud, "Operant Conditioning and HCI": Wendy Mackay (2013)
- Magdalini Grammatikou, University of Crete & Univ. Paris-Sud, "BricoSketch: Replicating and reusing electronic and physical material in professional illustrations.": Stéphane Huot & Theophanis Tsandilas (2013)
- Ghita Jalal, Supelec & Univ. Paris-Sud, "Co-adaptive instruments": Wendy Mackay (2013)
- Thibaut Jacob, Univ. Paris-Sud, "Sketching Interactions for Data Exploration": Anastasia Bezerianos & Theophanis Tsandilas (2013)
- Vlasenko Julia, Univ. Alberta, Canada, "Interactive Visualization of Temporal Data": Wendy Mackay (2013)

Other master and graduate-level activities:

- Rencontres Jeunes Chercheurs en IHM, *Technical Writing in English pour les français*, Montpellier: Wendy Mackay (2010)
- Ecole Doctorale d'Informatique Paris-Sud, *Technical Writing in English pour les français*: Wendy Mackay (2010)
- Ecole Polytechnique: Wendy Mackay (Research advisor for student projects on communication appliances, 2010)
- Les Ateliers ENSCI: Wendy Mackay (jury member for student projects, 2010)
- UC Berkeley: Wendy Mackay and Michel Beaudouin-Lafon (jury members for student projects, 2010)
- Stanford University, *The Future of Educational Interfaces*: Michel Beaudouin-Lafon and Wendy Mackay (jury members, 2011)
- Rencontres Jeunes Chercheurs en IHM, *Les reviews, le rebuttal et le comité de programme*, Lyon: Caroline Appert (2013)
- Rencontres Jeunes Chercheurs en IHM, *Les thèmes émergents de l'IHM*, Lyon: Olivier Chapuis (2013)

Theses and Habilitations

Habilitation à Diriger des Recherches

<i>Name</i>	<i>Defense</i>
Emmanuel PIETRIGA	06.2012
Stéphane HUOT	05.2013

Defended theses

<i>Name</i>	<i>Start</i>	<i>Defense</i>	<i>Funding</i>	<i>Advisor</i>
Olivier BAU	01.10.2006	09.06.2010	Alloc. Ministère	MACKAY
Guillaume BESACIER	01.10.2006	19.10.2010	COLL TERR	BEAUDOUIN-LAFON
Guillaume FAURE	01.10.2007	15.12.2011	Alloc. Ministère	BEAUDOUIN-LAFON
Emilien GHOMI	01.10.2008	17.12.2012	Alloc. Ministère	BEAUDOUIN-LAFON
Sofiane GUEDDANA	01.11.2005	29.09.2009	CDD sur contrat INRIA	BEAUDOUIN-LAFON
Jérôme LARD	25.11.2003	06.10.2008	CIFRE	BEAUDOUIN-LAFON
Nicolas MASSON	03.11.2005	29.09.2009	CDD sur contrat INRIA	BEAUDOUIN-LAFON
Mathieu NANCEL	01.10.2008	05.12.2012	Digiteo	BEAUDOUIN-LAFON
Yann RICHE	14.10.2004	22.09.2008	Alloc. Ministère	MACKAY
Aurélien TABARD	01.10.2005	27.09.2009	Alloc. Ministère	MACKAY
Julie WAGNER	01.10.2009	05.12.2012	CDD sur contrat INRIA	MACKAY

Theses in progress

<i>Name</i>	<i>Start</i>	<i>Funding</i>	<i>Advisor</i>
David BONNET	01.10.2011	Alloc. Ministère	BEAUDOUIN-LAFON
Jérémie GARCIA	01.10.2010	Alloc. Ministère	MACKAY
Can LIU	01.10.2012	Digicosme Labex	BEAUDOUIN-LAFON
Justin MATHEW	10.06.2013	CIFRE	HUOT
Cyprien PINDAT	01.09.2010	Alloc. Ministère	PUECH
Daniel STRAZZULLA	15.10.2012	Inria Cordi	MACKAY
Oleksandr ZINENKO	16.09.2013	Inria contract	HUOT

Self Assessment

Strengths

InSitu was recognized at the highest international level with many best paper awards, an ERC Advanced Grant, an appointment with the Institut Universitaire de France, a second member of the ACM/CHI Academy, and the organization of HCI's flagship ACM/CHI'13 conference in Paris, which, at 3500 attendees, was the largest ever. The group size stayed stable: three faculty left to found or co-found new Inria groups, and three joined the group (a fourth is joining in September, 2013).

The WILD platform has been a catalyst for developing fundamental research, participatory design studies and advanced software toolkits for interaction off-the-desktop, leading to the 22M€ Digiscope "Equipement d'Excellence". InSitu also continued its successful line of research in on-the-desktop interaction, including novel interaction techniques for pointing, multiscale visualization, gesture-based interaction and interactive paper. It also explored novel computational paradigms for interactive systems through a number of advanced toolkits and demonstrated the value of combining research in interaction techniques, methods and tools.

InSitu is a highly international group by any measure: Three of its faculty members started their careers abroad and two left the group to found Inria-Chile; Six of its 18 current or graduated Ph.D. students,

all seven incoming post-docs and all seven long-term visitors to the the group are also from abroad; seven graduated Ph.D. students went abroad for post-docs and research jobs, and two members spent a two-year sabbatical at Stanford. The group has strong international collaborations with the US, Canada, Denmark, and Chile. At the European level, the group was awarded an ERC Advanced grant and a Marie Curie grant (with MIT), and participates in the VCORE european project. Finally we created two successful international Masters programs, one for HCI research, the other for professional development, as part of the European EIT ICT Labs Master School.

Weaknesses

Despite our efforts, creating long-term collaborations with designers proved difficult and we have not been able to achieve as much of a multidisciplinary group as we would have liked. Design is not really part of the French academic system, and design research is barely represented in France. Our collaboration with music composers at IRCAM, while fruitful, is not a peer-to-peer research collaboration: composers are “extreme users” who help us understand and anticipate the needs of future users, they are not researchers exploring new design methods with us. We are still seeking a research collaboration with a design school and research center to better address the holistic design process that we think is necessary to create future interactive technologies.

On a different topic, developing and managing complex equipment such as the WILD room, the Digiscope project and its FabLab requires strong engineering support. InSitu has been lucky to get sufficient support so far, but this could change very quickly since no permanent staff is involved and the Digiscope funding for engineers will end in May, 2015. As computer science in general and human-computer interaction in particular involve more and more of an experimental approach, proper engineering support is needed to maintain and run both the hardware and software.

Opportunities

One of the primary goals for the founding of InSitu was to serve as an incubator for new research in HCI. We have successfully spun off three groups: the Inria-Saclay Aviz group (2007), part of the Inria-Lille MINT group (2009), and the Massive Data team at Inria-Chile (2012). InSitu is now at the end of the maximum 12-year tenure for Inria groups. We have achieved most of our goals and significantly surpassed a number of them. From theoretical concepts to concrete implementations, InSitu has contributed to the overarching goal of reinventing interactive computing. The successor to InSitu, HCC (Human-Centered Computing), is an opportunity to define new goals and explore new areas to continue inventing the future.

At the local level and in the context of the Paris-Saclay Campus, InSitu and HCC are in a central position regarding HCI research: we have created two international Master programs in HCI, we head the WILD and Digiscope projects, and we are collaborating with the Inria AVIZ group, the Venise group at LIMSI-CNRS, and the VIA group at Telecom ParisTech; Within LRI, we have begun a collaboration with the Parall group, and have discussed collaborations with the Bioinfo and A&O groups. This central position is an opportunity to be the driving force for establishing the plateau de Saclay as an international center for HCI research.

At the French level, the visibility of Human-Computer Interaction has greatly increased: Interaction is one of the four themes of Inria’s strategic plan, and human aspects of computing are present in most ANR thematic calls in computer science. InSitu members participated actively in the committees that made these decisions. We can leverage this increased awareness to develop more ambitious projects where interaction redefines computing.

Threats

Our visibility at all levels creates significant overhead for the faculty members of InSitu. Running two international Master programs has been a time sink as the University does not provide appropriate administrative support. We are rewarded by the quality of the students we are able to attract, but the EIT ICT Labs Master School students are barred from doing internships with us, limiting the value of this program for our research.

Participating in the many local and national committees to represent and defend our field is also very time-consuming. While we are pleased to see that the visibility of HCI research is rising, it is sometimes at the expense of advancing our own research.

The Paris-Saclay Campus is a great opportunity to create a top-notch center for HCI research, but it also adds to the complexity of our research environment: as shown by the funding of WILD and Digiscope, which involved separate contracts with Univ. Paris-Sud, CNRS and Inria, but also funding from the Digiteo RTRA, the Région Ile-de-France, the Digiscope Labex, ANR and more, it is likely that the Paris-Saclay Campus, its schools and departments will result in an even more complex mesh of funding sources without sufficient administrative support nor the necessary flexibility to operate a research group effectively.

5/ HCC

Strategy and five-year project

Permanent Members (October 1st, 2013)			
Name	First name	Position	Institution
APPERT	Caroline	CR2	CNRS
BEAUDOUIN-LAFON	Michel	PREX	Paris-Sud
BEZERIANOS	Anastasia	MCF	Paris-Sud
CHAPUIS	Olivier	CR1	CNRS
FLEURY	Cédric	MCF	Paris-Sud
HUOT	Stéphane	MCF HDR	Paris-Sud
MACKAY	Wendy	DR1	Inria
TSANDILAS	Theophanis	CR1	Inria

Doctoral Students (October 1st, 2013)			
Name	First name	Funding	Institution
BONNET	David	Alloc.	PARIS SUD
GARCIA	Jérémie	ATER	PARIS SUD
JALAL	Ghita	Inria	
LIU	Can	Digicosme	PARIS SUD
MATHEW	Justin	CIFRE	DMS
PINDAT	Cyprien	Alloc.	PARIS SUD
STRAZZULLA	Daniel	Cordi	Inria
ZINENKO	Oleksandr	Contract	Inria

Temporary Personnel (October 1st, 2013)					
Name	First name	Position	Institution	Arrival	Departure
TEZIER	Gabriel	Engineer	CNRS	06.2012	05.2013
OEHLBERG	Lora	Post-doc	Inria	12.2012	09.2013
SANAEI	Monireh	Engineer	Inria	02.2013	01.2015
THORPE	Jonathan	Engineer	CNRS	10.2013	05.2015
KOOLI	Amani	Engineer	CNRS	10.2013	05.2015

Scientific outlook

Research in Human-Computer Interaction is becoming increasingly diverse and complex. On one hand, technological advances constantly shift the ground. For example, the advent of FabLabs (fabrication laboratories) and the ability to create hardware at low cost makes it possible to design not only interactive software but also interactive objects, networked through the "Internet of Things". Pico-projectors, 3D cameras, wearable computers and, soon, implanted systems each challenge HCI researchers to design novel techniques and paradigms that make such technology useful and usable. On the other hand, the social impact of computer technology has never been so high, determined in large part by the interactive capabilities of modern computers. New uses challenge researchers even more than new technology, requiring truly multidisciplinary approaches to understand how people adopt, adapt and adapt to technology. Social networks, crowdsourcing and lifelogging, for example, raise technical, social and ethical questions that HCI researchers must take into account.

In this context, InSitu's successor, Human-Centered Computing (HCC), must carve out well-defined problems with high potential. Several previous research themes will endure but with more focus: understanding fundamental aspects of human behavior in interactive situations, designing novel interaction and visualization methods to increase the bandwidth of human-computer interaction, developing design methods that harness user innovation, and creating advanced tools for creating interactive systems.

The CREATIV ERC Grant will explore the problem of how to create truly productive human-computer partnerships, in which machine intelligence complements, rather than replaces, human intelligence. Addressing creativity, and more generally open-ended tasks, will provide additional opportunities for collaborating with other LRI groups, such as A&O.

The Digiscope project addresses an open problem with high potential for innovation and technology transfer, i.e. remote collaboration within and across interactive environments. Our plans to extend Digiscope into an international network will put HCC ahead of the pack: while much current HCI research focuses on "interaction in the small" (tablets, phones, watches, glasses), we are confident that the next big revolution will involve "interaction in the large", with large surfaces (walls, tables, floors, ceilings, ...) and interconnected interactive rooms for remote collaboration on virtual and physical tasks.

Strategy

InSitu has served as a successful incubator for establishing new research groups in human-computer interaction, with a productive synergy between design methods, interaction paradigms and software tools. In 2014, InSitu will reach the end of its 12-year tenure as an Inria group, which coincides with LRI's decision to create a smaller number of broad research themes, each with one or more research groups.

We have thus decided to create a new theme, called Human-Centered Computing (HCC), which will cover a wide spectrum of research in human-computer interaction. The Digiscope project, funded until 2020, will continue to drive research within HCC and will anchor research in human-computer interaction within the Paris-Saclay Campus.

Although the exact configuration post-InSitu is not yet fully defined, the most likely scenario is that the members of InSitu/HCC will split into two groups, each with a more restricted focus. One will be centered around the CREATIV ERC Grant to explore novel human-computer partnerships, with an emphasis on creative tasks and multi-surface environments. The details of the other group are still being defined. However, both HCC groups will continue to emphasize international reach, diverse collaborations, and publication in the best venues in the field.



InSitu publications

Journal articles

Major international journals

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- (2) M. Beaudouin-Lafon. Open access to scientific publications. *Communications of the ACM*, 53:32–34, 2010.
- (3) M. Beaudouin-Lafon, O. Chapuis, J. Eagan, T. Gjerlufsen, S. Huot, C. Klokmoose, W. Mackay, M. Nancel, E. Pietriga, C. Pillias, R. Primet, and J. Wagner. Multisurface Interaction in the WILD Room. *IEEE Computer*, 45(4):48–56, 2012.
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Other journals

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Conference articles

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- (16) C. Appert, O. Chapuis, and M. Beaudouin-Lafon. Evaluation of pointing performance on screen edges. In *Proceedings of the 9th International Working Conference on Advanced Visual Interfaces*, AVI '08, pages 119–126. ACM, 2008.

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- (115) E. Ghomi. *Designing expressive interaction techniques for novices inspired by expert activities: the case of musical practice*. Thèse de doctorat, Université Paris Sud, Décembre 2012.
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- (121) E. Pietriga. *Langages et techniques d'interaction pour la visualisation et la manipulation de masses de données*. Habilitation à diriger des recherches., Université Paris Sud, Juin 2012.
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6/ LaHDAK

Large-scale Heterogeneous Data and Knowledge



équipe LaHDAK

Responsable: Chantal Reynaud, Nicole Bidoit-Tollu

L'équipe LaHDAK rassemble les chercheurs des équipes Bases de Données (BD) et Intelligence Artificielle et Systèmes d'Inférence (IASI) avec pour objectif de relever les défis issus du phénomène de *déluge* de données et de connaissances.

Les travaux des membres de l'équipe BD se situent dans le domaine du traitement des données du Web. Ses contributions portent sur des modèles de données formels (données semi-structurées, annotées, graphes), l'optimisation des traitements des données du Web (réponse aux requêtes, optimisation des requêtes sur des données XML et RDF), leur distribution (P2P et Cloud) et la transformation de données complexes.

Les travaux de l'équipe IASI se situent dans le domaine de l'intégration d'information. Ils portent sur des problèmes que posent les systèmes de gestion de d'information et de connaissances actuels ayant à traiter des informations très volumineuses, hétérogènes et distribuées, tels que la gestion de données et de document à base d'ontologies (réponse aux requêtes et annotation sémantique), l'intégration de données et de connaissances (schémas ou d'ontologies) et raisonnement sur des systèmes distribués (systèmes d'inférence P2P, systèmes de diagnostic).

L'objectif de LaHDAK est de proposer des solutions pour gérer des données complexes, sémantiquement hétérogènes, incertaines, incomplètes et évolutives, provenant de sources variées, dont Internet et le Web social. Ses travaux seront plus particulièrement focalisés sur les problèmes d'efficacité, de pertinence sémantique et de robustesse, ainsi que sur l'adéquation des infrastructures de gestion de données et de connaissances distribuées aux problèmes d'interopérabilité et de passage à l'échelle.

Les travaux de recherche de LaHDAK sont organisés autour de cinq activités : l'intégration de données et de connaissances, le raisonnement automatique, la gestion des données du Web, les algorithmes pour les grands volumes de données distribuées, les transformations complexes et évolutives.



Large-scale Heterogeneous Data and Knowledge

Head: Chantal Reynaud, Nicole Bidoit-Tollu

The LaHDAK team brings together members of two former groups, the Database group (DB) and the Artificial Intelligence and Inference Systems group (IASI) which have complementary expertizes in order to meet the massive data and knowledge challenges.

The members of the Database group are specialists in the area of data management with a particular focus on formal models for complex data (semi-structured, annotated, graph data), Web data management optimization (query processing and optimization for XML and RDF), management of distribution (P2P and cloud platforms), and complex data transformations.

The members of the Artificial Intelligence and Inference Systems group are specialists in the area of information integration. They address problems raised by modern information and knowledge management systems that deal with numerous highly heterogeneous, and distributed information such as Ontology-based data and document management (query answering and semantic annotation), data and knowledge integration (integration of data and schemas or ontologies), and reasoning over distributed systems (P2P inference systems, diagnosis systems).

The aim of LaHDAK is to offer solutions to process complex-structured, semantically heterogeneous, uncertain, missing and evolving data, coming from any sources including the internet and the social web. Efficiency, semantic-based relevance, robustness are the main issues that we will be focusing on, as well as adequacy of infrastructures for distributed data and knowledge management to cope with interoperability and scalability.

The research activities of the LaHDAK team are organized in five tasks: Data and knowledge integration, Automated reasoning, Web data management, Massively distributed algorithms for complex data, Complex and evolving data transformations.

Research Group members

The LaHDAK team includes 13 permanent faculty (1 DR-INRIA, 4 Professors, 1 CR-CNRS, 7 Assistant Professors), 13 doctoral students and 5 temporary personnel (post-doc or engineer).

Permanent Members (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
BIDOIT ⁺	Nicole	PRCE	PARIS SUD
BIENVENU	Meghyn	CR2	CNRS
CAUTIS ⁺	Bogdan	PR2	PARIS SUD
CHATALIC	Philippe	MCFHC	PARIS SUD
DAGUE	Philippe	PRCE	PARIS SUD
HERSCHEL ⁺	Mélanie	MCF	PARIS SUD
MANOLESCU ⁺	Ioana	DR2	INRIA
PERNELLE	Nathalie	MCF	PARIS SUD
REYNAUD	Chantal	PR1	PARIS SUD
SAFAR	Brigitte	MCFHC	PARIS SUD
SAIS	Fatiha	MCF	PARIS SUD
VENTOS	Véronique	MCF	PARIS SUD
WALLER	Emmanuel	MCF	PARIS SUD

PhD students (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Funding</i>	<i>Institution</i>
ALEC	Céline	Alloc. Ministère	PARIS SUD
BONAQUE ⁺	Raphael	DIGICOSME	INRIA
BOURGAUX	Camille	CDD sur contrat UPS	PARIS SUD
DOS REIS	Julio Cesar	FNR Luxembourg	PARIS SUD
IBRAHIM	Hassan	ETR	PARIS SUD
LEBLAY ⁺	Julien	Alloc. Ministère	PARIS SUD
ROATIS ⁺	Ioana-Alexandra	CDD sur contrat UPS	INRIA
CAMACHO RODRIGUEZ ⁺	Jesus	Alloc. Ministère	PARIS SUD
KHEFIFI	Rania	CDD sur contrat UPS	PARIS SUD
MORTEROL	Martin	Alloc. Ministère	PARIS SUD
SYMEONIDOU	Danai	Alloc. Ministère	PARIS SUD
TZOMPANAKI ⁺	Aikaterini	Alloc. Ministère	PARIS SUD
ZAMPETAKIS ⁺	Stamatis	CDD sur contrat INRIA	INRIA

Temporary personnel (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
ARANDA ANDUJAR ⁺	Andrés	Engineer	INRIA
DUMONT	Cyril	Engineer	DIGITEO
GHOSH ⁺	Tushar	Engineer	INRIA
KAOUDI ⁺	Zoi	Post-doc	INRIA
ROY CHOWDHURY ⁺	Soudip	Post-doc	INRIA

Associate members (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
COLAZZO	Dario	PR	University Paris-Dauphine (LAMSADE)
GOASDOUE	François	PR	ENSSAT/IRISA Lannion, University of Rennes 1
HAMDI	Fayçal	MCF	CNAM (Paris)
HORINCAR	Roxana	Post-doc	Telecom Sud Paris
ILEANA	Ioana	PhD student	Telecom Sud Paris
SIMON	Laurent	PR	University of Bordeaux (LABRI)

⁺ Member of the LRI-INRIA joint group OAK, head: Ioana Manolescu.

The LaHDAK team is resulting from the merger of the Database (DB) and the Artificial Intelligence and Inference Systems (IASI) groups. We present first the research activities of the BD group over the past five years, then the research activities of the IASI group and in a third step the strategy of the LaHDAK group over a 5-year period.

Database Team: Synthetic presentation

Nom du responsable de l'équipe : **Nicole BIDOIT-TOLLU**

Effectifs de l'équipe

Début Janvier 2008, l'équipe été composée de 5 EC (3PR, 2MdC), 5 doctorants and 2 post-docs.

Personnels ayant quitté l'équipe pendant le contrat en cours

2 PR (changements d'équipe), 1 MdC (2 mois), 10 doctorants (400 mois), 6 post-docs (94 mois)

Nombre de recrutements réalisés au cours de la période considérée et origine des personnels

1 MdC BQR (PhD à Humboldt-Universität zu Berlin, puis post-doc à Hasso-Plattner-Institut Potsdam, à IBM Almaden Research Center et à University of Tübingen); 1 DR2 INRIA (leader EPI Oak).

Production scientifique au cours de la période écoulée

1. Technique d'analyse statique permettant de détecter l'indépendance entre requête et mise à jour XML. Cette technique prend en compte les schémas des documents XML, y compris dans le cas difficile de schémas récursifs. Une expérimentation basée sur une implantation efficace des algorithmes a validé l'approche.
2. Techniques d'optimisation de requêtes et mises à jour XML permettant de manipuler des documents XML très volumineux (> 100GO). Basée sur l'élagage et le partitionnement de documents XML, ces techniques applicables pour de grandes classes de traitements XML, ont été implémentées via MapReduce et validées par des tests.
3. Détection de doublons dans le contexte des données du Web. Deux défis ont été relevés pour le processus d'identification automatique de représentations hétérogènes de mêmes objets : (1) le passage à l'échelle pour traiter de larges volumes de données et (2) une efficacité acceptable pour des données complexes (hiérarchiques et données graphe).
4. Vues matérialisées pour l'optimisation de requêtes. La complexité des données du Web et de leurs langages associés rendent ces algorithmes d'optimisation difficile à développer. Le problème de réécriture à l'aide de vues a été résolu pour un langage de vues matérialisées XML expressif, défini à base de motifs d'arbre. Ont aussi été développés : la recommandation automatique de vues à matérialiser, la mise à jour incrémentale, la plateforme VIP2P.
5. Proposition d'une architecture générique de traitement de données sémi-structurées dans un cloud commercial. Distribution massive et passage à l'échelle sont les deux défis. L'originalité de notre architecture réside dans l'exploitation des différents services disponibles dans un environnement cloud (stockage de fichiers de très grande taille, stockage très efficace de données très simples) afin de construire un moteur d'évaluation de requêtes sur des très grands volumes de données complexes. Notre approche tire parti de l'allocation "élastique" de machines afin de paralléliser les traitements à chacune de leurs étapes.

Bilan quantitatif des publications de l'équipe

- Articles de revue internationales majeures : 15
- Articles de revue autres : 9
- Articles dans conférences et workshops internationaux majeurs : 33
- Articles dans conférences et workshops autres : 35
- Livres et chapitres de livres : 6

5 publications majeures

- T.Y. Jen, D.Laurent, N.Spyratos. Computing Supports of Conjunctive Queries in Relational Tables with Functional Dependencies. *Fundamenta Informaticae*, 99(3): 263-292, 2010
- Type-based Detection of XML Query-Update Independence. Nicole Bidoit, Dario Colazzo, and Federico Ulliana, *The Proceedings of the VLDB Endowment (PVLDB)*, Vol 5, No 9, pp 872-883, 2012
- Scalable Iterative Graph Duplicate Detection. Melanie Herschel, Felix Naumann, Sascha Szott, Maik Taubert in *IEEE Transactions on Knowledge and Data Engineering (TKDE)* vol. 24, num. 11, pp 2094-2108, 2012
- Asterios Katsifodimos, Ioana Manolescu, Vasilis Vassalos: "Materialized View Selection for XQuery Workloads", *Proceedings of the ACM SIGMOD International Conference on Management of Data (SIGMOD)*, pp. 565-576, 2012
- Tom Ameloot, Jan Van Den Bussche and Emmanuel Waller. On the expressive power of update primitives, *Proceedings of the 32nd ACM SIGMOD-SIGACT-SIGART Symposium on Principles of Database Systems (PODS)*, pp 139-150, 2013

5 (max) documents majeurs (autres que publications)

- Logiciel EdiFlow, Dépôt APP (par Inria) en 2013

- Plateforme Nautilus Analyzer
- Logiciel XPLOT/Andromeda
- Comité Scientifique ANR Blanc et JCJC
- Membre des comités d'évaluation des départements d'informatique de "Athens University of Economics and Business" et de "University of Ioannina", Grèce – Nicolas Spyratos

5 (max) faits illustrant le rayonnement ou l'attractivité académique

- I. Manolescu est éditeur en chef de ACM SIGMOD Record et éditeur associé de ACM TOIT
- les membres du groupe participent aux CP conférences internationales : ICDE 2010, EDBT 2010, VLDB PhD Workshop 2012, ACM SIGMOD 2012, ACM SIGMOD 2013, EDBT 2013
- LabEx DigiCosme : co-rédacteur de l'axe "DataSense" et animation de la tâche "Scalable and secure techniques for large-scale data management" I. Manolescu
- Membres de CP conférences internationales : ICDE 2010, EDBT 2010, VLDB PhD Workshop 2012, ACM SIGMOD 2012, ACM SIGMOD 2013, EDBT 2013
- Projet OakSAD, collaboration depuis 2013, avec le groupe base de données de UC San Diego

5 (max) faits illustrant les interactions de l'équipe avec son environnement socio-économique ou culturel

- Ioana Manolescu a coordonné l'ANR Codex
- Mélanie Herschel est membre de la IBM DB2 Community depuis 2010
- N. Bidoit a été président du Jury du Prix de Thèse Gilles Kahn
- I. Manolescu est intervenue à la conférence industrielle "Big Data" (<http://www.bigdataparis.com>) en Mars 2012 et Avril 2013 ainsi qu'au séminaire interdisciplinaire D'Alembert "Nouvelles pratiques et cultures du numérique dans les sciences et les technologies", Mars 2012

Principales contributions de l'équipe à des actions de formation

- N. Bidoit a créé et piloté avec P. Rigaud (Cnam) et P. Pucheral (UVSQ), l'Ecole Thématique "Masses de Données Distribuées" sous l'égide de BDA (1ère édition 2000, 2ème édition 2002, édition 2004 en cours de préparation). D. Colazzo et I. Manolescu sont intervenus lors des 1ère et 2ème éditions de l'école MDD.
- N. Spyratos intervient tous les ans depuis 2009 au Master Information Systems and Decision Support, Labanese University of Beyrouth (Liban)
- N. Bidoit a été VP Enseignement du Département Informatique de l'UPS, responsable de la mention Informatique du Master STS, responsable puis co-responsable du Master IAC. Elle est actuellement directrice de l'EDIPS.
- N. Bidoit et I. Manolescu ont participé à la création du Master EIT ICT Labs Distributed System and Services
- E. Waller est correspondant international pour d'enseignement, il coordonne et intervient dans les modules Innovation et Entrepreneuriat du Master EIT ICT Labs HCID.

Research Group Members and evolution since 2008

Permanent Members (June 30th, 2013)			
Name	First name	Position	Institution
BIDOIT	Nicole	PREX	UPS
COLAZZO	Dario	MCF	UPS
HERSCHEL	Melanie	MCF	UPS
MANOLESCU	Ioana	DR2	INRIA
WALLER	Emmanuel	MCF	UPS

PhD Students (June 30th, 2013)			
Name	First name	Funding	Institution
CAMACHO RODRIGUEZ	Jesus	Alloc. Ministere	UPS
LEBLAY	Julien	Alloc. Ministère	UPS
KATSIODIMOS	Asterios	Alloc. Ministere	UPS
ROATIS	Alexandra	DIM LSC Digiteo	UPS
TZOMPANAKI	Katerina	Alloc. Ministere	UPS
ZAMPETAKIS	Stamatis	CDD sur contrat INRIA	INRIA

Post Doc & Engineers (June 30th, 2013)			
Name	First name	Position	Institution
KAOUDI	Zoi	Post Doc	INRIA
ARANDA ANDUJAR	Andrés	Engineer	INRIA
GHOSH	Tushar	Engineer	INRIA

Group evolution

At the end of June 2013, the group comprises five permanent members, six PhD students, one postdoc and 2 engineers. The group has evolved since 2008 as follows:

- Melanie Herschel joined the team in October 2011 on a BQR MdC position. She obtained her PhD from Humboldt-Universität zu Berlin and was post doc at Hasso-Plattner-Institut Potsdam, at IBM Almaden Research Center and at the University of Tübingen.
- Ioana Manolescu who is leading the Oak Inria project joined the team in March 2012.
- Véronique Benzaken moved to the Toccata team in August 2010.
- Nicolas Spyrtos who has been the Database team leader until March 2012, moved to the A&O team in December 2012.

Research Description

The database research group (DB) at LRI conducts research in various aspects of data and information management, motivated by the continuously growing amount of data managed by current applications, the complexity of these data, the complexity of processes acting on them and the data distribution requirements of modern applications. During the last 5 years, the group interests were mostly centered on: (i) Web data management comprising static analysis for checking query correctness and also for optimizing query/update evaluation, view-based optimisation of queries, and large scale Web data management on distributed and Cloud architectures. (ii) Data Transformation Quality, (iii) Data Analysis and Data Mining, and (iv) Digital Libraries.

Web data management

In the last decades the Web has evolved to a data-centric system. Web applications generate, consumes and exchange huge amount of data, that needs to be efficiently stored and processed. Web data are in most cases semi-structured, and represented by means of standards format like XML, RDF or JSON. Many languages have been proposed to query, update or transform these documents such as XQuery, XQuery Update Facility, SPARQL, ... At the same time, a number of systems supporting these languages have been developed.

The DB team has dedicated substantial effort in research activities aiming at ensuring safe and efficient management of Web data. These activities are centred around three main directions that are detailed below: static analysis for checking query correctness and also for optimizing query/update evaluation, view-based optimisation of queries, and large scale Web data management on distributed and Cloud architectures.

Static analysis

One of the most important problems in data integration systems is the maintenance of schema mappings, which are dependencies among schemas, that are used during query answering for reformulating queries or, as in data exchange systems, for generating canonical solutions. In data integration systems, the detection of corrupted mappings, as a consequence of a change in the source or in the target schema, is a key problem. We worked on type checking techniques for **XML schema-mapping** correctness in XML data integration systems. In our framework, corruption of mappings is detected when correctness stops holding. We have proposed a notion of correctness and techniques to check it by relying on a notion of projection-based inclusion among XML schemas, which copes well with the fact that in an integration system scenario mapping do not cover the whole source and target schemas. Checking projection-based inclusion resulted to be NP-complete. We have devised, implemented and validated through extensive experiments efficient and precise type inference techniques for XQuery (used to specify mappings) and efficient algorithms to check projection-based inclusion among XML schemas. The combination of the two techniques enable precise and fast checking of XML schema-mappings (10).

Static checking of the correctness of XML programs often involves **checking inclusion** (hence equivalence) of XML schemas. Powerful and mainstream XML schema languages (like XML Schema and Relax NG) adopt regular expressions with interleaving (a.k.a. shuffle) and counting operators. For these kind of regular expressions, the problem of inclusion checking is EXPSpace-complete. We worked towards the characterisation and study of classes of such regular expressions for which inclusion can be checked in polynomial time (9). Such sub classes can be used either to design a new schema language, or to design adaptive algorithms, that use the PTIME algorithm whenever possible, and resort to the full algorithm when needed. An original contribution of this research line consists of the design of a new constraint language to exactly characterize the semantics of regular expressions falling in our restriction which we have shown to cover a large spectrum of expressions used in practice. Based on this characterisation, several research steps led us to the design and efficient implementation of a quadratic algorithm for checking $T < U$ where T is any regular expression and U is a regular expression in our restriction (39, 8). For the same kind of comparison $T < U$, we recently developed a more efficient algorithm which uses structural/non-backtracking comparison among expressions. This algorithm runs in linear time when compared expressions share structural similarities. We have demonstrated through experiments that in many cases this algorithm outperforms the previous quadratic one (38, 7).

We have developed static analysis techniques to optimise **XML update** execution via main-memory systems (30). These systems (Galax, Saxon, QizX and EXist) are widely used due to their easiness of integration in a programming environment, and to their efficiency (first all data are loaded in main-memory, and then they are processed, with no disc acces). At the same time these systems have a serious limitation: large documents cannot be loaded in the main-memory, and hence processed. To overcome this problem, we worked on the definition of new static analysis technique for XQuery updates allowing to infer, from an update and an input schema, a type-projector, consisting of a quite precise over approximation of the set of types of nodes that are strictly needed for the update execution. The type-projector is then used at loading time to prune out nodes whose type is not in the type-projector. We then developed efficient algorithms to propagate the updates performed on the projected document to the original document, by means of a streaming process. This *merge* process is unavoidable, and made necessary the design of a notion of type-projector for updates which differs deeply from the already existing notion for queries (previously developed in the DB team). Both static analysis and merging algorithms have been imple-

mented, and extensive tests have demonstrated that main-memory limitations were largely overcome. We subsequently investigated further improvements of this technique by devising and implementing a more sophisticated type projector. It turned out that the analysis was complicated by the strong interconnection between the two tasks: while minimizing the projection we need to ensure a fast and correct merge process.

The management of temporal data is a crucial issue in many database applications. We have investigated efficient storage and update methods for **temporal XML documents**, with a focus on compactness of the representation. The issue is of building and maintaining time-stamped XML documents under space limitations, processing large XML documents using main-memory engines. The two techniques that have been devised (29) enable compact representation of temporal XML documents under changes of the documents or under XML updates specified by XQuery Update Facility. In the last context, our projection-based approach was opportunely adapted in order to optimize temporal data evolution under updates.

In recent years, we worked on schema-based static analysis technique to detect **XML query-update independence** (4). A query and an update are independent when the query result is not affected by the update execution, on any possible input. Detecting query-update independence is of crucial importance in the context of view maintenance, concurrency, etc. Benefits are amplified when query-update independence can be checked statically. The approach we have developed is based on a type inference system able to infer chains of types from XQuery queries and updates. While this kind of type inference, thanks to contextual information and ordering information provided by chains, leads to a precise static independence analysis, it raised a challenging issue: recursive schemas may lead to the inference of infinitely many chains. To solve this problem, we have developed techniques to ensure a sound and complete finite analysis, together with an efficient implementation performing the finite chain-based analysis in polynomial space and time. Experimental results demonstrated that our technique largely outperforms the existing state-of-the-art approach for checking XQuery query-update independence.

XML Indexes and Views

This activity brings together researchers with data management backgrounds. It started in 2008 within the Gemo Inria project associated with the IASI team. It is now part of the Oak Inria Project associated with the BD team. Results related to this activity are developed in the DB report.

A powerful method for speeding up the evaluation of complex XML queries is to build efficient stores for XML data, providing selective data access primitives to the query processing engine. We have devised a path-partitioned XML storage model providing very efficient support for the important tree pattern matching primitive (1); further, in a P2P context, we have built a full-fledged XML tree pattern evaluation engine relying on a distributed content indexing platform (26), and validated its performance through a Wide-Area Network (WAN) of hundreds of peers; we have shown its interest for sharing also Semantic Web data in (25).

A large research project focused on XML storage optimization was based on our expressive XAM language for describing tree patterns characterized by: mandatory and optional nodes, many returning nodes, and different-granularity data items stored in views. Further, XAMs fit not only popular storage and indexing models, but also XQuery tree patterns. This enabled us to provide new algorithms for view-based query rewriting (55), automated recommendation of materialized views (37, 54), as well as incremental maintenance of XML materialized views (34, 5). These algorithms were deployed in the large P2P platform VIP2P (53, 52). The core concepts and algorithms for materializing XAM views in VIP2P have provided the starting point for dedicated chapters in (93).

Map-Reduce XML processing

In order to enable efficient processing of arbitrary large XML documents (such as those involving scientific data and logs for instance), we have devised techniques for statically and dynamically partitioning documents, so to distribute the computing load of XML queries and updates workload among the machines of a Map/Reduce cluster (33). We have characterized a class of manipulations for which this technique applies, namely iterative queries and updates that iterate the same query/update operations on a sequence of subtrees of the input document. From our experience, many real world queries and updates actually meet this property. Our partitioning technique is schema-less, and it only relies on path information extracted from the input query/update. Experiments have demonstrated that besides scaling

up, our system also ensures fast workload execution for huge documents, thanks to parallel query/update evaluation on the partition.

Web data in the Cloud

We have devised an architecture for warehousing large-scale Web data, in particular RDF data, in a commercial cloud platform, specifically, Amazon Web Services (73, 36, 28). Since cloud users support monetary costs directly connected to their consumption of cloud resources, in this work we focussed on indexing content in the cloud. We studied the applicability of several indexing strategies, and showed that they lead not only to reducing query evaluation time, but, importantly, also to reducing the monetary costs associated with the exploitation of the cloud-based warehouse (35). We demonstrated that our architecture can be easily adapted to carry on to other existing commercial cloud platforms. In connection with this work, we have performed a systematic classification and analysis of cloud-based RDF data management platforms, presented in (51).

Data Transformation Quality

When querying an transforming large amounts of data, it is essential to ensure that the data returned by a query or a more complex data transformation, e.g., in the context of Web data integration, data warehousing, or scientific workflows, is semantically correct. Errors in the data may be due to poor data quality in the input or the introduction of errors during data transformation. Our research has focused on the second aspect. More specifically, we have proposed algorithms for high quality *entity resolution*, a typical transformation during data integration and data warehousing. Second, we have devised foundations, methods, and tools to systematically analyze, fix, and test data transformations. We discuss our contributions in these two domains in more detail below.

Web Data Entity Resolution

Entity resolution is the problem of detecting multiple heterogeneous representations of a real-world object. We have proposed efficient and scalable methods for automatic high quality entity resolution for both hierarchical data (e.g., XML) and for data where relationships between entities form a graph (e.g., RDF), as demonstrated by experimental validation using both artificial and real-world data.

Concerning XML entity resolution, we have contributed to a novel algorithm that uses a Bayesian network to determine the probability of two XML elements being duplicates. The probability is based both on content and on structure information given by the hierarchical XML model. To efficiently evaluate the Bayesian network to find duplicates, we have devised two pruning techniques that either have no or negligible impact on the quality of the result (15).

As for duplicate detection in entity graphs, we defined a general framework that mainly consists of three stages, namely retrieval, classification, and update. We further proposed an algorithm complying to the framework that leverages an off-the-shelf relational database to store and to efficiently query information relevant for duplicate classification. We further extended our framework and algorithm to allow for parallel and batched processing (14).

Analyzing, Fixing, and Testing Data Transformations

When developing complex data transformations, e.g., in the context of pay-as-you-go Web data integration or scientific workflows, the data transformation process (i.e., the data transformations leading to the integrated result) is gradually adapted and refined. Our goal in the context of the Nautilus project (<http://nautilus-system.org>) is to semantically guide this refinement by providing semi-automatic support for (i) the analysis phase, where a developer verifies and analyzes the semantics of the data transformation (e.g., for debugging or what-if analysis), (ii) the adapt phase, where the transformation is changed (e.g., to fix a bug or to adapt to changing user requirements), and (iii) the test phase that helps in monitoring the impact of performed changes (e.g., to validate that the bug fix was indeed effective and no further error appeared).

Currently, we are leveraging data provenance techniques for the analysis phase (49) of data transformations specified in a subset of SQL. These techniques have been implemented in the Nautilus Analyzer.

Data Analysis and Data Mining

The analysis of data or data analytics is the process of highlighting useful information from data sets, with the goal to support decision making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, in different business, science, and social science domains. It differs from data mining which is a particular data analysis technique that focuses on modeling and knowledge discovery for predictive rather than purely descriptive purposes.

Our work in data analytics focuses on the proposal of a conceptual model for data analysis and visualization of query results (90). We proposed a high level query language for expressing analytic queries over big data sets having the following major features : (a) its definition is independent of whether the data set is structured or not; (b) a query can be mapped to either Map Reduce or SQL for its evaluation; (c) query evaluation can leverage structure and semantics to improve performance; (d) the language allows query rewriting and incremental updating.

Our work on data mining focuses mainly on query mining. We address the issue of mining frequent conjunctive queries in a relational database, a problem known to be intractable even for conjunctive queries over a single table (97, 20). We show that mining frequent projection-selection-join queries becomes tractable if joins are performed along keys and foreign keys, in a database satisfying functional and inclusion dependencies, under restrictions covering most practical cases, including databases operating over star schemas, snow-flake schemas and constellation schemas.

Digital Libraries

With the advent of the Web, the traditional concept of library has undergone a profound change: from a collection of physical information resources (mostly books) to a collection of digital resources. Additionally, the notion of digital resource includes not only texts in digital form, but any kind of multimedia resources. In a traditional library, physical information resources are managed through well understood manual procedures, whereas in a digital library digital resources are organized according to a data model, discovered through a query language and managed in a highly automated way.

Our work on digital libraries focuses on the proposal of a conceptual data model and query language together with a number of community services, namely content generation by reuse, query personalization and taxonomy based notification.

The data model and query language that we propose supports identification, structuring, metadata support, re-use and discovery of digital resources. The model is inspired by the Web and it is formalized as a first-order theory, certain models of which correspond to the notion of digital library. Additionally, we provide a full translation of the model in RDF and of the query language in SPARQL (21, 23). Moreover we use the model as a yardstick to assess the adequacy of the World Wide Web as a digital library and show why, in its present form, the Web is far from fulfilling this objective, while the Semantic Web does better in that respect. As for community services, our work focuses on query personalization through the incorporation of user preferences in query evaluation (87, 83, 43).

Other Activities

Data-intensive interactive workflows for visual analytics

Structured processes (workflows) have long been used to facilitate the enactment of complex interactions involving many users and systems. The success of process management languages and platforms and the simultaneous development of databases has made workflows data-intensive as increasing volumes of data have to be manipulated. At the same time, advances in the data visualization area have lead to novel expressive interaction primitives, while the complexity of contemporary visual analytics and the need to persist and share the result of visualizations raised the need for database and workflow-style support.

In collaboration with the Inria AVIZ team specialized on data visualization, we have proposed a formal model for data- and interaction-intensive workflows which allow users to work with large data volumes

while benefitting from state-of-the-art data visualization tools, declarative data manipulation as provided by data management systems, and formal semantics allowing the analysis and repair of the interaction process (77, 64, 59), and presented use cases of our model based on a full implementation on top of Oracle in (32).

Webstand

In the context of WebStand, a multidisciplinary ANR project involving database computer scientists and sociologists, we developed techniques and systems in order to equip sociologists with XML database tools tailored for their purposes. The main result consists of a platform that enables the social analysis of people posting on mailing lists, with a focus on W3C public mailing lists and discussion groups on specific technical issues (24).

Foundation of update languages

Evolution of data and metadata is a challenging issue. In (27), we investigate foundation of update languages and measure the expressive power of update primitives with the following motivation. The three basic update primitives for relational databases are the insertion, the deletion of a tuple and the modification of the components of a tuple in a relation. These three primitives are simple, natural and common place. Surprisingly enough, they are hardly ever questioned although SQL is providing much more powerful versions of the three basic update operations. For instance, it is showed, in the absence of temporary relations, that replacing the content of a relation by the result of a query cannot be expressed in terms of insertions, deletions, and modifications. This study also addresses simple programming constructors to measure their impact on the expressive power of the update languages.

6/ Database Team

Collaborations

Participation to national and international collaborative research projects

- CNRS-JST Franco-Japanese Project, 2007-2010, Coordinator: N. Spyrtos. Partners: the database group at LRI, the inference and learning group at LRI, the Meme Media Laboratory, the Graduate School of Information Science of Hokkaido University. This collaboration project addresses the following themes: knowledge federation, datamining, data visualisation and pervasive computing.
- Europa, *Efficient cloud-based data management*, KIC EIT ICT Labs. Coordinator: Wolker Markl, Technical University of Berlin (DE). Partners: Inria (FR), Swedish Institute of Computer Science (SE), KTH Royal Institute of Technology (SE), SZTAKY (Hu), TU Delft (NL), University Paris Sud (FR), University of Trento (IT).
- CODEX, *Efficiency, Dynamicity and Composition for XML: Models, Algorithms and Systems*, ANR - appel Domaines Emergents. Coordinator: Ioana Manolescu. Partners: Inria (Grenoble, Lille, Saclay) - Innovimax SARL - University Francois Rabelais (Tours), University Paris 7, University Paris Sud.
- WebStand, ANR funded project (ANR-05-JC05-53339): A customizable application platform for supporting specific sociological Web applications. Coordinator: Benjamin Nguyen. Computer Science Labs Partners: University of Versailles St-Quentin (B. Nguyen) INRIA-Futurs, Project GEMO (I. Manolescu) University of Paris XI (D. Colazzo) ENST-ParisTech (P. Senellart); Sociology labs Partners: University of the Méditerranée (A. Vion) University of Paris-Dauphine (F-X. Dudouet). Publication: (82, 24).
- Foundations and Algorithms to Compute Missing Data provenance (funded by the Baden-Württemberg Stiftung, Germany, 2011 - 2013). Coordinator: Melanie Herschel. This project set the foundations to compute different types of data provenance of expected but missing data in query results and supports our research on query analysis and debugging. Collaboration with the University of Tübingen, Germany (H. Eichelberger, T. Grust). Publication: (49)
- OakSad is an Inria associated team created in 2013 for a duration of three years, between Oak and the database team from UC San Diego. Coordinator: A. Deutsch. Ongoing research carried within OakSad includes:
 - query composition and optimization algorithm for semantically annotated databases: A. Deutsch (UCSD), F. Goasdoué, J. Leblay and I. Manolescu (BD-OAK)
 - provenance techniques for complex functional data-flow workflows: A. Deutsch (UCSD) and M. Herschel (BD-OAK)
 - common sub-expression factorization in large-scale parallel data processing workflows: D. Colazzo (BD-OAK), A. Deutsch (UCSD), M. Herschel and I. Manolescu (BD-OAK)
 - efficient distributed data dissemination: Y. Papakonstantinou (UCSD), A. Katsifodimos and I. Manolescu (BD-OAK), as well as K. Karanasos (formerly BD-OAK, now a post-doc at IBM Almaden)

Collaborations with other laboratories

- Michele Bugliesi, Ca' Foscari University de Venezia: Security and Concurrency Theory, (6)
- Silvia Crafa, Padova University: Security and Concurrency Theory, (6).
- Giovanna Guerrini, Genova University: XML processing, (95, 2, 7).
- Giorgio Ghelli, Pisa University: Static analysis for XML programming languages, (9, 44, 41, 40, 38, 39, 41, 7, 8).
- Marco Mesiti, Milano University: XML processing, (93, 2, 27)
- Carlo Sartiani, Basilicata University: Static analysis for XML programming languages, (9, 44, 40, 38, 10, 39, 42, 74, 41, 7, 8, 72).
- H. Eichelberger, T. Grust, University of Tübingen: missing data provenance (49)
- P. Calado, Technical University of Lisbon: XML entity resolution (15)
- F. Naumann, Hasso-Plattner-Institut Potsdam: graph entity resolution (14)
- Dominique Laurent, University of Cergy-Pontoise: data analysis and data mining
- Carlo Meghini, ISTI-CNR (Pisa, Italy) : Digital Libraries
- J. Van den Bussche and Tom Ameloot, Hasselt University (Belgium): Foundation of update transformations (27)
- Bilel Gueni, Bogdan Cautis, Talel Abdesselem LTCI-Telecom ParisTech: XQuery optimization (48, 62)
- Michael Benedikt, University of Oxford: updates in XML (2)
- Daniela Florescu, Oracle: updates in XML (2)

Other Collaborations

- Völker Markl, Technical University of Berlin, Germany: massively parallel processing of Web data
- Alin Deutsch, Univ. California in San Diego, USA: optimization framework for massively parallel data processing; languages for semantically annotated documents
- Paolo Atzeni, Univ. Roma Tre, Italy: adaptive storage for heterogeneous NoSQL stores

Participation to national and international networks

- COST Action KEYSTONES (Semantics keyword-based search on structured data sources): I. Manolescu, management committee (2013-now)

Participation to “investissement d’avenir” program

- I. Manolescu and N. Bidoit contributed to preparing the Labex Digicosme proposal. The group is participating to two activities of the action line *DataSense : Data Intelligence*: (1) Scalable, expressive and secure tools for large-scale data, and (2) Making sense of complex, heterogeneous data. These research activities lead to collaboration with B. Cautis, P. Senellart (LTCI – Télécom ParisTech) and B. Nguyen and P. Pucheral (PRISM at UVSQ). I. Manolescu is leading the activity DataSense-1.
- The *XR Social Search* project by B. Cautis, F. Goasdoué and I. Manolescu has been accepted in the DigiCosme 2013 call. It funds a three-years PhD scholarship, on social ranked search on semantically annotated documents.
- Datalyse has been accepted by the Cloud / Big Data program of Investissements d’Avenir (Caisse des Dépôts). The following organizations are member of the consortium: Business & Decision Eolas, Business & Decision, Inria Saclay, LIFL, LIG, LIRMM. The Datalyse project aims at providing models, algorithms and tools for Big Data Analytics applications. The project will be built taking into account three use cases, respectively, on Open Data analytics, retail data analysis (including an analysis of social network data referring to retail products), and monitoring data (for security, energy consumption etc.) collected in a data center. Datalyse will provide a conceptual perspectives, and a library of software primitives based on these concepts, for storing, indexing, analyzing and refining various classes of “Big Data”. Thus, Datalyse results will enable easy and flexible construction of scalable Big Data analytics.

Management Positions in Scientific Organisations

- Computer Science Dept.: N. Bidoit-Tollu, Vice President for Education (Janv. 2009 – Fev. 2012) with the participation to a number of committees of the university: CEO, Pedagogy Commission, etc
- Computer Science Dept.: N. Bidoit-Tollu, Head of the Computer Science program of the IST Master of UPS 11 (2009-2012)
- Idex STIC Working Group: N. Bidoit-Tollu, member (2009-2012)
- M2R Information, Apprentissage et Cognition: N. Bidoit-Tollu, Co-director (2009-2012)
- KIC EIT ICT Lab DSS Master: N. Bidoit-Tollu, in charge of the UPS exit point (2010-today)
- CS Doctoral School (ED 427) Board: N. Bidoit-Tollu, member (2004-2012)
- CS Doctoral School (ED 427): N. Bidoit-Tollu, director (Sept. 2012-today)
- HdR ad-hoc Committee: N. Bidoit-Tollu, member (Sept. 2012-today)
- EIT ICT Lab Doctoral Program: N. Bidoit-Tollu, in charge for the CS Doctoral School (Sept. 2012-today)
- INRIA SIF Scientific Committee: N. Bidoit-Tollu, member (Nov. 2012-today)
- LRI Council: N. Bidoit-Tollu, member (2010-today)
- Database Team: N. Bidoit-Tollu, leader (2012-today)
- EPI Oak: N. Bidoit-Tollu, co-leader of the join INRIA team (2012-today)
- CCSU 27: N. Bidoit-Tollu, member (2007-today)
- Telecom SudParis School Committee: N. Bidoit-Tollu, member (2012-today)
- BDA Steering Committee: N. Bidoit-Tollu, member (2004-today); Ioana Manolescu, president (2012-today);
- Computer Science Dept.: D. Colazzo, in charge of Apogée (2007-2010)
- LRI Council: D. Colazzo, member (2006-2009)
- LRI Library commission: D. Colazzo, member (2010-today)
- LRI Equipment commission: D. Colazzo, member (2008-today)
- CCSU 27: D. Colazzo, board member (2010-today)
- LRI Software commission: M. Herschel, member (2011-today)
- Digicosme Research & Innovation Committee: I. Manolescu (2012-today)
- EPI Oak: I. Manolescu, leader of the joint Inria team (2012-today)
- Inria Technological Development Commission: I. Manolescu (2008-today)
- FORTH Scientific Committee: N. Spyratos, member
- Computer Science Dept. at UPS, International Training: E. Waller (2010-today). A remote training at UFE (Cairo, Egypt) for the L3 Miage degree has been set up.
- KIC EIT ICT Labs HCID Master: E. Waller, coordinator of the I&E modules (2012-today)
- CSE 27 of UPS: E. Waller, board member (2008-2009)
- CSE 27 of Ecole Polytechnique: E. Waller, member (2000-2008)
- LRI Offices and building committee: E. Waller, member (2012-today)

Organisation of Conferences and Scientific Events

- *Very Large Distributed Data Summer School*, Les Houches, 16-21 Mai 2010: N. Bidoit-Tollu, scientific co-organizer
- *Very Large Distributed Data Summer School*, Aussois, 27 mai - 1er Juin 2012: N. Bidoit-Tollu, scientific co-organizer
- *Very Large Distributed Data Summer School*, Oléron, 2014: N. Bidoit-Tollu, scientific co-organizer
- *Fête de la Science*, UPS, 2012: D. Colazzo, co-organizer
- WOD, *International Workshop on Open Data*, Nantes, 25 May 2012: I. Manolescu, member of the steering committee
- ISIP, *International Workshop on Information Search, Integration and Personalization*, 2005-today, N. Spyratos, co-organizer

Working Groups

Participation to editorial committees

6/ Database Team

Honors

Prizes and Awards

Keynote Addresses

International

- N. Bidoit-Tollu, ICALP 2010 affiliated workshop on Semantics in Data and Knowledge Bases, 2010: Types and Constraints: From Relational to XML Data.
- I. Manolescu, VLDB 2012 affiliated workshop on Semantic Search (SSW), 2012: Triples with a purpose.
- N. Spyratos, Global Scientific Data Infrastructures: The Big Data Challenge, 2011: A Functional Model for Data Analysis.
- N. Spyratos, Global Scientific Data Infrastructures: The Findability Challenge, 2012: Rewriting Preferences as Queries.

France

Other Honors

- N. Spyratos, Senior Adjunct Researcher at FORTH-ICS (Greece), 1998-today.
- N. Spyratos, Affiliated Senior Scientist at Meme Media Laboratory of Hokkaido University (Japan), 2000-today.

6/ Database Team

Evaluation of Research

Editorial Boards

International

- *Special issue on Data Integration, Journal of Information Technology, Vol. 54, No 3*, Oldenbourg Wissenschaftsverlag: M. Herschel, guest editor (2012)
- *ACM SIGMOD Record*, ACM: I. Manolescu, editor in chief (2010-today)
- *TOIT, ACM Transactions on Internet Technologies*: I. Manolescu, associate editor (2010-today)
- *Experiment and Analysis Track of the Proceedings of the VLDB Endowment*: I. Manolescu, member (2012)
- *Research Track of the Proceedings of the VLDB Endowment*: I. Manolescu, member (2013)
- *Journal of Intelligent Information Systems*, Springer: N. Spyratos (2010-today)

National

- *Special issue on Advanced Database Technology, Ingénierie des Systèmes d'Information, Lavoisier*: I. Manolescu, guest editor (2013)

Program Committees

Chair

- ICDE 2012, *IEEE International Conf. on Data Engineering, Semistructured Data, XML and RDF track*, Washington (USA): I. Manolescu, Chair (2012)
- EDBT 2012, *15th International Conf. on Extending Database Technology, Tutorial track*: I. Manolescu, Chair (2012)
- VLDB 2012 *PhD workshop* Istanbul: I. Manolescu, Co-chair (2012)
- BDA 2012 *Bases de Données Avancées*: I. Manolescu, Chair (2012)

- Updates 2010, Workshop on Updates in XML, in conjunction with EDBT/ICDT, Lausanne (Switzerland), 2010: E. Waller, scientific organizer
- XOODB 2009, Workshop on XML and Object-Oriented Databases, in Conjunction with ECOOP, Genova (Italy), 2009: E. Waller, scientific organizer
- ACM-SIGDOC, 29th ACM International Conf. on Design of Communication, Tirrenia (Italy): N. Spyrtatos, General co-chair (2011)

Member (international events)

- ADBIS 2013, 7th East-European Conf. on Advances in Databases and Information Systems, Genoa (Italy): N. Bidoit-Tollu (2013)
- SDKB 2011, 5th Int. Workshop on Semantics in Data and Knowledge Bases, Zurich (Switzerland): N. Bidoit-Tollu (2011)
- SKDB 2010, 4th Int. Workshop on Semantics in Data and Knowledge Bases Bordeaux (France): N. Bidoit-Tollu (2010)
- WISE 2008 & 2009, 9th & 10th Int. Conf. on Web Information Systems Engineering, N. Bidoit-Tollu (2008, 2009)
- SBBDB 2008 Brazilian Symp. on Databases, Sao Paulo (Brasil): N. Bidoit-Tollu (2008)
- VLDB 2009, 35th Int. Conf. on Very Large Data Bases, Infrastructure for Information Systems track, Lyon (France): V. Benzaken (2009)
- PLAN-X 2008, Programming Language Technologies for XML, An ACM SIGPLAN Workshop colocated with POPL, San Francisco (USA): V. Benzaken (2008)
- ICDE 2012, 28th IEEE Int. Conf. on Data Engineering, Washington (USA): D. Colazzo (2012)
- ADC 2011, 22nd Australasian Database Conf., Perth (Australia): D. Colazzo (2011)
- Workshop on Updates in XML. In conjunction with EDBT/ICDT 2010, Lausanne (Switzerland): D. Colazzo (2010)
- EDBT 2010, 13th Int. Conf. on Extending Database Technology, Lausanne (Switzerland): D. Colazzo (2010)
- DataX 2009, Int. Workshop on Database Technologies for Handling XML Information on the Web (colocated with EDBT and ICDT), Saint Petersburg (Russia): D. Colazzo (2009)
- ICDE 2012 28th IEEE International Conf. on Data Engineering, Washington (USA): M. Herschel (2012)
- VLDB PhD Workshop 2012 PhD workshop joint with the 38th Int. Conf. on Very Large Database, Istanbul : M. Herschel (2012)
- EDBT 2012, 15th International Conf. on Extending Database Technology, Berlin (Germany): M. Herschel(2012)
- EDBT 2013, 16th International Conf. on Extending Database Technology, Genoa (Italy): M. Herschel(2013)
- Big Data 2013, IEEE Inter. Conf. on Big Data, Santa Clara (USA): M. Herschel (2013)
- Data 2013, 2nd Inter. Conf. on Data Management Technologies and Applications, Reykjavik (Iceland): M. Herschel (2013)
- ADBIS 2013, 7th East-European Conf. on Advances in Databases and Information Systems, Genoa (Italy): M. Herschel (2013)
- ACM SIGMOD Conf. 2012, Scottsdale (USA): I. Manolescu (2012)
- ICDE 2012, 28th IEEE Int. Conf. on Data Engineering, "Cloud, Data Warehousing, and Large Data track", Washington (USA): I. Manolescu (2012)
- Data Analytics in the Cloud Workshop, in colocation with EDBT/ICDT, Berlin (Germany): I. Manolescu (2012)
- Non-conventional Data Access Workshop, in collaboration with the ER Int. Conf., Florence, Italy: I. Manolescu (2012)
- Cloud Intelligence Workshop, in colocation with VLDB 2012, Istanbul: I. Manolescu (2012)
- ACM SIGMOD Conf., New York (USA): I. Manolescu (2013)
- EDBT 2013, 16th International Conf. on Extending Database Technology, Genoa, Italy: I. Manolescu (demonstration track) (2013)
- WebDB 2013, 16th International Workshop on the Web and Databases, New York, USA: I. Manolescu (2013)
- DeSWeb 2013, 4th International Workshop on Data Engineering meets the Semantic Web, in conj. with IEEE ICDE, Brisbane, Australia: I. Manolescu (2013)
- XSym 2009, 6th International XML Database Symposium, in conjunction with VLDB, Lyon (France): E. Waller (2009)
- VLDB PhD Workshop, in conjunction with VLDB, Lyon (France): E. Waller (2009)
- DataX 2009, 4th Intl. Workshop on Database Technologies for Handling XML Information on the Web, in conjunction with EDBT/ICDT, Saint-Petersburg (Russia): E. Waller (2009)

Member (national events)

- BDA, Journées Bases de Données Avancées: N. Bidoit-Tollu (2008, 2010, 2011)
- SEBD, 19th Italian Symposium on Advanced Database Systems, Maratea (Italy): D. Colazzo (2011)
- BDA, Journées Bases de Données Avancées Toulouse(France): D. Colazzo (2010).
- BDA, Journées Bases de Données Avancées: M. Herschel (2012, 2013)
- BTW 2013, 15th GI-Symposium Database Systems for Business, Technology and Web: M. Herschel (2013)
- BDA, Journées Bases de Données Avancées: E. Waller (2013)

Evaluation Committees and Invited Expertise

International

- Expert for the Romanian Research Assessment Exercise (RRAE): I. Manolescu (2012)
- Expert for the Italian Research and University Evaluation Agency's Evaluation of Research Quality (VQR 2004-2010): I. Manolescu (2012-2013)
- Evaluation Committee of Athens University of Economics and Business Computer Science Dept., Greece: N. Spyrtatos
- Evaluation Committee of University of Ioannina Computer Science Dept., Greece: N. Spyrtatos
- Hellenic Quality Assurance Agency for Higher Education, Greece: N. Spyrtatos, evaluator (2010-today)

National

- IUF Junior Committee: N. Bidoit-Tollu, member (2012)
- LAFMIA's Evaluation Committee: N. Bidoit-Tollu, member, (2012)
- ANR Scientific Committee (Projets Blancs & JCJC & Binationaux): N. Bidoit-Tollu, member (2008, 2009, 2011), Vice President (2010).
- ANR Scientific Committee (Projets Blancs & JCJC): I. Manolescu, member (2012)

Other evaluation activities

- Gilles Kahn PhD Award Committee: N. Bidoit-Tollu, Chair, (2010-2011-2012)
- Recruiting Committee – MdC Univ. Paris 1 (2008), Pr Univ. Paris 1 (2008) MdC ENS Cachan (2008), MdC Univ. Paris 1 (2009), Pr Univ. Paris 5 (2009), Pr Cnam (2010), Pr Univ. Paul Sabatier (2011), Pr Univ. Rennes1 (2011), MdC UPS11 (2011), MdC& CNRS Chair UJF (2012), Pr UJF (2012), MdC ENS Cachan (2012), Pr IUT UPS (2013): N. Bidoit-Tollu
- Recruiting Committee – MdC UPS11 (2011), MdC UJF (2011), MdC Cnam (2010), MdC ENSIMAG (2010): D. Colazzo
- Recruiting Committee – MdC Univ. Paris 6 (2013), MdC Univ. Paris 9 (2013), Pr Paris 9 (2013): I. Manolescu
- Recruiting Committee - MdC IUT Paris Sud (2010), Research Engineer INRA (2007, 2008): E. Waller

Interactions with the social, economic and cultural environment

Popularisation of Research Results

- Panel on the technology aspects of Big Data, March 2012, Big Data industrial conference, I. Manolescu.

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)

Type	Name	Managing Institution	Start / Duration	Amount
Digiteo	DIM EDIFLOW	Inria	12.2008 / 33 mo.	103.92 k€
Subvention	M. S	Univ. Sud Paris	06.2008 / 58 mo.	7.50 k€
EIT ICT Labs	Euopa 2012	Univ. Sud Paris	01.2012 / 12 mo.	26.10 k€
EIT ICT Labs	Europa 2012	Inria	01.2013 / 12 mo.	38.00 k€
EIT ICT Labs	Euopa 2013	Univ. Sud Paris	01.2013 / 12 mo.	14.10 k€
EIT ICT Labs	Europa 2013	Inria	01.2013 / 12 mo.	50.00 k€
ANR	WEBSTAND	Univ. Sud Paris	01.2006 / 36 mo.	22.00 k€
Subvention	WebNot	Univ. Sud Paris	01.2013 / 12 mo.	3.47 k€
ANR	CODEX	Univ. Sud Paris	03.2009 / 40 mo.	108.16 k€
Investissement d'Avenir	Datalyse	Inria	05.2013 / 36 mo.	208.721 k€
Digiteo	DIM DW4RDF.2	Univ. Sud Paris	09.2011 / 36 mo.	103.70 k€
EIT ICT Labs	DataBridges	Inria	01.2012 / 12 mo.	53.00 k€
ANR	DataBridges	Inria	07.2011 / 15 mo.	87.31 k€
ANR	ConnectedClouds	Inria	07.2011 / 15 mo.	24.55 k€
European	ASSETS	Univ. Sud Paris	04.2010 / 24 mo.	216.80 k€
European	KP-Lab	Univ. Sud Paris	02.2006 / 60 mo.	106.00 k€
Subvention	PIES 2012	CNRS	01.2012 / 12 mo.	5.00 k€
Digiteo	VISIR	Univ. Sud Paris	09.2008 / 24 mo.	56.00 k€
	Updates	Univ. Sud Paris	01.2012 / 13 mo.	1.50 k€

Ediflow

Partners: Inria, LRI

See <http://scidam.gforge.inria.fr/index.html>

Type: Digiteo
Amount: 103.92 k€
Duration: 33 mois months
Scientific director for LRI: V. Benzaken

This project is a collaboration between data management and information visualisation researchers (coordinator: I. Manolescu, Inria Gemo; participants: V. Benzaken - LRI and J.-D. Fekete - Inria AVIZ). The purpose is to study models and build a corresponding platform for efficient data-intensive workflow systems. A first prototype, ReaViz, has been developed on top of an industrial-strength database and demonstrated this year. It enables the declarative specification of a workflow via XML, and automatically compiles it into a database application.

Europa 2012/2013

Partners: Inria, Univ. Paris Sud, TU Berlin

D. Colazzo, F. Goasdoué and I. Manolescu participate to this 2012-2013 activity lead by Volker Markl from the Technical University of Berlin, Germany. The activity is part of the *Cloud Computing* action line. Within Europa, we work closely with the TU Berlin and SICS partners to devise efficient indexing models for complex data in a cloud environment, as well as compilers for higher-level data models (in particular, Web data) towards efficient parallel processing on the TU Berlin platform.

Type: EIT ICT Labs
Amount: 128 k€
Duration: 2x12 months
Scientific director for LRI:
D. Colazzo & I. Manolescu

WebStand

Partners: Inria Saclay, LEST, LRI, PRISM

The objective of this ANR (2006-09) is to analyze the problems surrounding the use of semi-structured databases in social sciences. This ANR regroups both computer science and sociology laboratories. Work done in Gemo which contributes to WebStand includes XML data cleaning and work on automatic selection and maintenance of materialized XML views. Ioana Manolescu is the scientific director for the IASI/Gemo team.

Type: ANR JCJC
Amount: 22.00 k€
Duration: months
Scientific director for LRI:
D. Colazzo

WebNot

Existing work on explaining why data, albeit expected, is not part of a query result so far limits to data stored in relational queries and transformed using simple SQL queries. However, using such explanations (commonly referred to as Why Not Provenance) for analyzing complex data transformation requires the support of more complex data models and transformations. Therefore, this project explores how Why Not provenance extends to XML and RDF data.

Type: Univ. Paris Sud
Amount: 3.47 k€
Duration: 12 mois months
Scientific director for LRI:
M. Herschel

Codex

Partners: Inria MOSTRARE, LRI, PPS, Univ. Blois, Univ. Paris 1, Inria WAM, Innovimax start-up

Codex – Efficiency, Dynamicity and Composition for XML: Models, Algorithms and Systems – is a research project supported by the ANR Domaines Emergents call. The project studies optimization, distributed processing and coordination, and adaptation techniques to cope with XML document dynamicity. Within CODEX significant effort have been dedicated to developing and testing ViP2P, an XML content sharing platform which scales up to hundreds of peers.

Type: ANR
Amount: 108.16 k€
Duration: 40 mois months
Scientific director for LRI:
D. Colazzo

Datalyse

Partners: Business & Decision Eolas, Business & Decision, Inria Oak, LIFL, Inria ADAM, LIG, LIRMM.

See <http://www.datalyse.fr/>

We participate to the national *Datalyse* project financed within the Investissement d'Avenir call *Cloud & Big Data* (2012). The project started in May 2013. The goal of Datalyse is to provide models, algorithms and tools for Big Data Analytics applications. The project will be built taking into account three use cases, respectively, on Open Data analytics, retail data analysis (including an analysis of social network data referring to retail products), and monitoring data (for security, energy consumption etc.) collected in a data center. Datalyse will provide a conceptual perspectives, and a library of software primitives based on these concepts, for storing, indexing, analyzing and refining various classes of *Big Data*. Thus, Datalyse results will enable easy and flexible construction of scalable Big Data analytics.

Type: Investissement d'Avenir
Amount: 208.721 k€
Duration: 36 months
Scientific director for LRI: I. Manolescu

DIM DW4RDF.2

Partners: Inria, LRI

DW4RDF is a Digiteo DIM project focused on efficient tools for warehousing Semantic Web data, in particular under the form of RDF. We aim at developing models, languages and algorithms for OLAP-style analysis of RDF data, taking into its heterogeneity, its lack of a strict structure, and its rich semantics.

Type: Digiteo
Amount: 103.70 k€
Duration: 36 months
Scientific director for LRI: F. Goasdoué

DataBridges

Partners: Inria Saclay Ile-de-France, Univ. Paris-Sud, DFKI (Germany), TU Delft (The Netherlands), Aalto University (Finland), KTH (Sweden), Alcatel-Lucent Bell Labs (France), DataPublica (France)

DataBridges work focuses on two main topics: (1) the interoperability, enrichment and personalization of data, e.g. data on the cultural activities within a city, based on user profiles, (2) efficient techniques for large-scale RDF data management, to be applied (among others) on digital city data.

Type: EIT ICT Labs & ANR
Amount: 140 k€
Duration: 12 months
Scientific director for LRI: I. Manolescu

ConnectedClouds

Partners: Inria, LRI

This one-year ANR grant concerns our research on cloud-based data management, in particular XML data. We have studied strategies for indexing XML content in a cloud-environment and built a prototype to test them.

Type: ANR
Amount: 24.55 k€
Duration: 12 mois months
Scientific director for LRI: I. Manolescu

ASSETS

Partners: 19 european partners

See http://ec.europa.eu/information_society/apps/projects/factsheet/index.cfm?projectref=250527

The Advanced Search Services and Enhanced Technological Solutions for the European Digital Library (CIP-ICT PSP-2009-3, Grant Agreement No 250527) project aims to improve the usability of Europeana (the European Digital Library) by developing, implementing and deploying large-scale services focusing on search, browsing and interfaces. These services are applicable to all digital libraries.

Type: European Grant
Amount: 216.80 k€
Duration: 24 months
Scientific director for LRI: N. Spyrtos

KP-LAB

Partners: 22 european partners

See <http://www.kp-lab.org>

The Knowledge Practices Laboratory (KPLab) Project is a 5 year project with a budget of about 10 million euros, bringing together over 20 European research groups. The KP-Lab Project focuses on creating a learning system aimed at facilitating innovative practices of sharing, creating and working with knowledge in education and workplaces. It also aims at developing theories, tools, and practical models that enhance deliberate advancement and creation of knowledge as well as transformation of knowledge practices. The essential way of developing the collaborative technologies is a co-evolution process of researchers, technological developers and users.

Type: European Grant
Amount: 106.00 k€
Duration: 60 mois months
Scientific director for LRI: N. Spyrtos

VISIR

Partners: LRI, Meme Media Lab (Japan)

See

The objective of the Visual Interaction (VISIR) project is the design and implementation of a user friendly interface to data warehouses allowing users to: (i) express online analytic queries (OLAP queries) easily,

Type: Digiteo
Amount: 56.00 k€
Duration: 24 months
Scientific director for LRI: N. Spyrtos

through a sequence of clicks, (ii) visualize their results in a number of different forms, chosen interactively by the user, and (iii) navigate on different dimensions of the result.

NOVA

Partners: ISTI-CNR-Pisa, LRI

This is a basic research project whose main objective is the proposal of a data model and query language for digital libraries supporting identification, structuring, metadata support, re-use and discovery of digital resources. The model that we propose is inspired by the Web and it is formalized as a first-order theory, certain models of which correspond to the notion of digital library. Additionally, we provide a full translation of the model in RDF and of the query language in SPARQL.

Type: PICS
Amount: external k€
Duration: 36 mois months
Scientific director for LRI:
N. Spyrtatos

FedWedK

Constructing a federation model for Web-based knowledge, and applying it to ubiquitous knowledge discovery for Grid modelling : the main objective of the project is to propose a model for federating (as opposed to integrating) web-based knowledge, as well as tools for the discovery of such knowledge.

Type: CNRS-JST
Amount: external k€
Duration: 32 mois months
Scientific director for LRI:
N. Spyrtatos

FacileMedia

Partners: Univ. Kasetsart (Thailand); Univ. Cergy-Pontoise, Univ. de Bourgogne, Univ. Paris Sud

See

Constructing a federation model for Web-based knowledge, and applying it to ubiquitous knowledge discovery for Grid modelling : the main objective of the project is to propose a model for federating (as opposed to integrating) web-based knowledge, as well as tools for the discovery of such knowledge.

Type: Project PHC SIAM
Amount: external k€
Duration: 24 mois months
Scientific director for LRI:
N. Spyrtatos

Private contracts and grants (jan 2008 - jun 2013)

Type	Name	Managing Institution	Start / Duration	Amount
Industry	DataPublica	INRIA	05.2011 / 24 mo.	86.42 k€

DataPublica

Partners: Inria, DataPublica, LRI

This collaboration with the DataPublica start-up brings new applications concerned with Linked Data. Data produced and made public by numerous public administration offices (in France, Europe, and the world) opens many perspectives for integrating, analyzing, and combining data sources into added-value information sources. Time is also an essential dimension here; so is data matching and reconciliation, since the same entity may be referenced from many different viewpoints and reconciliation is needed when joining data sources. Users of such applications could be public administration analyzing the impact of its policies, social scientists and journalists which already work on the data (but gather it with much difficulty) etc.

Type: Industry
Amount: 86.42 k€
Duration: 24 months
Scientific director for LRI: I. Manolescu

Software Licensing and Distribution

AMADA - AMADA

Contact: J. Camacho Rodriguez

AMADA is a platform for storing Web data (in particular, XML documents and RDF graphs) based on the Amazon Web Services (AWS) cloud infrastructure. AMADA operates in a Software as a Service (SaaS) approach, allowing users to upload, index, store, and query large volumes of Web data.

XupOp - XupOp

Contact: D. Colazzo

XUpOp (XML Update Optimization) is a general purpose type based optimizer for XML updates. Its main feature is a pruning technique using schema information coupled with an efficient streamable merge step. This technique enables any existing main-memory XQuery Update engines to process large XML documents.

XPIOT-Andromeda - XPIOT

Contact: D. Colazzo

This tool enables existing XML main-memory systems to process very large documents. The tool relies and combines two main techniques for both XQuery queries and updates: projection and data partitioning. Adopted projection and partitioning techniques has been implemented so that for parallel evaluation of queries and updates is performed on top of MapReduce clusters.

XupIn - XML query-update independence tester

Contact: D. Colazzo

XUpIn (XML Update Independance) is a static analyzer designed for detecting XML query update independence, in presence of a schema. It has been inspired by experienced research on type systems for XML languages. The resulting method features solid formal foundation, high precision, efficiency and scalability.

XUpTe - XUpTe

Contact: D. Colazzo

This tool enables processing very large time stamped XML documents, by means of techniques based on streaming processing. One of the method assumes that document changes are performed via XQuery updates and uses type-based projection.

Nautilus Analyzer - Nautilus

<http://nautilus-system.org>

Contact: M. Herschel

The Nautilus Analyzer is an Eclipse Plugin designed to help developers in understanding and debugging their declaratively specified data transformations. More specifically, our prototype allows to analyze SQL queries with the help of why- and why-not provenance algorithms.

WaRG - Warehousing RDF Graphs

Contact: A. Roatis

WaRG allows performing warehouse-style analytics on RDF graphs using typical OLAP operations. This framework keeps the warehousing process purely in the RDF format and takes advantage of the heterogeneity and semantics inherent to this model.

ViP2P - views in peer-to-peer

<http://vip2p.saclay.inria.fr>

Contact: I. Manolescu

ViP2P is a fully functional Java-based platform for the efficient, scalable management of XML documents in structured peer-to-peer networks based on distributed hash table (DHT) indices. We exploit indices (or materialized views) to answer tree pattern queries.

FactMinder - A browser (Chrome) extension targeted at online fact checkers and data journalists

Contact: F. Goasdoué

FactMinder is a browser (Chrome) extension targeted at online fact checkers and data journalists. It enables users to analyze web pages with entity extractors and create, in a separate panel, views to cross these annotations with background knowledge from trusted XML or RDF sources such as data sets from the Linked Open Data or governmental agencies.

XRP - The XR platform

Contact: F. Goasdoué

XRP (a.k.a. the XR platform) is a data management platform for RDF-annotated XML data, relying on the XR data model and the XRQ query language. The platform works as a data integrator on top of XML and RDF data management systems. It features components for query evaluation, optimization and composition, as well as modules for managing XML node URIs. The platform can be accessed from command-line or through a web-based interface in the spirit of SPARQL endpoints.

EdiFlow - EdiFlow

<http://www.grid-observatory.org>

Contact: I. Manolescu

The prototype Ediflow is platform for data-intensive visual analytics (eg user-dataset interactions in scientific applications). The platform is built in Java, and it has been deployed on top of the Oracle database management system. It integrates visualization and computation units.

LiquidXML - LiquidXML

<http://vip2p.saclay.inria.fr/?page=liquidxml>

Contact: I. Manolescu

LiquidXML is built on top of ViP2P. It is a self-tuning P2P system for distributing XML content according to the query needs of the distributed peers.

RDFViews - RDFViews

<http://rdfvs.saclay.inria.fr>

Contact: F. Goasdoué & I. Manolescu

RDFViewS – View Selection in Semantic Web Databases – is a system capable of choosing the most suitable views to materialize, in order to minimize the query response time for a specific SPARQL query workload, while taking into account the view maintenance cost and storage space constraints. It exploits the available semantic information (eg RDF Schema) to ensure the completeness of the query evaluation. Demonstrated in the ACM CIKM 2010 conference.

Training and Education

- Bilel Gueni, Optimisation de requêtes XQuery, Telecom ParisTech, september 2009: E. Waller, co-advisor with Talel Abdessalem

Graduate Courses

M2R, UPS

- *Fondements Bases de Données Avancées*: N. Bidoit-Tollu
- *Données et connaissances pour le WEB*: N. Bidoit-Tollu
- *Langages pour bases de données*: V. Benzaken, D. Colazzo
- *Données semi-structurées et XML: langage et optimisation*: D. Colazzo, I. Manolescu
- *Intégration de données et WEB sémantique*: M. Herschel, N. Spyratos
- *Intégration de sources de données hétérogènes*: N. Spyratos
- *Formation à la Recherche*: V. Benzaken, E. Waller

Others Master (M2R)

- Mention Informatique, Université Paris-Dauphine, *Services Web: Technologies et Applications*: I. Manolescu
- Master Information Systems and Decision Support, Labanese University of Beyrouth (Liban), *Multidimensional Databases and OLAP*: N. Spyratos (Since 2009)

Tutorials & Summer school

- IEEE International Conference on Data Engineering (ICDE), Hannover, Germany, *Schemas for Safe and Efficient XML Processing*: D. Colazzo, G. Ghelli, C. Sartiani (2011).
An enriched version has been presented by Dario Colazzo at the Summer School "Masses de données distribuées", Aussois (2012)
- Summer School "Masses de données distribuées", Les Houches, *Type-based optimization for XML query execution and static verification*, D. Colazzo, (2010)
- Tutorial session at the Workshop on Open Data, Paris, *Entity Resolution*: Melanie Herschel (2013)
- Tutorial session at the Workshop on Open Data, Paris, *Linked Data Management on the Cloud*: Zoi Kaoudi (2013)
- IN2P3 Summer School on "Big Data and NoSQL", Roscoff, *Big Data in 2013: status and a perspective*: I. Manolescu (2013)
- Tutorial session at the Workshop on Open Data, Paris, *Fact-Checking the Web: Content Management Technologies for a Democratic Decision Process*: I. Manolescu (2013)
- EIT ICT Labs summer school "Imagine the Future", Paris, *A journey into semistructured data: Where the wild things are*: I. Manolescu (2012)
- Summer school in Mathematics, Physics and Information Systems organized by AUF at the Institute of Technology of Cambodia in Phnom Penh, *Intégration d'informations*: N. Spyratos (2009)

Thesis

Habilitation à Diriger des Recherches

Name	Defense
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Dario COLAZZO	09.2011
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Defended thesis				
Name	Start	Defense	Funding	Advisor
Mohamed Amine BAAZIZI	01.09.2008	07.09.2012	Alloc. Ministère	N. Bidoit & D. Colazzo
Hanan BELHAJFREJ	01.10.2004	15.07.2009	ATER	N. Spyratos
Konstantinos KARANASOS	01.01.2009	29.06.2012.	ANR grant	I. Manolescu & F. Goasdoué
Asterios KATSIFODIMOS	04.11.2009	03.07.2013	Alloc. + CDD INRIA	I. Manolescu
Wael KHEMIRI	01.10.2008	12.12.2011	Alloc. Ministère	V. Benzaken
Noor MALLA	18.11.2008	21.09.2012	ETR-BGF	N. Bidoit & D. Colazzo
Mamadou NGUER	01.12.2005	27.09.2010	EGIDE BGF + ATER	N. Spyratos
Marina SAHAKYAN	17/11/2008	17/11/2011	ETR-Cotutelle	N. Bidoit & D. Colazzo
Ekaterina SIMONENKO	15.09.2007	16.09.2011	Alloc. + ATER	N. Spyratos
Federico ULLIANA	01.10.2009	12.12.2012	Alloc. Ministère	N. Bidoit & D. Colazzo
Jitao YANG	01.10.2008	30.05.2012	ETR	N. Spyratos & C. Meghini

Thesis in progress			
Name	Start	Funding	Advisor
Jesus CAMACHO RODRIGUEZ	01.10.2011	Alloc. Ministère	D. Colazzo
Julien LEBLAY	22.09.2010	Alloc. Ministère	F. Goasdoué & I. Manolescu
Alexandra ROATIS	21.09. 2011	DIM LSC Digiteo	I. Manolescu & D. Colazzo & F. Goasdoué
Katerina TZOMPANAKI	01.10.2012	Alloc. Ministère	N. Bidoit & M. Herschel
Stamatis ZAMPETAKIS	15.10.2012	CDD sur contrat INRIA	I. Manolescu & F. Goasdoué

6/ Database Team

Self Assessment

The last evaluation report recommendation was :

L'équipe doit veiller à conserver et renforcer une bonne unité avec un programme de recherche commun. Certes, la petite taille de l'équipe explique que l'on perçoive cette équipe organisée autour d'axes indépendants, chacun porté par un professeur. Le risque à terme est que l'équipe perde sa cohésion globale. . . . Compte-tenu de sa qualité et de son activité scientifique, l'équipe mériterait d'être renforcée. Il faudrait également veiller à faire croître le nombre de thèses soutenues . . .

During the last period, the team evolution led to creating the joint Inria research project Oak with a clear focus on Database optimizations and architectures for complex large data. The team recruited Melanie Herschel (MCF) and Ioana Manolescu (DR INRIA), as the leader of Oak, joined the team. In Sept. 2013, D. Colazzo, has been promoted to a PR position at Univ. Paris 9 and B. Cautis has been recruited on a PR position at IUT of UPS. Although the composition of the team has changed to a large extent, its size stays the same. The research activities of the group still need to be reinforced by new faculty members. The number of PhD students increased although our priority goes to the motivation and quality of the applicants rather than to just the number.

The members of the Database and IASI teams are merging into the new LRI team LaHDAK. The strategy and five-year project of the LaHDAK team can be found in Section 6.24.2.

IASI Team: Synthetic presentation

Nom du responsable de l'équipe : **Chantal REYNAUD**

Effectifs de l'équipe

As of 1 January, 2008, the group had 9 faculty members (2 PR, 7 MC), 2 INRIA researchers (1 DR, 1 CR), as well as 8 post-doctoral students, 13 Ph.D. students and 3 research engineers.

Personnels ayant quitté l'équipe pendant le contrat en cours

3 faculty members: 1 MC (42 months), 2 DR INRIA (93 months) ; 22 Ph.D. students (630 months) ; 15 post-doctoral students (125 months) ; 4 engineers (56 months).

Nombre de recrutements réalisés au cours de la période considérée et origine des personnels

1 MC (previously post-doctoral student at the University of Montpellier) ; 1 CR2-CNRS (previously post-doctoral student at the University of Bremen in Germany).

Production scientifique au cours de la période écoulée

1. Predictive measure of new learnt clauses pertinence remained an open issue to have a deep understanding of SAT solvers. We have tried to predict the usefulness of a learnt clause during search (IJCAI 2009), opening up a new research direction around GLUCOSE which won the SAT Competition 2009 in the Application (Industrial) UNSAT Track. Since then, the majority of SAT solvers uses that measure.
2. We proposed a query optimization technique for RDF data management systems when end-user requirements are known and modeled by a query workload. These new algorithms (PVLDB 2011), based on a RDF materialized view selection, give the best optimization calculated so far and scale to large query workloads.
3. Integration of heterogeneous sources is a main issue in the framework of a software development project and at the heart of advances of research. We now have, in the group, integration tools at the ontological (three times participation to the international alignment contest from 2008 to 2010) and data levels (JoDS 2009). Both techniques have a high precision and are complementary to each other.
4. The Web is rich of tables that host a considerable wealth of high-quality relational data. We identified *Google Fusion Tables* (GFT) as a promising data source and proposed an efficient algorithm that annotates entities in GFT tables (EDBT 2013). We also proposed an algorithm for discovering missing cross-language links in *Wikipedia* (ECAI 2012), achieving high accuracy accross all datasets that we selected, and useful to translate the concepts in GFT.
5. We explored important foundational issues in the ontology-based data access (OBDA) area: expressive power and connections with other formalisms (e.g. CSP, Disjunctive Datalog) (PODS 2013), query containment and minimization in the presence of ontologies (KR 2010), and alternative semantics for querying inconsistent data (AAAI 2012).

Bilan quantitatif des publications de l'équipe

- Articles in major international journals: 13 - Other journals: 12
- Articles in major international conferences: 43 - Other conferences: 132
- Books and chapters: 16

5 publications majeures de l'équipe

- Fatiha Saïs, Nathalie Pernelle, and Marie-Christine Rousset, Combining a Logical and a Numerical Method for Data Reconciliation. *Journal on Data Semantics*, Volume 12: 66-94 (2009).
- Gilles Audemard, and Laurent Simon, Predicting Learnt Clauses Quality in Modern SAT Solver. *Twenty-first International Joint Conference on Artificial Intelligence (IJCAI'09)*, July 2009.
- François Goasdoué, Konstantinos Karanasos, Julien Leblay, and Ioana Manolescu, View Selection in Semantic Web Databases. *Proceedings of the VLDB Endowment (PVLDB)*, vol. 5, num. 2, 2011/2012.
- A.Penta, Gianluca Quercini, Chantal Reynaud, and Nigel Shadbolt, Discovering Cross-Language Links in Wikipedia through Semantic Relatedness. *European Conference on Artificial Intelligence (ECAI)*, Montpellier, August 2012.
- Meghyn Bienvenu, On the Complexity of Consistent Query Answering in the Presence of Simple Ontologies. *AAAI* 2012.

5 (max) documents majeurs (autres que publications)

- Glucose, a SAT Solver with auto-adaptative clause database management.
- APP deposits for the prototypes LN2R-LT (IDDN.FR.001.520006.000.S.P3012.000.10000) , TaxoMap Alignment (IDDN.FR.001.220033.000.S.) and TaxoMap Refinement (in progress).

- SomeWhere2 prototype, a peer-to-peer infrastructure for propositional reasoning and GEXTOOLS for management / deployment of experiments on G5K.
- Co-organization of the SAT competition and publication of the results, SAT Conference, Swansea Wales (UK), 2009.

5 (max) faits illustrant le rayonnement ou l'attractivité académique

- Glucose won a trophy in 2009 (Applications, UNSAT), a Gold Medal in 2011 Glucose v2, (Applications, SAT+UNSAT) and a best prize at SAT Challenge 2012, as "the best single-engine solver in the application track". (L. Simon)
- EGC Application Best paper Award, 2009 (F. Hamdi, B. Safar, H. Zargayouna, C. Reynaud)
- Invited speaker at Journée Interopérabilité des systèmes, GIS INTEROP Grande Region (2010), Journée Web et Médiation, Rhône-Alpes Web Intelligence Project (2011), Journées Nationales de l'IA Fondamentales (2011), at the National Institute of Informatics in Japan (2011)
- Co-Organization of the SAT conférence in 2011 (Ann Arbor, USA)
- Co-chair of program committees of workshops joined to national conferences: EvalECD workshop (2009, 2010, 2011), OntoGeo workshop (Toulouse 2010), SOS-DLWD (2012, 2013)

5 (max) faits illustrant les interactions de l'équipe avec son environnement socio-économique ou culturel

- Co-organization of the *Fête de la Science* for LRI in 2012 (M. Bienvenu).
- Participant in the competition for the recognition of research results in the University Paris-Sud in 2012 (F. Saïs et N. Pernelle) and obtaining of a funding for a one full year engineer in 2013 for the IASI-Tools Digiteo OMTE (*Opération de Maturation Technico-Economique*) aiming at grouping innovative tools to integrate information from numerous and highly heterogeneous data sources.
- Invited speaker at First Business Objects ARC workshop in 2008 and at the Digiteo researchers meetings on traceability of software developments in 2013 (C. Reynaud).
- Expertises for the tax administration for determining if a company is an innovative young company in the settings of the *Crédit Impôt Recherche* from 2010 to 2013 and for the fiscal control of young innovative companies in 2011 and 2012, Consulting activities in the SemSoft company from 2009 (F. Goasdoué).
- Invited talks and demos at the *Journée iMatch: Réseaux/Bases de Données* (INRIA Match Matching Technologies) in 2011. Five software demonstrations have been organized (P. Chatalic, F. Goasdoué, I. Manolescu, N. Pernelle, C. Reynaud, B. Safar, F. Saïs).

Principales contributions de l'équipe à des actions de formation

- Responsabilités en lien avec des filières de formation
Vice-Président of Département Informatique (2009-2012), Member of the concil of the Ecole Doctorale d'Informatique of the University of Paris-Sud (from 2013), Teaching responsibilities of training courses in Paris-Sud: apprenticeship L3-Miage (2008 to 2012), standard M2 Miage (from 2009), Research Master IAC (co-responsible from 2012), Apprenticeship DUT in computer science (from 2004).
- Responsabilités pédagogiques d'enseignements niveau master
 - Coordination of a teaching module in the common part of the M2R IAC of the University of Paris-Sud (co-responsability with Nicole Bidoit), and of two optional modules. Creation of classes in these modules.
 - Responsible of a module of the common part of the *Mathématique-Informatique-Décision-Organisation* (MIDO) Master, *spécialité recherche Informatique: systèmes intelligents* (ISI) of the University of Paris-Dauphine (2011-2013), and of one optional module from 2008. Creation of classes in these modules.
- Enseignements dispensés à l'étranger
 - XML, University of Thies, Senegal (2009, 2010).
 - Knowledge Representation and Semantic Web, Master in Computer Science at the Libanese University in Beirut (2009-2011).
 - Responsible of one training week (out of four) at *Ecole Ibn Sina* (Ramallah) in Palestine under the direction of Pr. Adnan Darwiche in 2012.
- Conception of an educational Web tool for teaching programming languages to beginners students.

Research Group Members and evolution since 2008

As of June 30, 2013, the IASI group included ten permanent members (two Professors, seven Assistant Professors and one CNRS junior researcher) and seven doctoral students.

Permanent Members (June 30th, 2013)

<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
BIENVENU	Meghyn	CR2	CNRS
CHATALIC	Philippe	MCFHC	Paris Sud
DAGUE	Philippe	PRCE	Paris Sud
GOASDOUÉ	François	MCF	Paris Sud
PERNELLE	Nathalie	MCF	Paris Sud
REYNAUD	Chantal	PR1	Paris Sud
SAFAR	Brigitte	MCFHC	Paris Sud
SAÏS	Fatiha	MCF	Paris Sud
SIMON	Laurent	MCF	Paris Sud
VENTOS	Véronique	MCF	Paris Sud

PhD students (June 30th, 2013)

<i>Name</i>	<i>First name</i>	<i>Funding</i>	<i>Institution</i>
DOS REIS	Julio Cesar	FNR Luxembourg	Paris Sud
IBRAHIM	Hassan	ETR	Paris Sud
KHEFIFI	Rania	CDD sur contrat UPS	Paris Sud
LEBLAY	Julien	Alloc. Ministère	Paris Sud
ROATIS	Alexandra	CDD sur contrat UPS	INRIA
SYMEONIDOU	Danai	Alloc. Ministère	Paris Sud
ZAMPETAKIS	Stamatis	CDD sur contrat INRIA	INRIA

Group evolution

The team composition has changed during the five years as follows:

- F. Saïs was hired as an Assistant Professor in September 2008.
- M. Bienvenu joined the group in September 2010 as a junior CNRS researcher.
- H. Gagliardi, Assistant Professor, retired in October 2010.
- S. Abiteboul, INRIA senior researcher, moved to the Dahu INRIA Group and LSV (ENS Cachan) in September 2011.
- I. Manolescu, INRIA senior researcher, moved to the BD group in March 2012 when creating the OAK INRIA project.

Research Description

The group Artificial Intelligence and Inference Systems focuses its work on the topic of information integration for several years. It addresses problems raised by modern information and knowledge management systems that deal with numerous, highly heterogeneous, and distributed information. Indeed the ever-increasing quantity of data produced requires the development of intelligent tools for a better integration and exploitation of this data.

The research of the group is organized into five themes: Ontology-based Data and Document Management, Knowledge and Data Integration, Scalable techniques for Semantic Web Data Management, Reasoning over Distributed Systems, and Sat solving.

Ontology-Based Data and Document Management

More and more RDF data sets are published on the Web. Nevertheless, the Web remains concentrated on the interchange of unstructured documents. We are investigating ontology-based automatic document annotation approaches and we developed query engines that can be used in this setting. We are also currently studying problems related to query answering in the presence of ontologies formulated in lightweight descriptions logics.

Semantic annotation

Semantic annotation consists in assigning to a document metadata whose semantics is defined in an ontology. We have investigated ontology-based automatic annotation approaches.

In a first approach called Shiri-Extract, terms are discovered in HTML documents and compared to those that are described in the lexical part of an OWL Ontology. Since this lexical component can be incomplete, the Web is used via a search engine to classify new terms (267, 344). Moreover, terms are generally not located in accurate manner in the HTML document. Shiri-Annot associates different types of semantic metadata to a tagged part of the document depending on its structuration level (266). Using Shiri-Querying, a user query is reformulated to propose first answers that come from the more structured parts of the documents (292, 168, 202). We have also defined a knowledge-based annotation approach (REISA) that exploits the structure and the semantic annotations of an HTML document to propose new property instances that are filtered by using ontology axioms and existing property instances (167, 340, 202).

In a second approach, we have been interested in extracting data in an automatic way from Google Fusion Tables (GFT) with the aim of enriching a data warehouse related to a given domain in regard to classes of an ontology that we want to instantiate. GFT's tables are a good starting point for structured information extraction, and we have used it in our joint work between Paris-Sud and DFKI, allowing the multi-facetted browsing of city point-of-interest data (295), (258) in the settings of the ANR DataBridge project. An algorithm has been proposed to annotate entities in tables that do not necessarily belong to a pre-compiled catalogue and have little metadata (257). This led us also to propose an algorithm for recognizing different-language versions of Wikipedia pages, based on the analysis of links across the Wikipedia database (170). We then extended this research work in the setting of the activity Data Integration in Digital Cities of EIT ICT Labs in two directions: recognizing types of columns in GFT tables (171) and connecting data in the data warehouse with social data (261).

Query enrichment based on adaptative ontologies

We addressed the problem of Web Information Retrieval using the Semantic Web technologies and focusing on knowledge evolution. We introduced the new paradigm of adaptive ontology as a process for making ontologies smoothly follow the evolution of the domain. After having worked on the representation of Web data and the ASK query language tailored for the extraction of relevant information from Web data, we proposed a set of query enrichment rules based on the exploitation of ontological elements as well as on adaptive ontologies characteristics (123). The tool TARGET was designed for managing adaptive ontologies and for searching relevant information on the Web as well as experimental validation of the introduced concepts (237). This work was the core of a PhD thesis in joint supervision between the University of Paris-Sud and the University of Luxembourg, defended in april 2009 (342).

Query answering over description logic knowledge bases

We have pursued several lines of research related to query answering in the presence of description logic (DL) ontologies, paying particular attention to the so-called lightweight DLs which offer tractable reasoning. The importance of these latter logics is attested by the addition of two profiles to the latest version of the OWL ontology language based on lightweight DLs of the DL-Lite and $\mathcal{EL}$ families.

In a first line of work (154), we proposed a general version of query containment which is relevant in applications but, unlike the classical version, cannot be reduced to query answering. We established the

complexity of deciding generalized query containment for ontologies expressed in DL-Lite or $\mathcal{EL}$, considering both conjunctive queries and the simpler instance queries. We also investigated global minimization of queries in the presence of DL ontologies.

More recently, in (155), we studied the properties of ontology-mediated queries defined using ontologies formulated in expressive DLs (e.g. $\mathcal{ALC}$) or other popular fragments of first-order logic. We established tight connections to disjunctive Datalog, constraint satisfaction problems, and the related formalism MM-SNP, which we exploited to derive new complexity and decidability results for generalized query containment, first-order rewritability, and Datalog rewritability. Some preliminary results concerning first-order rewritability of instance queries for ontologies in the lightweight DL $\mathcal{EL}$ were presented in (219).

Another important issue in DL query answering is how to handle data which is inconsistent with the ontology. A standard solution is to adopt an inconsistency-tolerant semantics, with the CQA semantics being the most popular choice. Unfortunately, query answering under CQA semantics is intractable even for lightweight DLs like DL-Lite. This motivated us to conduct a fine-grained complexity analysis, with the aim of identifying tractable subcases. In (218), we presented general conditions for deciding if a given instance query can be efficiently evaluated under CQA semantics w.r.t. a given DL-Lite ontology. Then in (153), we considered a simpler ontology language (allowing only class inclusion and disjointness) but moved to the richer class of conjunctive queries. Our study provided a full classification of the complexity of queries with at most two existentially quantified variables, and significantly improved earlier hardness results.

Finally, we investigated extracting from a reference ontology-based data management system (DMS) a piece of ontology, a module, possibly personalizing it with extra constraints w.r.t. the application under construction and then managing a data set using the resulting ontology. In (193, 118), we extended existing definitions of modules and introduced novel properties of robustness that provide means for checking easily that a robust module-based DMS evolves safely w.r.t. both the ontology and the data of the reference DMS. Our results concern the DL-lite_A dialect, which forms the basis of the OWL 2 QL profile.

Data and Knowledge Integration

We investigated the reconciliation problem encountered when different heterogeneous sources have to interoperate or have to be integrated. The first challenge is the reconciliation of ontologies through mappings. The second challenge is data linking. The reconciliation problem is addressed in the settings of classical information management systems but also in the settings of Adaptive Hypermedia (AHS) and Personal Information Management Systems (PIMS). Our research works on integration both at the ontology and data level led us to obtain a one year DIGITEO funding for an engineer in computer science for technico-economics maturation of a framework integrating our tools in these two fields.

Mapping between ontologies

We worked on ontology alignment by aiming to provide full life-cycle support for ontologies. We addressed alignment of very large ontologies and mapping refinement in the settings of the PhD thesis of Fayçal Hamdi (335). We proposed two partitioning methods which have been designed to take the alignment objectives into account in the partitioning process as soon as possible (197, 307). We proposed an environment, called TaxoMap Framework, based on TaxoMap, an alignment tool designed in our group, which helps an expert to specify treatments based on alignment results (194, 238, 163). The aim was to refine these results or to merge or enrich ontologies (204, 135, 195, 196). At the same time, developments on TaxoMap have been pursued and techniques have been improved, allowing us to participate four times in the international alignment contest OAEI (241, 239, 240) in order to test the robustness of TaxoMap, the partitioning algorithms, new structural techniques and the refinement process.

The success of Semantic Web applications relies on the use of up-to-date ontologies and mappings. We investigated the problem of maintaining semantic correspondences between heterogeneous dynamic medical Knowledge Organizing Systems (KOS) in a (semi-)automatic way. Based on the analysis of two medical KOS, SNOMED CT and ICD9, we studied the correlation from a quantitative and qualitative point of view between the way a KOS evolves over time and its impact on the mappings (233). We proposed a global framework supporting an approach based on change patterns to characterize and formalize complex changes, and heuristics to guide the mapping maintenance process, (231, 158). We characterized and formalized KOS evolution (232). A first investigation on the definition of heuristics has been

done in collaboration with the database Group of the University of Leipzig. We proposed a set of adaptation actions usable to maintain mapping up-to-date and investigated a method to identify conceptual information that served to define existing mappings and facilitate their automatic maintenance.

Data linking

We have addressed the data linking problem when different data descriptions refer to the same world entity. We first developed an automatic and knowledge based approach named LN2R (124, 259) that exploits key constraints to infer identity (*sameAs*) links. The major originality of the approach is the combination of a logical method L2R and a numerical method N2R. LN2R (259) has been ranked 2nd out of seven tools in the Person-Restaurant track of the international OAEI'2010 campaign. N2R method has been extended to be able to infer identity links between fuzzy relation instances (41, 46) of Web data tables in the food risk assessment domain. We have developed a graphical tool (305, 189) based on Petri Nets that gives semantic and graphical explanations for the obtained *sameAs* links. We extended LN2R to deal with data described by different ontologies (254, 256). In the interests of data linking tool scalability we proposed a classification rule based approach (255). We have developed an efficient approach named KD2R (265, 326) to discover automatically keys in RDF datasets. We have also addressed the data fusion problem in (172, 260).

Integration of existing materials

Nowadays there is a growing demand for personalization and the "one-size-fits-all" approach for hypermedia systems is no longer applicable. We proposed a semi-automatic merging/specialization process to integrate an author's model into a model of an existing system only made up of generic components (179, 180), implemented in a Protégé plug-in (280). Another real challenge is to enable personalized access to information using Adaptive Hypermedia Systems (AHSs). We proposed to address the definition of adaptation strategies at a high level. We defined a typology of elementary adaptation patterns for adaptive navigation (279), and a process to generate adaptation strategies based on the use and the automatic combination of patterns (205, 278). We showed how the generated adaptation strategies can be integrated into existing AHSs (125). The EAP framework has been implemented and experiments in the e-learning domain have been conducted. This thesis work in joint supervision between the University of Paris-Sud and Supelec was defended by Nadjat Zemirline on July 12th, 2011 (346).

Context-Aware Personal Information Integration

Users are faced with an increasing amount of personal information that are available under different formats (e.g., pdf, doc, mails, calendar). This leads to a real need to develop tools that can help them to manage efficiently this big amount of heterogeneous personal information. Personal Information Spaces (PIS) are at the core of Personal Information Management Systems (PIMS). They enable the structuring, storage, and retrieval of data on-demand. In (42, 66), we have proposed a semantic context-aware PIS. The user may define his/her own ontology for personal information ontology directly or by reuse of existing domain ontologies. Furthermore, we have considered the fact that the usability of personal information depends on contexts.

Scalable techniques for Semantic Web Data Management

This activity brings together researchers from knowledge representation and data management backgrounds. It started in 2009 in the Gemo INRIA project associated with the IASI team. Since March 2012, it has been a part of the OAK INRIA project associated with the BD team while including one member of the IASI team (F. Goasdoué).

The complex structure and semantics of Semantic Web databases represented in RDF raise important challenges for query processing. A first challenge is brought by the irregularity of the data structure: RDF triples are suited for describing heterogeneous data but impractical for massive query processing in database style since properties of a given item are scattered over many triples and costly joins are required to put them together. In (160, 117) we have defined the Semantic Web data storage optimization

problem as a search problem, characterized the corresponding search space, and proposed powerful algorithms capable of recommending highly efficient RDF stores consisting of sets of materialized, conjunctive views over the RDF data. The recommended views can be stored as relational tables and we demonstrate gains of up to four orders of magnitude in query processing performance based on our recommended store, with respect to the state-of-the-art method of storing RDF data in relational databases.

A second source of inefficiency in RDF query processing comes from the difficulty in handling implicit data, that is, RDF triple whose presence in the database is due to reasoning on the explicit data based on RDF semantic rules. We have proposed in (289, 162) the novel Database fragment of RDF, strictly more expressive than the well-studied Description Logics (DL) fragment previously investigated in the literature, and studied query answering for this database fragment both through reformulation (where we introduced novel algorithms) and through database saturation. Our algorithms have all been implemented based on conjunctive relational queries handled to a relational database engine, leading to an efficient solution for answering RDF queries of our expressive database fragment, using relational database management systems.

Large-scale analytical processing of data in order to aggregate it and search for interesting pattern requires data analytics models, tools and algorithms, akin to those provided by relational data warehouses to relational databases. Designing an RDF equivalent of the relational data warehouse processing chain, however, is challenging, given the heterogeneity of RDF data, where facts can be characterized by different sets of dimensions (thus, a simple relational cube built on top of an RDF database would have very numerous empty cells). In (188), we have proposed a complete analytics framework for RDF data analytics, including RDF analytical schemas, aggregation queries (cubes), and demonstrated its performance opportunities through a complete prototype implementation.

The increasing availability of semantic analysis and semantic annotation tools, coupled with the development of many useful domain ontologies for a variety of areas, allows attaching meaning to structured and unstructured datasets, under the form of: relevance to a given concept from an ontology, connection with another data fragment, endorsement by a specific user or organization etc. Indeed, semantic annotations may be seen as a flexible means of semantically integrating existing heterogeneous datasets. In (236, 190), we have defined XR, a data model for XML document with RDF annotations, as a first incarnation of the concept of structured Web data with semantic annotations, and introduced an associate simple query language. In (116) we have shown how to build an XR query evaluation engine by capitalizing upon existing data management engines for XML, on one hand, and for RDF on the other hand. We illustrated the interest of XR as a platform for exchanging annotated documents in (159) on a fact-checking scenario inspired from the recent progress in Web-based journalism: XR is used to build, enrich and connect a repository of facts connected to their sources, which are Web (XML) documents, facilitating the tasks of journalists which check new content against the existing accumulated news stories and known facts.

Reasoning over Distributed Systems

Reasoning in Peer-to-Peer Inference Systems

P2P inference systems (P2PIS) are networks of autonomous agents (peers), where each peer models its application domain using a knowledge base (KB) and where those having similar interests can establish semantic correspondences between their KBs called mappings. The challenge in P2PIS is to design algorithms that reduce an inference task to a decentralized calculus among the peers, while none of them has a comprehensive view of the global KB.

Pioneering work initiated in the group with the SOMEWHERE framework has been pursued and extended in several ways. A complete reengineering of the SOMEWHERE platform, for decentralized consequence finding, (with or without inconsistencies) has been undertaken within the DISQuE project, resulting in a much more robust and modular implementation. A new tool GEXTOOLS has also been developed, in order to facilitate experimentations through the automated deployment of large scale instances on a grid. It can also be used for automating integration tests during further developments.

In contrast with SOMEWHERE, in which mappings are considered as *undirected*, we proposed an alternative approach for P2PISs in which mappings are *directed* (181). Such P2PISs are of great interest because

they can model many real applications in which autonomous components communicate through interfaces.

We proposed a Bayesian approach based on user feedbacks, in order to assess the trust that a user may have into answers depending on quality of their semantic annotations (293, 253).

The notion of non conservative extension of a knowledge base is important in the setting of P2PIS. It is useful for a peer to detect/prevent that a P2PIS corrupts (part of) its knowledge or to learn more about its own application domain from the P2PIS. It has connections with the privacy of a peer within a P2PIS and with the quality of service provided by a P2PIS. We have studied both the theoretical and decentralized algorithmic perspectives the problem of deciding whether a P2PIS is a conservative extension of a given peer and how to compute the witnesses to the corruption of a given peer's KB within a P2PIS (206, 182, 127).

We investigated a decentralized data model and associated algorithms for peer data management systems (PDMs) based on the DL-LITE_R description logic (138, 183). That logic is a fragment of the forthcoming W3C recommendation for the Semantic Web: OWL2. Our approach relies on reducing query reformulation and consistency checking for DL-LITE_R into reasoning in propositional logic. This enables a straightforward deployment of DL-LITE_R PDMs on top of SomeWhere. We have also shown how to answer queries using views (i.e. predefined queries) in DL-LITE_R in the centralized and decentralized cases, by combining the query reformulation algorithm of DL-LITE_R and the state-of-the-art query rewriting algorithm: MiniCon.

We were interested in the problem of discovering mappings between distributed ontologies in the setting of the MediaD project, applied to the PDMS SomeRDFS. Various peer strategies and filtering methods have been applied to focus on the most relevant mapping candidates (287), (157). We investigated alignment techniques suitable to this decentralized context and we investigated a methodology to help validating discovered mappings. All these propositions have been implemented in SpyWhere (332).

In another line of work (139), we proposed a Datalog-style rule-based language for distributed data management. A novel feature of our language is *delegation*, that is, the possibility of installing a rule at another peer. We studied the impact on expressiveness of delegations and explicit timestamps, showing that both strictly augment the power of the language. To validate the semantics, we proved that under certain natural conditions, our semantics converges to the same semantics as the centralized system with the same rules. Some first results concerning extensions to allow for contradictions and uncertainty were presented in (219).

Distributed Diagnosis and distributed diagnosability

The new research axis on consistency-based distributed diagnosis and on diagnosability analysis (mainly also in a distributed framework), initiated in 2007, pursued up to now along three main research directions.

Consistency-based logical distributed diagnosis is set up in the framework of propositional P2PIS, with privacy constraints about the local theory of each peer. Minimal diagnoses are obtained by a distributed algorithm computing directly prime implicants of the global theory (that is never built) along a dynamically built covering tree of the peers involved. Systems that guarantee a sound distributed diagnosis are characterized in terms of graphs and a new tree decomposition algorithm preserving privacy is proposed, based on local elections and token transmission. Experimental analysis on small worlds networks families show that the join trees produced are better than the state of the art of distributed algorithms (210, 211, 146, 330, 147, 209).

The work devoted to *monitoring and on line diagnosis of composite Web services* and more generally of large distributed software systems has been conducted in both automata and Petri nets frameworks. In the first case the Web service described in BPEL language is modeled by communicating automata formally expressing the semantics of the activities of BPEL as well as the topology and variables dependencies of the process. The abductive diagnosis triggered by an exception rise is done by a causal analysis from the possible trajectories consistent with observations, obtained from the synchronized product of the process automaton by the observations automaton (137). In the second case colored Petri nets are used to model both activities and data flows of a BPEL Web service as well as their possible faults. The diagnosis is obtained by solving, in backward chaining from symptoms, a system of algebraic linear inequalities obtained from the marking evolution equation of the network. The whole procedure is fully automated (269, 304, 246, 247, 248, 337).

The aim of *diagnosability analysis* in design stage is to formally prove, from a model of a partially observable system with a given set of possible faults, that any fault will be detectable and identifiable without ambiguity in a finite time after its occurrence. Several contributions were done these past six years on diagnosability analysis of discrete-event systems.

Probabilistic diagnosability analysis was studied when information about probability of events occurrence is available in the form of a probabilistic automaton. System dynamics is modeled by a Markov chain, from which an asymptotic analysis is done, very useful to provide a qualification of the non-diagnosability degree (169).

In order to reduce state space explosion, a first approach (131) uses *Petri nets* modeling and *unfolding* techniques to represent all executions, with a partial order semantics, in the compact form of the minimal prefixes of an unfolding and provides diagnosability checking algorithms. A second approach (224) uses *input output symbolic transition systems* modeling and adapts the twin plant method to the symbolic case by using a symbolic model checker.

Relationships between *observability* and diagnosability were studied and algorithms to reach an optimal observability for diagnosability were developed (228, 227).

The main focus of our work on diagnosability analysis is about *distributed diagnosability*, where the system is modeled as a set of (event-)labeled automata sharing some communication events (345). Algorithms for distributed checking of diagnosability have been defined, implemented and tested when observations are supposed to be global (centralized) (178, 271). They have been extended to distributed pattern diagnosability where single fault event is replaced by a surveillance pattern represented by a regular language (268, 276, 277, 270, 273, 274). Then the case where observations themselves are local, i.e. distributed, has been considered and a definition of cooperative diagnosability has been provided. Deciding it has been proved undecidable when communication events are not observable, before proposing an algorithm to test a sufficient condition. Decidability result and algorithm have been given when communications are observable (272, 275).

A generalization of diagnosability has been proposed for *open systems*, i.e. systems that are partially controllable from the environment. Game structure has been used to define *active diagnosability* and Alternating-time Temporal Logic has been used to check it (250). This applies not only to one system and its environment but also to a set of interacting systems.

More applied research on *embedded diagnosis of distributed functions* in hardware/software architecture inside vehicles was led in the framework of the DIAFORE ("DIAGnostic de FONctions REparties") ADEME/ANR/PREDIT project (262, 251, 216).

Another work was led in the framework of a CIFRE thesis with Sherpa Engineering with the objective of making a bridge between off-line diagnosability analysis and on-line embedded diagnosis (234, 286, 217).

Sat Solving

The team is also involved in the practical solving of SAT problems (303, 343). Laurent Simon was first involved in the organization of SAT Competitions until 2009 (119). In parallel, he tried to understand why SAT solvers were so efficient in practice (149). This first study allowed him, with G. Audemard (Lens, CRIL) to propose a new way of measuring the importance of learnt clauses. This measure, which is nowadays considered as one of the essential ingredients of any SAT solver, led to the award-winning solver Glucose (150, 151, 148, 215). Glucose is one of the few SAT solvers that won gold medals at the SAT competition at 4 distinct events. It is distributed via the LRI web site.

More recently, the power of Glucose was adapted to the incremental SAT solving case, which is of first importance in many industrial problems (including optimization problems) (148, 213). We also tried to increase the power of SAT solvers, by proposing the basis of learning mechanisms for polynomials in GF(2) (instead of propositional logic) (165, 173).

At last, it is important to mention the constant effort in trying to analyse and understand some of the reasons for the incredible efficiency of SAT solvers. In (214, 174), the structure of industrial problems is analyzed w.r.t. some essential components of modern SAT Solvers.

6/ IASI Team

Collaborations

Participation to national and international collaborative research projects

International Projects

- ConnectedClouds: Clouds for Connected Cities, EIT ICT Labs KIC, Coordinator: D. Zeghlache (Telecom SudParis), Main partners: LRI-University of Paris-Sud (France), INRIA Saclay Île-de-France (Leo team), Telecom SudParis, TU Berlin (Germany).
- DataBridges: Data Integration for Digital Cities, EIT ICT Labs KIC, Coordinator: I. Manolescu (INRIA Saclay Île-de-France), Partners: LRI-University of Paris-Sud (France), INRIA Saclay Île-de-France (Leo team - France), DFKI (Germany), TU Delft (The Netherlands), Aalto University (Finland), KTH (Sweden), Alcatel-Lucent (France), DataPublica (France).
- DATE, STIC-AmSud project, Coordinator: CNRS (France), Partners: LRI-University of Paris-Sud (France), MYNCIT (Argentina), CONYCIT (Chile).
- DynaMO, FNR Luxembourg, Coordinator: C. Pruski (CR SANTEC Luxembourg) Partners: CR SANTEC (Luxembourg), LRI-University of Paris-Sud (France).
- WS-DIAMOND, FP6 European project (FET Open Strep), Coordinator: L. Console (University of Turin), Partners: University of Turin (Italy), Polytechnic University of Milan (Italy), Vrije University of Amsterdam (The Netherlands), University of Vienna (Austria), University of Klagenfurt (Austria), LAAS-CNRS (France), University of Rennes 1 (France), LRI-University of Paris-Sud (France).

National Projects

- BR4CP, ANR Blanc project, Coordinator: H. Fargier (University of Toulouse), Partners: University of Toulouse (IRIT), University of Artois (CRIL), University of Montpellier (LIRMM), Cameleon, IBM-ILOG, Renault. L. Simon is a member of this project (via the CRIL) but LRI-University of Paris-Sud is not a partner. This project deals with models and algorithms for recommendation and preference management in product configuration.
- CODEX, ANR Domaines Emergents project, Coordinator: I. Manolescu (INRIA Saclay Île-de-France), Partners: INRIA Saclay Île-de-France (Leo team), LRI-University of Paris-Sud, INRIA Lille (Mostrare team), INRIA Grenoble (WAM team), University of Tours (LIB), University of Paris 7 (PPS), Innovimax SARL.
- ConnectedClouds, ANR project, Coordinator: D. Colazzo (LRI-University of Paris-Sud) Partners: LRI-University of Paris-Sud (France), INRIA Saclay Île-de-France (Leo team).
- DataBridges: Data Integration for Digital Cities, ANR project, Coordinator: I. Manolescu (INRIA Saclay Île-de-France), Partners: LRI-University of Paris-Sud (France), INRIA Saclay Île-de-France (Leo team).
- Datarling, ANR Domaines Emergents project, Coordinator: P. Valduriez (INRIA Sophia-Antipolis - Zenith team), Partners: University of Grenoble (LIG), Telecom ParisTech, INRIA Sophia-Antipolis (Zenith team), LRI-University of Paris-Sud.
- DIAFORE, ANR PREDIT project, Coordinator: O. Heron (CEA LIST), Partners: CEA LIST, Renault Trucks (Volvo group), Serma Ingénierie, UTC and LRI-University of Paris-Sud.
- DocFlow, ANR Masses de données project, Coordinator: A. Benveniste (University of Bordeaux), Partners: INRIA-Rennes (Distribcom), University of Bordeaux (LABRI).
- DW4RDF, Digiteo DIM project, Coordinator: F. Goasdoué (LRI-University of Paris-Sud), Partners: LRI-University of Paris-Sud, INRIA Saclay Île-de-France.
- EDIFlow, Digiteo project, Coordinator: I. Manolescu-Goujot (INRIA Saclay Île-de-France), Partners: INRIA Saclay Île-de-France (Leo and Aviz teams), LRI-University of Paris-Sud.
- GEONTO, ANR MDCO project, Coordinator: C. Reynaud (LRI-University of Paris-Sud), Partners: LRI-University of Paris-Sud, IGN (COGIT), University of Toulouse III (IRIT), University of Pau (LIUPPA).
- PAGODA, ANR JCJC project, Coordinator: M. Bienvenu (LRI-University of Paris-Sud), Partners: LRI-University of Paris-Sud, University of Grenoble (LIG), University of Montpellier (LIRMM), University Hospital of Grenoble (LJK and Anatomy laboratories).
- PIMI, ANR VERSO project, Coordinator: O. Nicolas (Genigraph), Partners: Genigraph, Institut Telecom Sud Paris, Montimage, LRI-University of Paris-Sud, INRIA, University of Toulouse III (IRIT).
- QUALINCA, ANR CONTINT project, Coordinator: M. Leclère (University of Montpellier), Partners: University of Montpellier (LIRMM), LRI-University of Paris-Sud, University of Grenoble (LIG), ABES, INA.
- SHIRI, Digiteo project, Coordinator: N. Pernelle (LRI-University of Paris-Sud), Partners: LRI-University of Paris Sud, Sup-elec.
- UNLOC, ANR Blanc project, Coordinator: L. Simon (LRI-University of Paris-Sud), Partners: LRI-University of Paris-Sud, University of Artois (CRIL), University of Amiens, University of Marseille (LSIS).
- WebStand, ANR JCJC project, Coordinator: B. Nguyen (University of Versailles), Partners: University of Versailles (PRISM), LRI-University of Paris-Sud, INRIA Saclay Île-de-France (Leo team), Télécom ParisTech, University of the Méditerranée, University of Paris-Dauphine.
- DataPublica, industrial project, Coordinator: I. Manolescu (INRIA Saclay Île-de-France), Partners: DataPublica (Paris), INRIA Saclay Île-de-France (Leo team), INRIA Sophia-Antipolis (Zenith team).
- HEDI, industrial project, Coordinators: N. Pernelle and F. Saïs (INRIA Saclay Île-de-France) Partners: INRIA Saclay Île-de-France, LRI-University of Paris-Sud, Thales Corporate Services.

- MEDIAD, industrial project, Coordinator: F. Goasdoué (LRI-University of Paris-Sud) Partners: LRI-University of Paris-Sud, France Télécom R&D Rennes.
- PICSEL3, industrial project, Coordinator: M.-C. Rousset (LRI-University of Paris-Sud) Partners: LRI-University of Paris-Sud, France Télécom R&D Rennes.
- PossiblePasts, industrial project, Partners: INRIA Saclay Île-de-France, ThinkStraight.
- SHERPA, CIFRE project, Partners: LRI-University of Paris-Sud, SHERPA Engineering, CEA-LIST (LISE)
- SIRASAS, FRAE project, Coordinator: A. Zolghadri (University of Bordeaux), Partners: University of Bordeaux (IMS), ENS Cachan, CNRS LAAS, LRI-University of Paris-Sud), CNES Toulouse, Airbus France Toulouse, Thales Alenia.

Collaborations with other laboratories

- G. Audemard, University of Artois (CRIL): SAT Solvers, Incremental SAT Solving (149, 214, 214, 150, 173, 263, 151, 215, 213)
- N. Aussenac, University of Toulouse III: co-author of the chapter "Knowledge Engineering" in the book "Panorama de l'Intelligence Artificielle" - Construction of an ontology in the geographic domain in the settings of the GEONTO project (204, 135, 298)
- N. Bennacer, Supélec Gif-sur-Yvette: co-supervision of two PhD students on semantic annotation of heterogeneous documents (266, 292, 267, 344, 168, 203, 340, 167, 202)
- O. Benjelloun, Google Research (USA): Active XML (114, 297)
- A. Bonifati, CNR Italy (Italy): Static analysis for XML query optimization - Maintenance of XML views (156)
- Y. Bourda, F. Popineau, Supélec Gif-sur-Yvette: co-supervision of three PhD students on adaptive Hypermedia Systems (180, 179, 280, 278, 205, 279, 328, 327, 125)
- P. Buche, INRA Montpellier (IATE JRU): co-supervision of a master internship on duplicate detection in data tables (41, 46)
- J. Charlet, INSERM: co-author of the chapter "Semantic Web take-off in an Industry perspective" in the book "Semantic Web for Business: Cases and Applications and co-author of the chapter "Knowledge Engineering" in the book "Panorama de l'Intelligence Artificielle" (308, 298)
- J. Dibia-Barthélemy, AgroParisTech: co-supervision of a master internship on duplicate detection in data tables (41, 46)
- N. Guelfi, University of Luxembourg: co-supervisor of the PhD thesis of C. Pruski in co-tutelle with Paris-Sud University: TARGET for optimal Adaptive information management over the web (306, 342, 237, 123)
- M. Lo, Gaston Berger University (Sénégal): co-supervisor of the PhD thesis of M. Thiam in co-tutelle with Paris-Sud University on integration of semi-structured data for information retrieval (267, 344)
- C. Lutz, University of Bremen (Germany): query answering in description logics (154, 219, 155)
- C.-M. Li, University of Amiens: Minimizing SAT in (175, 126, 245)
- T. Melliti, University of Evry-Val d'Essonne (IBISC): colored Petri nets modeling and diagnosis of composite web services, game structure based diagnosability of open discrete-event systems (246, 247, 248, 250)
- T. Milo, Tel Aviv University (Israel): Active XML (114, 297, 143).
- S. Mustière, N. Abadie, IGN (COGIT): Geographic ontology merge and enrichment (204, 322, 135)
- P. Poizat, University of Paris X-Nanterre: co-supervision of a PhD student on Personal Information spaces and Data-Flow Oriented Service Composition (42, 66)
- N. Polyzotis, UC Santa Cruz (USA), XML indexing in P2P and Webdam project (121, 128, 143, 285)
- C. Pruski, M. Da Silveira, CR SANTEC (Luxembourg), Project DYNAMO on Evolution of Medical Knowledge Organizing Systems, co-supervision of the PhD thesis of J. Dos Reis (231, 232, 233)
- M.-C. Rousset, University of Grenoble (LIG), co-training of a PhD thesis on a probabilistic trust model for semantic P2P systems (253, 293), Reference reconciliation (124, 310, 259), Decentralized data model and algorithms for peer data management systems and module-based data management (138, 183, 193, 118), Distributed Datalog (207)
- H. Soldano, University of Paris XIII (LIPN): Concept lattices (176, 225, 226)
- D. Sonntag, DFKI (Germany), Faceted search for Digital Cities in the settings of the Databridges project (258, 295)
- R. Thomopoulos, S. Destercke, INRA Institute of Montpellier (IATE): possibilistic reference fusion (172, 260)
- V. Vassalos, Athens University of Management and Business (Greece): Materialized XML views: rewriting and view recommendation - a chapter in the Springer Encyclopedia of Database Systems co-published in 2009 (299, 309)
- V. Vianu, A. Deutsch, Y. Papakonstantinou, U.C.San Diego (USA): Active XML (145), XML tuple algebra (309), joint tutorial with I. Manolescu, A. Deutsch (UCSD) and V. Vassilos (Greece) in BDA 2010
- F. Wolter, University of Liverpool (UK): query answering in description logics (154, 219, 155)

Visiting Professors and students

- S. Amer-Yahia, Researcher, Yahoo Research, 2009 - 1 month
- A. Bonifati, Researcher, CNR Italy, 2009 - 1.5 months and 2010 - 1 month
- A. Marian, Assistant Professor at Rutgers University, USA, 2008 - 1 month, 2009 - 2 months

- T. Milo, Professor at the University of Tel-Aviv, 2008 - 1 month
- Y. Papakonstantinou, Associate Professor, UCSD, USA, 2009 - 1 month and 2010 - 2 weeks
- N. Polyzotis, Assistant Professor at the University of Southern California, USA, 2008 - 1 month and 2009 - 1 month
- P. Rigaux, Professor at Paris 9, 2009 -12 months
- M.-C. Rousset, Professor at the University of Grenoble, 2009 -12 months
- D. Theodoratos, Professor at New Jersey Institute of Science and Technology, USA, 2009 -1 month
- V. Vianu, Professor at UC San Diego, 2008 - 6 months; The visit was joint with the Dahu INRIA group in Cachan
- Y. Yan, Associate Professor at Concordia University, Canada, 2008- 1 month, 2009 -1.5 months, 2010 - 2 months
- F. Bugiotti, PhD student, 2011 - 4 months
- M. Goodfellow, PhD student, 2009 - 6,5 months, (15/10/2009, 30/04/2010)
- D. Sileo, PhD student, 2010 - 6 months
- M. Sileo, PhD student, 2009/2010 - 6,5 months
- D. Trivela, PhD student, 2012/2013 - 7 months

Other Collaborations

- J. Falcou, LRI, PARALL group: massive parallelization of SAT solvers
- C. Froidevaux, LRI, Bioinformatics group: Reasoning for biological networks
- S. Perez, LRI, Bioinformatics group: Metabolic Network Analysis by SAT solvers
- F. Zaïdi, LRI, ForTesSE group: Formal Analysis of Diagnosability and Testability in Distributed and Concurrent Systems modeled with Label Transition Systems and Petri Nets
- M. Atencia University of Grenoble (LIG), J. David, INRIA Rhone-Alpes (EXMO team): Key constraints for data linking
- N. Aussenac, N. Hernandez, M. Kamel: University of Toulouse (IRIT): Improvement in Knowledge Acquisition/Extraction from texts
- U. Berdugo, Z. Sellami, Wepingo start-up: Data extraction for automatic populating of an ontology
- M. Chein, M. Leclerc, M. Croitoru, F. Scharffe, University of Montpellier (LIRMM): Data quality
- P. Courounet, INA institute (Institut National de l'Audiovisuel): Data quality in large catalogs
- A. Cristea, University of Warwick (UK): Adaptive Hypermedia - N. Zemirline was visiting student in the IAS group coordinated by A. Cristea (two visits of one month each)
- A. Doucet, S. Gancarsky, UPMC (LIP6): Event oriented detection and intelligent web archiving
- J. Euzenat, INRIA Rhone-Alpes (Exmo team): Ontology Matching
- D. Frey IRISA/INRIA Rennes: Distributed and secure data reconciliation
- G. Gottlob, University of Oxford (UK): S. Abiteboul was Visiting Fellow at Sainte-Anne's College in winter 2008
- K. Inoué, NII (Japan): A two days workshop was organized at Gemo in September 2009 with the research group of K. Inoué. Both P. Dague and K. Inoué were invited at the JST-ANR French Japanese workshop in the field of Information and Communication Science and technology organized by ANR at Paris in November 2009. K. Inoué and a selection of Japanese Researchers have visited the IAS and BioInfo teams in September 2010, October 2011 and November 2012.
- Y. Nicolas, ABES (Agence Bibliographique de l'enseignement Supérieur): Data quality in large catalogs
- F. Paulus, Semsoft Corporation: Data integration
- E. Rahm, M. Hartung: University of Leipzig (Germany), Propagation of the evolution on KOS to semantic annotations attached to medical documents
- S. Si-said Cherfi, F. Hamdi, CNAM Paris (CEDRIC): Sensitive data protection in the context of open data

Participation to national and international networks

- HYCON2 FP7 Network of Excellence: Philippe Dague is involved more particularly in the following work packages: Analysis of complex systems, System-wide coordination and control, Self-organizing systems and control, for the tasks of distributed diagnosis and distributed diagnosability analysis, 2010-2014.
- MIA network: this network is supported by the INRA Institute. The aim is to share methods and tools that are developed for data integration in the domain of life/environmental science.

Participation to “investissement d’avenir” program

- The group took part in the Labex DigiCosme proposal. P. Dague, head of the LRI, was the coordinator for LRI. The IASI group participates to the action line DataSense: Making sense of complex, heterogeneous data (task 2) and P. Dague to the action line SCILEX: Continuous and discrete systems: models and verification (task 2).
- The XR Social Search project common with the BD group and including F. Goasdoué as a member, has been accepted in the DigiCosme 2013 call.

6/ IASI Team

Volunteer Professional Service

Management Positions in Scientific Organisations

- University of Paris-Sud, Faculté des Sciences: P. Chatalic, elected member of Conseil d’UFR (2008-2011)
- University of Paris-Sud, Département d’Informatique: P. Chatalic, vice-President Finances & Infrastructures (2009-2012)
- University of Paris-Sud: P. Chatalic, elected member of "Commission de Spécialistes" and CCSU Informatique and of Assistant Professor Selection Committee (2008-2010)
- Digeo cluster: P. Dague, representative of LRI at the program committee (January 2008 - May 2010) and representative of Université Paris-Sud at the steering committee (from June 2010)
- IFIPS engineer school of Paris-Sud: P. Dague, director of the computer science department, elected member of the conseil d’administration, nominated member of the conseil de direction and conseil de perfectionnement (up to end of 2009)
- LRI: P. Dague, deputy director and elected member of the laboratory council (up to end of 2009) and director (from beginning of 2010)
- Polytech Paris-Sud engineer school: P. Dague, representative of LRI at the conseil de perfectionnement (from April 2011)
- University of Paris-Sud: P. Dague, member of "Commission de Spécialistes" for IFIPS (2007 and 2008) and CCSU Informatique (from 2009)
- University of Paris-Sud, Ecole Doctorale EDIPS: P. Dague, F. Goasdoué, member of the council (from 2013)
- University of Paris-Sud, Faculté des Sciences: P. Dague, elected member of Conseil de la Recherche d’UFR (from end of 2008)
- University of Evry: F. Goasdoué, external member of a selection committee in 2012
- INRIA Saclay Île de France: I. Manolescu, head of the Gemo (2008-2009) and Leo (2010-2012) teams
- INRIA Saclay Île de France: I. Manolescu, Elected representative in the local INRIA Saclay personnel committee (2008-2009)
- INRIA Saclay Île de France: I. Manolescu, member of the Inria Commission de Développement Technologique (CDT) (2008-2012)
- INRIA Saclay Île de France: I. Manolescu, member of the Inria Working Group *Actions Incitatives* (GTAI) (2008-2010)
- University of Paris 5: I. Manolescu, member of the selection committee for an Assistant Professor position (2010), member of the selection committee for a Full Professor position Université Paris 10 (2012)
- LRI: N. Pernelle member of "Commission de Spécialistes" and "CCSU Informatique", member of selection committees in University of Paris-Sud from 2009 and in external universities (Caen in 2009, University of Paris XIII (LIPN) in 2012)
- LRI: N. Pernelle, elected member of the laboratory council (2001-2009)
- University of Paris-Sud, IUT de Sceaux: N. Pernelle, elected member of the Conseil d’IUT (2002-2006 and from 2012)
- INRIA Saclay Île-de-France: C. Reynaud, co-manager of the Leo team (from 01/01/2010 to 31/03/2012)
- LRI: C. Reynaud, head of the IASI team (from 2005)
- LRI: C. Reynaud, elected member of the laboratory council (2001-2005 and from 2010)
- University of Paris-Sud: C. Reynaud, member of "Commission de Spécialistes" and "CCSU Informatique", member of selection committees at University of Paris-Sud from 2009 to 2013 (Chair in 2009 et 2010) and in external universities (Angers in 2009, UPMC (LIP6) from 2009 to 2011, University of Lyon (LIRIS) in 2011, AgroParisTech in 2012 (chair), University of Paris XIII (LIPN) in 2013)
- Cemagref: F. Saïs, member of selection committee in 2011
- University of Lyon (LIRIS): F. Saïs, external member of selection committee in 2010
- LRI: B. Safar, elected member of the laboratory council (from January 2010)
- University of Paris X: B. Safar, member of "Commission de Spécialistes" (2008)
- University of Paris-Sud - IFIPS: L. Simon, member of "Commission de Spécialistes mixte" in 2008, member of "Commission de Spécialistes" at Université of Provence (2008) and member of a selection committee at Université of Artois - Lens (2009)

Organisation of Conferences and Scientific Events

- DL, *International Workshop on Description Logics*, 2009-2012: M. Bienvenu - steering committee member.
- EvalECD, Évaluation des méthodes d'Extraction des Connaissances dans les Données - EGC workshop, 2009-2011: F. Saïs, co-chair.
- OntoGeo workshop, *Workshop on geographic ontologies in conjunction to SAGEO*, Toulouse, 2010: C. Reynaud - program chair.
- SAT, *Fourteenth International Conference on Theory and Applications of Satisfiability Testing*, Ann Arbor (USA), 2011: L. Simon, co-chair (organization).
- SAT, *SAT Conference*, Swansea Wales (UK), 2009: L. Simon, SAT Competition co-chair
- SOS-DLWD, des Sources Ouvertes au Web de Données - EGC workshop, Bordeaux, 2012: N. Pernelle, F. Saïs, co-chairs
- SOS-DLWD, des Sources Ouvertes au Web de Données - PFIA workshop, Lille, 2013: F. Saïs, co-chair

Working Groups

- working group "Data and knowledge management" (FET-Flagship proposal "The Social Computer - Internet-Scale Human problem solving"), I. Manolescu, 2010

6/ IASI Team

Honors

Prizes and Awards

- N. Bennacer, Y. Mrabet, N. Pernelle, Mouhamadou Thiam *Poster Award at Digiteo Forum*, 2011.
- F. Hamdi, B. Safar, H. Zargayouna, C. Reynaud, *EGC Application Award*, 2009.
- L. Simon, *First prize at the international SAT competition*, industrial UNSAT category in 2009, Application SAT+UNSAT category in 2011, SAT Challenge in 2012, Application certified UNSAT category in 2013.
- F. Suchanek, *Best Demo Award at the 2011 WWW Conference*, 2011.

Keynote Addresses

International

- S. Abiteboul, *Time'09*, 2009: The AXML Artifact Model
- I. Manolescu, *Stanford University database group seminary*, 2008: XML Access Modules: Towards Physical Independence in XML Databases
- I. Manolescu, *XSym/DBLP workshops in conjunction with VLDB*, 2009: XML processing in DHT networks
- I. Manolescu, *Masses de Données summer school*, 2010: ViP2P: XML Views in Peer-to-peer
- I. Manolescu, *International Workshop on Data Engineering Meets the semantic Web (DeSWeb) in conjunction with IEEE ICDE*, 2011: Warehousing Web Data
- C. Reynaud, *First Business Objects ARC Workshop*, 2008: Ontology-based Semantic Integration
- L. Simon, *NII, Japan*, 2011: Towards a new era of SAT solvers
- L. Simon, *Ecrypt II Summer School*, 2012: Past and Future of efficient SAT solvers

France

- M. Bienvenu, *Journées nationales de l'IA Fondamentale (IAF)*, 2011: Reasonner en présence d'ontologies
- I. Manolescu, *D'Alembert Interdisciplinary Seminar*, 2012: The Web in the Era of Linked Data: Toward the Universal Database

- I. Manolescu, *Digiteo Forum*, 2011: Linked OpenData: Scientific Challenges and Applications
- C. Reynaud, *Journée Interopérabilité des systèmes, GIS ITEROP Grande Région*, 2010: Interopérabilité sémantique
- C. Reynaud, *Journée Web et médiation, Projet Web Intelligence Rhone-Alpes*, 2011: L'alignement d'ontologies nombreuses et hétérogènes
- C. Reynaud, *Rencontres chercheurs - Digiteo*, 2013: Retour d'expérience de la traçabilité des développements logiciels dans l'équipe IASI du LRI

Other Honors

- S. Abiteboul, *ERC Advanced Grant Webdam*, 2008.
- S. Abiteboul, *Elected to the Academie des Sciences*, 2008.

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Evaluation of Research

Editorial Boards

International

- ACM SIGMOD Record, ACM: I. Manolescu, 2010 editor in chief
- ACM Transactions on Internet Technology, ACM: I. Manolescu, 2010 Editorial Board
- Applied Ontology Journal, IOS Press: C. Reynaud, 2011, reading committee for special issue on *Ontologies and Terminologies: Continuum or Dichotomy*
- DKE, Data & Knowledge Engineering, Elsevier, Special Issue on Ontologies in Designing Advanced Information Systems: C. Reynaud and F. Saïs, 2009 reading committee
- IJMSO, International Journal of Metadata, Semantics and Ontologies, Springer: F. Saïs, 2012 Editorial Board
- Journal of Data Semantics, Springer: C. Reynaud, 2012, reading committee for special issue on *Evolution and Versioning in Semantic data Integration Systems*
- Journal of Information Systems, Elsevier: I. Manolescu, 2008, Guest editor of a special issue on Performance Evaluation in Database Systems
- JSAT, Journal on Satisfiability, IOS Press: L. Simon, 2008-2013 Editorial Board and Guest Editor of a Special Issue on Competitions and Evaluations
- Ontology Theory, Management and Design: Advanced Tools and Models (book), IGI Global: C. Reynaud, 2009, reading committee
- PVLDB, *The Proceedings of the VLDB Endowment*, VLDB Endowment: S. Abiteboul, Steering committee, 2008
- Search Computing Challenges and Directions (book), Springer: I. Manolescu, 2009, reading committee
- Semantic Web Methodologies for E-Business Applications: Ontologies, Processes and Management Practices (book), Idea Group Publishing: F. Goasdoué, 2009, reading committee
- Scalable Fuzzy Algorithms for Data Management and Analysis: Methods and Design (book), IGI Publishing: F. Saïs, 2010, member of the Editorial Advisory Board

National

- JEDAI, *Journal Electronique d'IA de l'AFIA*, C. Reynaud, 2008
- RI3, *Revue Information, Interaction, Intelligence*, Eyrolles: C. Reynaud, 2008 and 2009
- RNTI, *Revue des Nouvelles Technologies de l'Information*, Hermann: F. Saïs, 2011, Guest editor of a special issue on "Mesurer et évaluer la qualité des données et des connaissances"
- TSI, *Techniques et Science Informatique*, Hermès-Lavoisier: F. Goasdoué, 2009, Guest editor of a special issue on the Semantic Web

Program Committees

Chair

- ACM CIKM, *Conference on Information and Knowledge Management*, Napa Valley (USA): I. Manolescu, 2008, co-chair of the database track
- ACM SIGMOD, *ACM Special Interest Group on Management of Data*, Vancouver (Canada): I. Manolescu, 2008, Experiment Repeatability chair, Providence (Rhode Island, USA): I. Manolescu, 2009, Repeatability and Workability co-chair, Indianapolis (USA): I. Manolescu, 2010, Repeatability and Workability co-chair
- ECAI, *European Conference on Artificial Intelligence*, Patras (Greece): P. Dague, 2008, area chair
- Experiments, Applications and Systems track, *Track of the IEEE ICDE Conference*, Hannover (Germany): I. Manolescu, 2011, chair
- EDBT, *Extending Database Technology*, Nantes (France): I. Manolescu, 2008, demonstration chair, Lausanne (Switzerland): I. Manolescu, 2010, program chair
- EGC, *Conférence Francophone sur l'Extraction et la Gestion des Connaissances*, Toulouse (France), 2013, C. Reynaud, moderator
- ICDE, *International Conference on Data Engineering*, Hannover (Germany): S. Abiteboul, 2011, program chair, Long Beach, CA (USA): I. Manolescu, 2010, demo co-chair
- PIKM, *PhD Workshop on Information and Knowledge Management*, California (USA): F. Suchanek 2011, co-chair
- PLAN-X Workshop-POPL, *Programming Language Techniques for XML*, San Francisco: I. Manolescu, 2008, program committee co-chair
- RFIA, *Congrès Francophone sur la Reconnaissance des Formes et l'Intelligence Artificielle*, Amiens (France): C. Reynaud, 2008, member of the steering committee
- SAT, *Fourteenth International Conference on Theory and Applications of Satisfiability Testing*, Ann Arbor (USA): L. Simon, 2011, program co-chair
- VLDB, *Very Large Database*, Lyon (France): S. Abiteboul, 2009, general program chair
- WWW, *International World Wide Web Conference*, Madrid (Spain): I. Manolescu, 2009, Web Engineering track co-chair, Hyderabad (India): S. Abiteboul, 2011, track chair

Member (international events)

- AAAI, Association for the Advancement of Artificial Intelligence conference, San Francisco (USA): M. Bienvenu, 2011, L. Simon, 2011, Atlanta (USA), L. Simon 2010
- ACM CIKM, *Conference on Information and Knowledge Management*, Napa Valley (USA): I. Manolescu, 2008, Glasgow (Scotland): I. Manolescu, 2011
- ACM SIGMOD, *ACM Special Interest Group on Management of Data Conference*, Vancouver (Canada): I. Manolescu, 2008
- APWeb, Thirteenth Asia-Pacific Web Conference: I. Manolescu, 2011
- ECAI, European Conference on Artificial Intelligence, Patras (Greece): P. Dague, 2008, Montpellier (France): P. Dague, 2012, L. Simon, 2012
- ECDL, European Conference on Research and Advanced Technology for Digital Libraries: F. Goasdoué, 2010
- EDBT, *Extending Database Technology*, Nantes: I. Manolescu, 2008
- EKAW, International Conference on Knowledge Engineering and Knowledge Management - Knowledge Patterns: C. Reynaud, 2008, 2010 and 2012 (general conference and Doctoral Symposium)
- ESWC, Extended Semantic Web Conference: C. Reynaud, 2010 (Demonstration session and poster programme committee), 2011 (general conference), 2012 (general conference)
- ICDE, International Conference on Data Engineering: I. Manolescu, 2008
- ICTAI, IEEE International Conference on Tools with Artificial Intelligence: P. Chatalic, 2011, F. Goasdoué, 2010, 2011, 2012 and 2013
- ICWE, International Conference on Web Engineering: I. Manolescu, 2009 : PC member
- ICWIT, International Conference on Web and Information Technologies, Sidi Bel Abbès (Algeria), 2008, Sfax (Tunisia), 2009, Marrakech (Morocco), 2010, Sidi Bel Abbès (Algeria), 2012: C. Reynaud
- I-ESA12, International Conference on Interoperability for enterprises Systems and Applications, Valencia (Spain): C. Reynaud, 2012
- IJCAI, International Joint Conference on Artificial Intelligence, California (USA): F. Goasdoué, 2009, Barcelona (Spain): M. Bienvenu (senior PC), F. Goasdoué and L. Simon (senior PC), 2011, Beijing (China): M. Bienvenu, F. Goasdoué (senior PC) and L. Simon, 2013
- IMMM, International Conference on Advances in Information Mining and Management, Barcelona (Spain), 2011, Venice (Italy), 2012, Lisbon (Portugal), 2013: N. Pernelle
- KR, International Conference on the Principles of Knowledge Representation and Reasoning, Rome (Italy): M. Bienvenu, 2012
- MEDI, International Conference on Model and data Engineering, Obidos (Portugal): C. Reynaud, 2011 and Poitiers

- (France): C. Reynaud, 2012
- PODS, Principle of Database Systems, Vancouver (Canada): S. Abiteboul, 2008
- RR, International Conference on Web Reasoning and Rule Systems, Mannheim (Germany): M. Bienvenu 2013
- SAT, International Conference on Theory and Applications of Satisfiability Testing: L. Simon, 2012, 2011, 2010.
- SIIE, International Conference on Information Systems and Economic Intelligence, Djerba (Tunisia): N. Pernelle, 2012, F. Saïs, 2012
- VLDB, Very Large Dada Bases, Auckland (New Zealand): I. Manolescu, 2008
- WebTouch2, Track Modeling the Collaborative Web Knowledge Conference at the WETICE Conference, Toulouse (France): C. Reynaud, 2012
- WWW, World Wide Web Conference, Beijing (China): S. Abiteboul, 2008
- Dali, ICDE Workshop on Data Management through its Life Cycle: I. Manolescu, 2011
- DL, International Workshop on Description Logics: M. Bienvenu, 2011, 2012, 2013
- DX, International Workshop on Principles of Diagnosis: P. Dague, 2008-2012
- MEDES-SW, Student workshop of the ACM international conference on Management of Emergent Digital Ecosystems, Lyon (France): F. Saïs, 2009
- OAIS, International Workshop on Ontologies meet Advanced Information Systems: C. Reynaud, 2012
- OTM Academy, workshop for Ph.D. students: F. Saïs, 2012 and 2013
- OWLED, International Workshop on OWL: Experiences and Directions: M. Bienvenu, 2012, 2013
- PLAN-X Workshop-POPL, *Programming Language Techniques for XML*, San Francisco, 2008: I. Manolescu, general chair
- QR, International Workshop on Qualitative Reasoning: P. Dague, 2008, 2009, 2011, 2012
- RED, International Workshop on Resource Discovery: F. Saïs, 2011-2013, C. Reynaud 2009 and 2010
- SAS, IJCAI Workshop on Self and Autonomous Systems: reasoning and integration challenges: P. Dague, 2009
- WOD, 2nd International Workshop on Open Data: F. Goasdoué and C. Reynaud, 2013

Member (national events)

- BDA, Journées en Bases de Données Avancées: F. Goasdoué, 2010, 2012, I. Manolescu, 2008-2011
- COSI, Colloque sur L'Optimisation et les Systèmes d'Informations: F. Saïs, 2009-2012
- CNRIA, Colloque National sur la Recherche en Informatique et ses Applications: N. Pernelle 2011-2013
- EGC, Extraction et Gestion des Connaissances: C. Reynaud, 2008-2013, F. Saïs 2011-2013
- EGC-M, Conférence Maghrébine sur Extraction et Gestion des Connaissances: F. Saïs, 2011-2012
- IAF, Journées Nationales de l'Intelligence Artificielle Fondamentale: P. Dague, 2008-2013, L. Simon, 2008-2013
- IC, Journées Francophones d'Ingénierie des Connaissances: N. Pernelle 2012-2013, C. Reynaud, 2008-2013, F. Saïs 2011
- INFORSID, Congrès INFormatique des ORganisations et Systèmes d'Information et de Décision: C. Reynaud, 2011
- JFO, Journées Francophones sur les Ontologies: C. Reynaud, 2008-2011, B. Safar, 2008-2011
- JFPC, Journées Francophones de Programmation par Contraintes: P. Chatalic, 2008, 2009, L. Simon, 2012-2013.
- MFI, Modèles Formels de l'Interaction: P. Chatalic, 2009-2011
- RFIA, Reconnaissance des Formes et Intelligence Artificielle: P. Dague, 2008, 2010, 2012, F. Goasdoué, 2008, 2010 C. Reynaud, 2008, 2009, 2010, 2012
- CO, Atelier Construction d'Ontologies : vers un guide de bonnes pratiques - Plate-forme AFIA: C. Reynaud, 2009
- COTation des Informations : Théorie et Applications, workshop collocated with IC 2011: F. Saïs, 2011 .
- EvalECD, Evaluation des méthodes d'Extraction des Connaissances dans les Données - EGC Workshop: N. Pernelle, 2009-2011 C. Reynaud, 2009, 2011
- Ingénierie des Connaissances pour l'interopérabilité sémantique dans les applications de e-santé - IC Workshop: C. Reynaud, 2012
- Modélisation des connaissances and Mesures de similarité sémantique - EGC workshop: C. Reynaud
- OJD, Ontologies et Jeux de Données pour évaluer le web sémantique - EGC workshop: N. Pernelle, 2012
- QDC, Qualité des Données et des Connaissances - EGC Workshop: N. Pernelle, 2009-2011, C. Reynaud, 2009-2011, F. Saïs, 2009-2011
- QetR, Qualité et Robustesse dans le Web de Données, IC workshop: F. Saïs 2011-2013.
- SOS-DLWD, des Sources Ouvertes au Web de Données - EGC/IC workshop: N. Pernelle, 2012-2013, C. Reynaud, 2012, F. Saïs, 2012-2013, B. Safar, 2012-2013
- WS, Web Social - EGC workshop: N. Pernelle, 2010-2011, F. Saïs, 2010-2011

Evaluation Committees and Invited Expertise

National

- AERES, Univ. Lyon, LIRIS evaluation committee: C. Reynaud, 2010
- AERES, Univ. Rennes 1, Research unit U936 (Modélisation conceptuelle des connaissances biomédicales) evaluation committee: C. Reynaud, 2010
- ANR ARPEGE (Systèmes Embarqués et Grandes Infrastructures) evaluation committee: P. Dague, 2008, 2009
- ANR Blanc (non thematic) evaluation committee: C. Reynaud, 2008, 2010, 2011, 2012
- ANR Blanc (non thematic) and Jeunes Chercheurs Jeunes Chercheuses (JCJC) evaluation committee: P. Dague, 2009
- ANR Jeunes Chercheurs Jeunes Chercheuses (JCJC SIMI 2) evaluation committee: N. Pernelle, C. Reynaud, 2010 and 2013, F. Saïs, 2013
- ANR CONTINT (Systèmes Embarqués et Grandes Infrastructures) evaluation committee: C. Reynaud, 2009, 2010, 2013
- ANR RIAM evaluation committee: C. Reynaud, 2010
- ANR Technologies Logicielles evaluation committee: C. Reynaud, 2008
- CAPERS-COPECUB (Cosinus) evaluation committee: C. Reynaud, 2009

Other evaluation activities

- ANR, invited expertise: F. Goasdoué 2010-2013
- Member of the CEI evaluation committee (Engineers evaluation) of the INRA Institute: N. Pernelle, 2013
- Evaluation of a CIFRE PhD project: F. Goasdoué, 2008, 2013, C. Reynaud, 2008, 2009, 2012
- CPER (Contrat de Projets Etat-Region), Conseil Régional Midi-Pyrénées, invited expertise: N. Pernelle, 2008
- ERC, invited expertise (FP7, starting grant): F. Goasdoué 2010, 2013

6/ IASI Team

Interactions with the social, economic and cultural environment

Popularisation of Research Results

- article *La gestion de données pair-à-pair*, in *La Recherche*, 2008, S. Abiteboul
- article *Le Web malin de demain*, in *La science c'est fun!*, Okapi et Bayard Jeunesse, 2008, S. Abiteboul
- talk *Le Web Nouvelle génération*, at conference organized by La Recherche at CNAM, 2008, S. Abiteboul
- article *Les réseaux sociaux*, in *Les Entretiens du Nouveau Monde Industriel*, Centre Georges Pompidou, 2008
- article *Le Web de demain*, in *Journal du Net*, 2008, S. Abiteboul
- interview podcast *Le Web de demain*, in *Vnunet*, 2008, S. Abiteboul
- article *Et demain...* in *01 Informatique*, 2008, I. Manolescu
- interviews in *Science et Vie*, *Le Nouvel Economiste* et *l'informaticien*, 2009, S. Abiteboul
- panel, colloquium "Une histoire de DIM, Domaines d'Intérêt Majeur" organized by the Île-de-France région, 2009, S. Abiteboul
- talk, colloquium INRIA "Web et Industrie" in Lille, 2009, S. Abiteboul
- talk, *Demain, la république du Web : une utopie ?*, La Cantine, 2009, S. Abiteboul
- talk, *Perspectives IT pour le Codir*, OLG Clubs, at La Villette, 2009, S. Abiteboul
- talk, presentation of *Gemo work on ViP2P*, La Cantine, 2009, I. Manolescu
- radio, *Le téléphone sonne* program, France Inter, 2009, S. Abiteboul

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)

Type	Name	Managing Institution	Start / Duration	Amount
Subvention	AAP 2012	Université Paris Sud	01.2012 / 12 mo.	13.00 k€
ANR	CODEX	INRIA	03.2009 / 40 mo.	123.25 k€
ANR	PROJET ConnectedCities	INRIA	07.2011 / 15 mo.	24.54 k€
ANR	PROJET DATABRIDGES	Université Paris Sud	07.2011 / 15 mo.	75.62 k€
ANR	PROJET DATABRIDGES	INRIA	07.2011 / 15 mo.	87.31 k€
ANR	DATARING	INRIA	12.2008 / 45 mo.	22.90 k€
Subvention	DATE	CNRS	01.2013 / 24 mo.	13.00 k€
ANR	DIAFORE	CNRS	01.2006 / 44 mo.	481.00 k€
DIGITEO	DIM DW4RDF.2	Université Paris Sud	09.2011 / 36 mo.	103.70 k€
ANR	DOCFLOW	INRIA	01.2007 / 36 mo.	190.16 k€
FNR Luxembourg	DynaMO	autre	04.2011 / 36 mo.	9.00 k€
ANR	EDIFLOW	INRIA	12.2008 / 33 mo.	103.92 k€
Contrat européen	EIT ICT Labs - KIC 2011	INRIA	01.2011 / 12 mo.	52.00 k€
Contrat européen	EIT ICT LABS-KIC 2012	Université Paris Sud	01.2012 / 12 mo.	27.84 k€
Contrat européen	EIT ICT LABS-KIC 2012	INRIA	01.2012 / 12 mo.	53.00 k€
Contrat européen	EIT ICT LABS-KIC 2012	Université Paris Sud	01.2012 / 12 mo.	8.70 k€
ANR	GEONTO	CNRS	01.2008 / 46 mo.	156.48 k€
Contrat européen	HYCON 2	INRIA	09.2010 / 48 mo.	14.56 k€
ANR	PAGODA	Université Paris Sud	01.2013 / 48 mo.	260.31 k€
ANR	PIMI	Université Paris Sud	11.2010 / 36 mo.	180.57 k€
ANR	QUALINCA	Université Paris Sud	04.2012 / 48 mo.	99.58 k€
DIGITEO	SHIRI	Université Paris Sud	10.2007 / 48 mo.	96.08 k€
ANR	UNLOC	Université Paris Sud	10.2009 / 30 mo.	91.00 k€
ANR	Web-Content	INRIA	06.2006 / 36 mo.	261.73 k€
ANR	WEBSTAND	INRIA	01.2006 / 36 mo.	22.00 k€
Contrat européen	WS-DIAMOND	Université Paris Sud	10.2005 / 33 mo.	188.10 k€

AAP2012

This one-year project provided travel support for M. Bienvenu to carry out research on ontology-based data access in collaboration with colleagues from the University of Bremen, the University of Rome La Sapienza, and the Technical University of Vienna. Specific topics addressed: first-order rewritability of atomic queries in Horn description logics, tractable approximations of consistent query answering semantics for simple ontology languages, querying lightweight description logic knowledge bases using path queries, and tractability results for restricted classes of conjunctive queries. The research begun during this project is being pursued as part of the ANR PAGODA project.

Type: Subvention
University of Paris-Sud
Amount: 13 k€
Duration: 12 months
Scientific director for LRI:
M. Bienvenu

CODEX

Partners: INRIA Lille-Nord Europe (MOSTRARE team), LRI-University of Paris-Sud (BD and IASI teams), University of Paris 7 (PPS), University François Rabelais of Tours, University of Paris 1, INRIA Grenoble-Rhône-Alpes (WAM team), In-

Type: ANR
Amount: 123.25 k€
Duration: 40 months
Scientific director for LRI: I. Manolescu

See <http://codex.saclay.inria.fr>

Codex is a research project supported by the ANR Domaines Emergents call. The project studies optimization, distributed processing and coordination, and adaptation techniques to cope with XML document dynamicity. Within CODEX we have spent significant effort developing and testing ViP2P, an XML content sharing platform which scales up to hundreds of peers.

PROJET Connected Cities

Partners: INRIA Saclay Île-de-France (Leo Team), LRI-University Paris-Sud (IASI and BD teams)

Type: ANR
Amount: 24.54 k€
Duration: 15 months
Scientific director for LRI: I. Manolescu

This funding is a complement of the funding of the EIT activity *Europa* within the KIC application area "Computing in the cloud". This one-year ANR grant concerns our research on cloud-based data management, in particular XML data. We have studied strategies for indexing XML content in a cloud-environment and built a prototype to test them.

PROJET DataBridges

Partners: INRIA Saclay Île-de-France (Leo team), LRI-University Paris-Sud (IASI team)

Type: ANR
Amount: 75.62 k€
Duration: 15 months
Scientific director for LRI: C. Reynaud

DataBridges is an *ICT Labs/ANR* activity, within the KIC application area *Digital cities*. It has been funded by the EIT as a "catalyst" to other activities of our group, and has led furthermore to national funding through the *Agence Nationale de la Recherche*. This ANR grant was devoted to research on data integration in particular through the technologies and models of open data, with a particular interest in applications connected to the Digital Cities. This is the funding of the Databridges project for LRI-University of Paris-Sud (IASI team).

PROJET DataBridges

Partners: INRIA Saclay Île-de-France (Leo team), LRI-University Paris-Sud (IASI team)

Type: ANR
Amount: 87.31 k€
Duration: 15 months
Scientific director for LRI: I. Manolescu

This is the funding of the Databridges project for INRIA Saclay Île-de-France (Leo team).

Dataring - P2P data sharing for online communities

Partners: INRIA Saclay Île-de-France (Gemo team), INRIA Sophia, University of Grenoble, Telecom-ParisTech

Type: ANR
Amount: 22.90 k€
Duration: 45 months
Scientific director for LRI: S. Abiteboul

See http://www.lina.univ-nantes.fr/projets/DataRing/DataRing_Home.html

The project addresses the problem of P2P data sharing for online communities, by offering a high-level network ring across distributed data source owners. Users may be in high numbers and in different kinds of collaboration and sharing their knowledge, ideas, experiences, etc. Data sources can be in high numbers, fairly autonomous, i.e. locally owned and controlled, and highly heterogeneous with different semantics and structures. What we need then is new, decentralized data management techniques that scale up while addressing the autonomy, dynamic behavior and heterogeneity of both users and data sources.

DATE: Distributed Diagnosability and Testability of Faulty Systems

Partners: LRI-University of Paris-Sud (IASI team), Universidad Nacional de Cordoba (FaMAF - Argentine), Universidad Austral de Chile (UACH - Chile)

DATE is a project on formal analysis of diagnosability and testability in distributed and concurrent systems, formally modelled with label transition systems and Petri nets.

Type: Subvention
STIC-AmSud
Amount: 13 k€
Duration: 24 months
Scientific director for LRI: P. Dague

DIAFORE: DIAGnostic de FONctions Reparties

Partners: LRI-University of Paris-Sud (IASI team), CEA-List, Renault Trucks, Serma Ingenierie, CNRS - UTC of Compiègne

DIAFORE is an open project that aims at providing a software-based platform for designing and implementing on-line diagnosis functions in the electronic architecture of trucks. Research is focused on modeling and decentralized diagnosis of the Smart Distance Keeping function, used as a case study. The embedded (sensors faults) diagnostic architecture with a global diagnostic algorithm implemented in a dedicated Electronic Control Unit acting as diagnostic supervisor between the local diagnostic algorithms is the first experiment of an embedded diagnostic function decentralized on several ECUs and decision making and reconfiguration action achieved at the supervisor level.

Type: ANR
Amount: 481 k€
Duration: 44 months
Scientific director for LRI: P. Dague

DIM DW4RDF.2

Partners: LRI-University of Paris-Sud (IASI and BD teams), INRIA Saclay Île-de-France (Leo team)

DW4RDF is a Digiteo DIM project focused on efficient tools for warehousing Semantic Web data, in particular under the form of RDF. We aim at developing models, languages and algorithms for OLAP-style analysis of RDF data, taking into its heterogeneity, its lack of a strict structure, and its rich semantics.

Type: Digiteo
Amount: 103.70 k€
Duration: 36 months
Scientific director for LRI: F. Goasdoué

DocFlow

Partners: INRIA Saclay Île-de-France (Gemo team), University of Bordeaux1 (LABRI), INRIA Rennes (Distribcom team)

See <http://www.labri.fr/perso/anca/docflow/>

DocFlow was a research project supported by the ANR Masses de données (2007-2009) with the Distribcom team at INRIA-Rennes and the Méthodes Formelles group at Labri-Bordeaux. The topic was the analysis, monitoring, and optimization of Web documents and services. It builds on Active XML, a formalism for data exchange across peers developed by Gemo. The project aimed at achieving a convergence of data and workflow management over the Web through the concept of active peer-to-peer documents.

Type: ANR
Amount: 190.16 k€
Duration: 36 months
Scientific director for LRI: S. Abiteboul

DynaMO

Partners: CRT H. Tudor (Luxembourg), LRI-University of Paris-Sud (C. Reynaud)

DynaMO is a project which aims to develop and propose a new method of mapping maintenance. The objective is to provide a tool-supported formal framework that takes into account the characteristics of changes affecting KOS elements and KOS models as well as the nature of the existing mappings in order to automate the adaptation of mappings that are made invalid by KOS evolution. C. Reynaud plays the role of a mentor in order to advise the project leader for research project management and also for PhD student management.

Type: FNR Luxembourg
Amount: 9 k€
Duration: 36 months
Scientific director for LRI: C. Reynaud

EdiFlow

Partners: INRIA Saclay Île-de-France (Gemo and AVIZ teams), LRI-University Paris-Sud (IASI, BD and then Toccata teams)

See <http://scidam.gforge.inria.fr/index.html>

Type: DIGITEO
Amount: 103.92 k€
Duration: 33 months
Scientific director for LRI: I. Manolescu

This project is a collaboration between data management and information visualisation researchers (coordinator: I. Manolescu - Inria Gemo and LRI IASI, V. Benzaken - LRI BD and J.-D. Fekete - Inria AVIZ). The purpose is to study models and build a corresponding platform for efficient data-intensive workflow systems. A first prototype, ReaViz, has been developed on top of an industrial-strength database and demonstrated this year. It enables the declarative specification of a workflow via XML, and automatically compiles it into a database application.

EIT ICT LABS-KIC 2011

Partners: INRIA Saclay Île-de-France, University of Paris-Sud (IASI and BD teams), DFKI (France), TU Delft (The Netherlands), Aalto University (Finland), KTH (Sweden), Alcatel-Lucent Bell Labs (France)

Type: European contract
Amount: 52.00 k€
Duration: 12 months
Scientific director for LRI: I. Manolescu

This is the funding of the EIT in 2011 for the *DataBridges* activity within the KIC application area *Digital cities*. Digital cities are information exchange marketplaces where companies, individuals, and administrations all interact through many-directional flows. Interesting recent development in this context are: the open data trend, aiming at making data freely shared by several parties, and the linked data technical initiative, leading to establishing connections across data sets toward integrating them. This activity studies concrete and fundamental aspects connected to the creation, integration, personalization, and efficient sharing of open linked data in digital cities.

EIT ICT LABS-KIC 2012

Partners: LRI-University of Paris-Sud (IASI team), INRIA Saclay Île-de-France (Leo Team), DFKI (Germany), TU Delft (The Netherlands), Aalto University (Finland), KTH (Sweden), Alcatel-Lucent (France), DataPublica (France)

Type: European contract
Amount: 27.84 k€
Duration: 12 months
Scientific director for LRI: C. Reynaud

This is the funding of the EIT in 2012 for LRI-University of Paris-Sud (IASI team) for the *DataBridges* activity within the KIC application area *Digital cities*. In 2012, members of the IASI team worked on interoperability, enrichment and personalization of data, e.g. data on the cultural activities within a city, based on user profiles; a separate thread of work focuses on efficient techniques for RDF data management.

EIT ICT LABS-KIC 2012

Partners: INRIA Saclay Île-de-France (Leo team), LRI-University of Paris-Sud (IASI team), DFKI (Germany), TU Delft (The Netherlands), Aalto University (Finland), KTH (Sweden), Alcatel-Lucent Bell Labs (France), DataPublica (France)

Type: European contract
Amount: 53.00 k€
Duration: 12 months
Scientific director for LRI: I. Manolescu

This is the funding of the EIT in 2012 for INRIA Saclay Île-de-France (Leo team) for the *DataBridges* activity within the KIC application area *Digital cities*. In 2012, members of INRIA Saclay Île-de-France worked on efficient techniques for large-scale RDF data management, to be applied (among others) on digital city data.

EIT ICT LABS-KIC 2012

Partners: INRIA Saclay Île-de-France, University of Paris-Sud (IASI and BD teams), DFKI (France), TU Delft (The Netherlands), Aalto University (Finland), SICS (Sweden)

Type: European contract
Amount: 8.70 k€
Duration: 12 months
Scientific director for LRI: F. Goasdoué

This activity, EUROPA, is part of the KIC *Computing in the Cloud* action line. The aim was to work closely with the TU Berlin and SICS partners to devise efficient indexing models for complex data in a cloud environment, as well as compilers for higher-level data models (in particular, Web data) towards efficient parallel processing on the TU Berlin platform.

GeOnto

Partners: LRI-University of Paris-Sud (IASI team), IGN (Cogit), University Paul Sabatier (IRIT), University of Pau and Pays de l'Adour (LIUPPA)

See <http://geonto.lri.fr/>

Type: ANR
Amount: 156.48 k€
Duration: 46 months
Scientific director for LRI: C. Reynaud

The objective of the GEONTO project was to make data in the geographic domain interoperate. We focused on two main goals. On one hand, we aimed at integrating heterogeneous geographic databases using schema matching techniques. On the other hand, we aimed at querying a large collection of textual documents which are more various and for a larger readership than databases mentioned just before. C. Reynaud was the coordinator of this project.

HYCON2: Highly-complex and networked control systems

HYCON 2 aims at stimulating and establishing a long-term integration in the strategic field of control of complex, large-scale, and networked dynamical systems. It focuses in particular on the domains of ground and aerospace transportation, electrical power networks, process industries, and biological and medical systems.

Type: European contract
Amount: 14.56 k€
Duration: 48 months
Scientific director for LRI: P. Dague

PAGODA

Partners: LRI-University of Paris-Sud (IASI team), University of Montpellier 2 (LIRMM), University of Grenoble (LIG, LADAF)

See <http://pagoda.lri.fr>

Type: ANR
Amount: 260.31 k€
Duration: 48 months
Scientific director for LRI: P. M. Bienvenu

PAGODA (Practical algorithms for ontology-based data access) is a basic research project whose objective is to improve the efficiency and robustness of ontology-based data access by developing scalable algorithms for query answering in the presence of ontologies as well as pragmatic approaches to handling inconsistent data.

PIMI

Partners: Genigraph, INRIA, Institut Telecom – Sud Paris, Montimage, LRI-University of Paris-Sud (ForTesSe and IASI teams), University Paul Sabatier (IRIT)

The future Internet will bring a growing number of networked applications (services), devices and individual data (including private ones) to end-users (citizens, consumers, employees). The important challenges are the organization of their access, and the guarantee of trust and privacy. The objectives of the PIMI project (Personal Information Management through Internet) are the definition of a model-based design environment and a deployment platform for Personal Information Management System (PIMS).

Type: ANR
Amount: 180.57 k€
Duration: 36 months
Scientific director for LRI: P. Poizat

QUALINCA

Partners: University of Montpellier 2 (LIRMM), University of Grenoble (LIG), LRI-University of Paris-Sud (IASI team), ABES (Agence Bibliographique de l'Enseignement Supérieur), INA (Institut National de l'Audiovisuel)

See <http://www.lirmm.fr/qualinca/?q=en>

Type: ANR
Amount: 99.58 k€
Duration: 48 months
Scientific director for LRI: F. Sais

Qualinca is a ANR Contint funded research project looking at developing mechanisms allowing to quantify the quality level of a bibliographical knowledge base, to improve the afore mentioned quality level, to maintain the quality when updating the knowledge base and to exploit the knowledge bases taking into account their quality levels. The project started in April 2012 and will end September 2015.

SHIRI

Partners: LRI-University of Paris-Sud (IASI team), Supelec

See <http://www.di.supelec.fr/~bennacer/SHIRI.htm>

Type: DIGITEO
Amount: 96.08 k€
Duration: 48 months
Scientific director for LRI:
N. Pernelle

SHIRI is an automatic ontology-driven and unsupervised approach for the semantic annotation of documents which contain more or less structured parts. The aim of this project was to build an integration system which allows the user access to documents related to a specific domain. In this system, the querying process is guided by an ontology of the domain and the answers are only made of the pertinent parts of the documents unlike keywords-based search engines. The annotation step exploits a set of metadata and a set of logical rule patterns which are automatically instantiated from the domain description.

UNLOC

Partners: LRI-University of Paris-Sud (IASI team), Physicists from University of Paris-Sud, University of Artois (CRIL, Lens), University of Picardie Jules Verne, University of Marseille (LSIS)

Type: ANR
Amount: 91.00 k€
Duration: 30 months
Scientific director for LRI: L. Simon

In UNLOC, we focused on incomplete search for UNSAT, a challenging and promising question, and developed new learning schemes for Conflict Directed Clause Learning algorithms. L. Simon was the coordinator of this project.

WebContent

Partners: CEA LIST, Thales Research & Technology, EADS, Soredab, New Phenix, INRA, ADRIA, Exalead, University of Pierre & Marie Curie (LIP6), University of Versailles-St Quentin en Yvelines (PRISM), INRIA Saclay Ile-de-France (In Situ and Gemo teams), INRIA Lille-Nord Europe (Mostrare team), INRIA Grenoble-Rhône-Alpes (Exmo team), LIMSI-CNRS-University of Paris-Sud, University of Grenoble (LIG), GRIMMPSY.CO

Type: ANR
Amount: 261.73 k€
Duration: 36 months
Scientific director for LRI: S. Abiteboul

See <http://www.webcontent-project.org>

The WebContent project is creating a software platform to accommodate the tools necessary to efficiently exploit and extend the future of the Internet : the Semantic Web. The first targeted domain is the watch, a subpart of intelligence dedicated to warn the decider on the occurrence of an event or the evolution of a situation. It joins several Open Source tools to create the core of a Service Oriented Application and it defines the interface of several services that are available through several partners, either freely or through commercial licences. These services then exchange data in a formalized manner.

WebStand

Partners: INRIA Saclay Île-de-France (Gemo team), University of Versailles-St Quentin en Yvelines (PRISM), LRI-University of Paris-Sud (BD team), LEST

Type: ANR
Amount: 22 k€
Duration: 36 months
Scientific director for LRI: I. Manolescu

The objective of this ANR was to analyze the problems surrounding the use of semi-structured databases in social sciences. This ANR regrouped both computer science and sociology laboratories. Work done in Gemo included XML data cleaning and work on automatic selection and maintenance of materialized XML views. I. Manolescu was the scientific director for the IASI/Gemo team.

WS-DIAMOND: Web Services - DIAGNOSability, MONitoring and Diagnosis

Partners: University of Torino (I), Vrije Universiteit Amsterdam (NL), Politecnico di Milano (I), University of Klagenfurt (A), University of Vienne (A), LAAS-CNRS (F), University of Rennes 1-IRISA (F), LRI-University of Paris-Sud (F)

Type: European contract
Amount: 188.10 k€
Duration: 33 months
Scientific director for LRI: P. Dague

See <http://wsdiamond.di.unito.it/>

Ws-Diamond, Web Services - DIAGNOSability, Monitoring and Diagnosis is a project of the Sixth Framework Programme Priority2 - Information Society Technologies. It's a Specific Targeted Research or Innovation

Project. Self-healing software is one of the challenges for IST research. This project aims to take a step in this direction by developing a framework for self-healing Web Services. The project will produce (1) an operational framework for self-healing service execution of conversationally complex Web Services, where monitoring, detection and diagnosis of anomalous situations, due to functional or non-functional errors (e.g., Quality of Service) is carried on and repair/reconfiguration is performed, thus guaranteeing reliability and availability of Web Services; (2) a methodology and tools for service design that guarantee effective and efficient diagnosability/repairability during execution; (3) demonstration of these results on real applications.

Private contracts and grants (jan 2008 - jun 2013)

Type	Name	Managing Institution	Start / Duration	Amount
Industriel	DataPublica	INRIA	05.2011 / 24 mo.	86.42 k€
Industriel	HEDI	INRIA	10.2009 / 8 mo.	25.00 k€
Industriel	MEDIAD	Université Paris XI	04.2005 / 36 mo.	89.72 k€
Industriel	PICSEL 3	Université Paris XI	01.2005 / 36 mo.	149.16 k€
Industriel	PossiblePasts	INRIA	05.2010 / 6 mo.	10.00 k€
CIFRE	SHERPA	Université Paris XI	11.2008 / 38 mo.	9.00 k€
Industriel	SIRASAS	Université Paris XI	10.2007 / 36 mo.	94.82 k€

DataPublica

Partners: INRIA Saclay Ile-de-France (Leo team), INRIA Sophia (ZENITH team), DataPublica start-up

Type: Industrial
Amount: 86.42 k€
Duration: 24 months
Scientific director for LRI: I. Manolescu

A collaboration has been initiated with the DataPublica start-up and the Zenith INRIA team (ex-ATLAS) from Montpellier. DataPublica aims at drawing up a catalog of the public data sources of the french domain, and in particular those produced by public administration, mostly in Excel files. The contract with DataPublica aims at designing a semantic annotation tool for typing entities in columns of tables in the geographic domain.

HEDI

Partners: LRI-University of Paris-Sud (IASI team), INRIA Saclay Ile-de-France (Gemo team), Thales Corporate Services

Type: Industrial
Amount: 25.00 k€
Duration: 8 months
Scientific director for LRI: N. Pernelle & F. Saïs

HEDI, for Heterogeneous Electronic Data Integration, is a collaboration agreement between Gemo team of INRIA Saclay and Thales Corporate Services started in September 2009. This project aimed at designing a data reconciliation tool for electronic component descriptions.

MEDIAD

Partners: LRI-University of Paris-Sud (IASI team), France Télécom R&D Rennes

See <http://www.lri.fr/~goasdoue/MediaD/>

Type: Industrial
Amount: 89.72 k€
Duration: 36 months
Scientific director for LRI: F. Goasdoué

The purpose of MediaD was to investigate distributed reasoning in a peer-to-peer setting. Its roadmap was (1) the design of a scalable peer-to-peer infrastructure for efficient distributed reasoning, (2) the design of peer data management systems for the Semantic Web (and their query answering algorithms) that uses the above infrastructure, and (3) the design of algorithms for automated ontology mapping in the above peer data management systems.

PICSEL 3

Partners: LRI-University of Paris-Sud (IASI team), France Télécom R&D Rennes

See <http://www.lri.fr/~sais/picse3/>

Type: Industrial
Amount: 149.16 k€
Duration: 36 months
Scientific director for LRI:
M.-C. Rousset

In PICSEL 3, the mediation architecture of the information integration system is hybrid. The mediator also integrates a local data warehouse which contains data given by content providers. These data are conform to the mediator schema represented in RDFS+ language (RDFS extended by a fragment of OWL-DL). The data warehouse was progressively enriched by external data. One of the main goals of PICSEL 3 was the semantic treatment of the mediator answers. More accurately we studied the references reconciliation problem in order to eliminate redundancies and to fusion data coming from different sources. Another goal was to propose an approach where wrappers and integration systems are built semi-automatically.

PossiblePasts

Partners: INRIA Saclay Ile-de-France (Leo team), ThinkStraight

Type: Industrial
Amount: 10.00 k€
Duration: 6 months
Scientific director for LRI: I. Mandolescu

The ThinkStraight start-up had identified an interesting data forensic problem in the specialized context of financial (accounting) data. The project allowed us to analyze the scientific questions raised by their problem, which we found novel, and draw a state of the art of the two closest areas, namely data cleaning and data quality analysis. We have also analyzed the software architecture that ThinkStraight was planning to build and compared it to existing technologies developed within the team, notably the LN2R and EdiFlow prototypes; we found that the ThinkStraight problem required quite radically different functionalities and given the very early stages of the company's development, the collaboration was not further pursued.

SHERPA

Partners: LRI-University of Paris-Sud (IASI team), SHERPA Engineering, CEA LIST

Type: CIFRE
Amount: 9.00 k€
Duration: 38 months
Scientific director for LRI: P. Dague

The objective is to make a bridge between off-line diagnosability analysis and on-line embedded diagnosis. The project focused on defining, implementing, testing and validating on a real case study (a fuel cell system) an all-in-one tool to design a diagnostic system for technological systems by integrating representation of the system and its potential faults, off-line diagnosability analysis and automatic generation of the on-line embedded diagnoser.

SIRASAS

Partners: LRI-University of Paris-Sud (IASI team), University of Bordeaux (IMS), CRAN (Nancy), LAAS-CNRS, ENS Cachan (SATIE), ONERA (Toulouse), CNES (Toulouse), Airbus (Toulouse), Thales Alenia Space (Cannes)

Type: Industrial
Amount: 94.82 k€
Duration: 36 months
Scientific director for LRI: P. Dague

See <https://extranet.ims-bordeaux.fr/External/SIRASAS/>

The project gathers together industrial and academic partners to promote innovative and robust technologies that could significantly increase spacecraft autonomy. It addresses the model-based Fault Detection, Identification and Recovery (FDIR) challenges for G&C (Guidance and Control). The actions undertaken within SIRASAS aim at overcoming the dead zone between the scientific advanced methods proposed by the academic and research communities and the technological solutions demanded by the aerospace industry, with stringent operational constraints.

Software Licensing and Distribution

Active XML - Declarative specification of Web applications

<http://www.activexml.net>

Contact: S. ABITEBOUL

Active XML is a system for declarative specification of Web applications (AXML for short). It is also a declarative framework that harnesses web services for data integration, and is put to work in a peer-to-peer architecture.

AlignViz - AlignViz

Contact: B. SAFAR

AlignViz is a visualization tool of mappings between ontologies. It enables to visualize one or two ontologies at the same time in order to show the correspondences generated by an alignment tool. It is based on the GraphViz tool, the PROTEGE-OWL APIs and the Jena framework.

AnnoVip - AnnoVip

Contact: I. MANOLESCU-GOUJOT

AnnoVip is a tool for editing and exploiting XML documents with annotations in a distributed P2P setting.

BPEL2CPN - BPEL2CPN

Contact: P. DAGUE

BPEL2CPN is a tool to convert a composite Web service written in BPEL into a Colored Petri Net model used to achieve decentralized diagnosis.

EAP Framework - EAP Framework

Contact: C. REYNAUD

EAP framework is a pattern-based framework to support the definition of adaptation strategies at a high level in the setting of Adaptive Hypermedia Systems. Adaptation strategies are built by composing elementary adaptations in a semi-automatic way. This prototype has been experimented in the e-learning domain.

EdiFlow - EdiFlow

<http://scidam.gforge.inria.fr/>

Contact: I. MANOLESCU-GOUJOT

The prototype Ediflow is a platform for data-intensive visual analytics, such as user-dataset interactions in scientific applications. The prototype is a result of the Ediflow Digiteo DIM project (2008-2011), a collaboration between Ioana Manolescu (Inria Gemo and LRI IASI team), Véronique Benzaken (LRI BD team), and Jean-Daniel Fekete (Inria AVIZ). The platform is built in Java, and it has been deployed on top of the Oracle database management system. It integrates visualization and computation units.

FactMinder - A browser (Chrome) extension targeted at online fact checkers and data journalists

Contact: F. GOASDOUE

FactMinder is a browser (Chrome) extension targeted at online fact checkers and data journalists. It enables users to analyze web pages with entity extractors and create, in a separate panel, views to cross these annotations with background knowledge from trusted XML or RDF sources such as data sets from the Linked Open Data or governmental agencies.

GLUCOSE - GLUCOSE, a SAT solver which predicts learnt-clause usefulness

<http://www.lri.fr/~simon>

Contact: L. SIMON

Glucose is based on a new scoring scheme (well, not so new now) for the clause learning mechanism, based on our IJCAI'09 paper. Solver's name is a contraction of the concept of glue clauses, a particular kind of clauses that glucose detects and preserves during search.

GUNSAT - GUNSAT, a greedy local search algorithm for unsatisfiability

<http://www.lri.fr/~simon>

Contact: L. SIMON

This algorithm, coded in java, is a first step to propose the first incomplete schema for unsatisfiability, in the boolean framework (SAT).

KD2R - OWL2 key discovery on RDF datasets

Contact: N. PERNELLE

KD2R aims to discover composite keys in one or several RDF data source. These data conform to the same OWL ontology and are described in RDF files for which the UNA is fulfilled. KD2R takes into account the properties that the RDF files may have: incompleteness and multi-valuation. Since the data may be numerous, KD2R discovers maximal undetermined/non keys (exploring only a part of the dataset) that are used to compute keys. Keys that are discovered using different datasets are merged.

LiquidXML - LiquidXML

<http://vip2p.saclay.inria.fr/?page=liquidxml>

Contact: I. MANOLESCU

LiquidXML is built on top of ViP2P. It is a self-tuning P2P system for distributing XML content according to the query needs of the distributed peers.

LN2R-LT - A Logical method and a Numerical method for Reference Reconciliation

<http://www.lri.fr/~sais>

Contact: F. SAIS

This tool implements two methods of reference reconciliation: the logical one and the numerical one (developed in the IASI-Gemo team). These methods allow deciding whether different identifiers refer to the same data, i.e., correspond to the same world entity. Our reconciliation system exploits the semantics of a rich data model named RDFS+. It is based on recommendations and on submissions of the W3C for the semantic Web.

MESAM - MESAM

Contact: C. REYNAUD

A plug-in for Protege 2000 to merge generic and specific models. Given two models, a generic model used in a generic system and a specific system provided by a designer, MESAM supports the construction of a model that integrates all the particularities of the specific model and be usable in the generic system. The tool needs a definition of the mappings between elements of both models and a validation process at the structural and semantic level. It has been designed in the setting of Adaptive Hypermedia Systems.

POI-HELPER - An extraction service of data from social networking sites

Contact: C. REYNAUD

This tool supports an approach to enrich an existing RDF repository about POIs with data obtained from social networking sites. It identifies a POI across multiple social networking sites and extracts information from the reviews that users leave on these sites.

RDFViews - RDFViews

<http://rdfvs.saclay.inria.fr>

Contact: I. MANOLESCU

RDFViewS is a system capable of choosing the most suitable views to materialize, in order to minimize the query response time for a specific SPARQL query workload, while taking into account the view maintenance cost and storage space constraints. It exploits the available semantic information (eg RDF Schema) to ensure the completeness of the query evaluation. Demonstrated in the ACM CIKM 2010 conference.

REISA - Controlled Knowledge Base Enrichment from Web documents

Contact: N. PERNELLE

REISA allows to enrich RDF/OWL knowledge bases with property instances using HTML documents annotated with class instances. Neighbor domain entities in the annotated documents are used to generate candidate properties according to the domain and range axioms defined in a domain ontology. These candidates are filtered using ontology axioms and existing property instances.

SHIRI-Querying - Semantic Search on Heterogeneous Semi-structured Documents

Contact: N. PERNELLE

SHIRI-QUerying is a solution to tackle incompleteness and imprecision of semantic annotations of semistructured documents at querying time. We particularly introduce three elementary reformulations that rely on the notion of aggregation and on the document structure. The Dynamic Reformulation and Execution of Queries algorithm (DREQ) combines these elementary transformations to construct reformulated queries w.r.t. a defined order relation.

SomeWhere+ - Paraconsistent Peer-to-Peer Consequence Finding algorithm

Contact: P. CHATALIC

SomeWhere+ is an extension of the SomeWhere Peer-to-Peer architecture for distributed consequence finding, tolerant to inconsistencies in the global network of peers. Despite the fact that no peer has a global view of the network, it allows for the detection of all possible inconsistencies due to incompatible sets of mappings. This makes possible to produce only those consequents that are well-founded.

SomeWhere2 - Peer-to-Peer Consequence Finding

Contact: P. CHATALIC

SomeWhere2 is a completely new implementation of earlier platforms SomeWhere and SomeWhere+ for consequence finding in distributed propositional theories. Its multilayered and very modular design increases its robustness and extends its functionalities. The new framework is able to cope with dynamically evolving networks of peers. Alternative implementations of components and further extensions are greatly facilitated. This framework is thus reusable as a building block of more advanced peer data management systems.

SpyWhere - SpyWhere

Contact: C. REYNAUD

Spywhere is a generator of mapping candidates for enriching peer ontologies. Ontologies are the descriptions of peer data belonging to the peer data management system SomeRDFS. SpyWhere takes advantage of query answering in order to help discovering two kinds of mappings: mapping shortcuts corresponding to a composition of pre-existent mappings and mappings which can not be inferred from the network but yet relevant.

TARGET - Adaptative ontology-based Web search framework

Contact: C. REYNAUD

TARGET aims at improving, in terms of relevance, the results of a Web search. It implements an original approach based on adaptive ontologies for improving Web search. The tool is made of two parts. A Java front-end that acts as an interface with the user and a second part made up of the PROLOG inference engine that manages both ontology adaptation and the adaptive Web search.

TaxoMap Alignment - A prototype to automate semantic mappings between taxonomies

<http://www.lri.fr/~hamdi/TaxoMap/TaxoMap.html>

Contact: C. REYNAUD

TaxoMap is an alignment tool which aim is to discover rich correspondences between concepts. It performs an oriented alignment from a source to a target ontology and takes into account labels and sub-class descriptions. Three types of correspondences are computed: equivalence (isEQ), subclass(isA),

proximity (isClose).

TaxoMap Refinement - TaxoMap Framework

<http://www.lri.fr/~hamdi/TaxoMap/TaxoMap.html>

Contact: C. REYNAUD

TaxoMap Refinement is an environment to specify treatments to refine mappings and to enrich ontologies. It implements a pattern-based approach allowing to take into account specific conventions used in the ontologies. An APP deposit is in progress.

TEXAN - A service to extract entities from tables

Contact: C. REYNAUD

This tool identifies rows in a table that contain information on entities of specific types (e.g. restaurant, museum, ...) derived from an ontology and determines the cells in which the names of these entities occur. It supports an algorithm implemented while developing a faceted browser over a repository of RDF data on points of interest of cities that have been extracted from Google Fusion tables.

ViP2P - views in peer-to-peer

<http://vip2p.saclay.inria.fr>

Contact: I. MANOLESCU

ViP2P is a fully functional Java-based platform for the efficient, scalable management of XML documents in structured peer-to-peer networks based on distributed hash table (DHT) indices. We exploit indices (or materialized views) to answer tree pattern queries.

XRP - The XR platform

Contact: F. GOASDOUE

XRP (a.k.a. the XR platform) is a data management platform for RDF-annotated XML data, relying on the XR data model and the XRQ query language. The platform works as a data integrator on top of XML and RDF data management systems. It features components for query evaluation, optimization and composition, as well as modules for managing XML node URLs. The platform can be accessed from command-line or through a web-based interface in the spirit of SPARQL endpoints.

WaRG - Warehousing RDF Graphs

Contact: A. ROATIS

WaRG allows performing warehouse-style analytics on RDF graphs using typical OLAP operations. This framework keeps the warehousing process purely in the RDF format and takes advantage of the heterogeneity and semantics inherent to this model.

Training and Education

Master Internships

- J. Ait Alla, Mohammadia Graduate School, Morocco, 2008 - 3 months
- F. Hamdi, University of Paris-Sud, 2008, 6 months
- Y. Mrabet, University of Paris-Sud, 2008, 6 months
- S. Gahbiche, University of Paris-Sud, 2009, 6 months
- L. Cazenille, University of Paris-Sud, 2010, 9 months
- M. Ceccaldi, University of Paris-Dauphine, 2010, 6 months
- R. Kheffi, University of Paris-Dauphine, 2010, 6 months
- J. Leblay, UPMC (LIP6), 2010, 6 months
- S. Quenette, University of Paris-Dauphine, 2010, 4 months
- S. Zampetakis, University of Crete (Greece), 2010, 4 months
- C. Morel, University of Lille III, 2011, 6 months
- A. Roatis, West Timisoara University, Romania, 2011 - 6 months
- D. Symeonidou, University of Crete (Greece), 2011 - 6 months
- S. Zampetakis, University of Crete (Greece), 2011 - 8 months
- M. Koutraki, University of Crete (Greece), 2012, 6 months
- C. Alec, University of Paris-Dauphine, 2013, 6 months
- C. Bourgaux, Supélec, 2013, 6 months
- M. Morterol, Polytech Paris-Sud, 2013, 6 months
- L. Zheng, University of Paris-Sud, 2013, 6 months

Graduate Courses

- Master Informatique (I3), University of Paris-Sud, *Information, Interaction, Intelligence*:
 - *Formation à la recherche* : P. Chatalic (2008, 2009)
 - *Ontologies: fondements du web sémantique*: C. Reynaud, B. Safar (2008-2009)
- Master Informatique (IAC), University of Paris-Sud, *Information, Apprentissage, Cognition*:
 - *Données et connaissances pour le Web*: F. Goasdoué, C. Reynaud, B. Safar (2010-2013)
 - *Données semi-structurées et XML: langage et optimisation*: I. Manolescu (2010-2013)
 - *Intégration de données et Web Sémantique*: C. Reynaud, B. Safar, N. Pernelle, F. Saïs (2010-2013)
 - *Modèles de raisonnement distribué*: M. Bienvenu, P. Chatalic, P. Dague, F. Goasdoué, L. Simon (2010-2013)
- Master Mathématique, Informatique, Décision, Organisation (MIDO), University Paris Dauphine, *Systèmes Intelligents*:
 - *Raisonnement et décision*: F. Goasdoué (2012-2013)
 - *Ontologies et Web Sémantique*: F. Goasdoué (2011-2013)
 - *Gestion sémantique des données*: F. Goasdoué (2008-2011)
 - *Web Sémantique*: N. Pernelle and F. Saïs (2011-2013)
- Master Informatique, University of Beirut, Lebanon:
 - *Logiques de description pour le Web sémantique*: F. Goasdoué, (2009-2011)
- Master Informatique, ENS Lyon, *Modélisation des systèmes complexes*:
 - *Problèmes de satisfaction de contraintes*: L. Simon, (2008-2011)

Thesis

Habilitation à Diriger des Recherches	
Name	Defense
François GOASDOUE	07.2012
Ioana MANOLESCU-GOUJOT	10.2009
Laurent SIMON	12.2010

Defended thesis				
Name	Start	Defense	Funding	Advisor
Nada ABDALLAH	01.10.2006	13.07.2010	Alloc. Ministère	S. Abiteboul, F. Goasdoué
Vincent ARMANT	01.10.2007	27.09.2012	Alloc. Ministère	P. Dague, L. Simon
Michel BATTEUX	01.11.2008	13.12.2011	CIFRE	P. Dague
Pierre BOURHIS	01.10.2007	11.02.2011	Alloc. Ministère	S. Abiteboul
François-Elie CALVIER	01.09.2006	17.09.2010	Bourse BDI CNRS	C. Reynaud
Alban GALLAND	01.07.2008	28.09.2011	Alloc. Ministère	S. Abiteboul
Fayçal HAMDİ	06.10.2008	02.12.2011	CDD sur contrat CNRS	C. Reynaud, B. Safar
Konstantinos KARANASOS	01.01.2009	29.06.2012	CDD sur contrat INRIA	I. Manolescu, F. Goasdoué
Wael KHEMIRI	01.10.2008	12.12.2011	Alloc. Ministère	V. Benzaken, I. Manolescu, J.-D. Fekete
Yingmin LI	15.10.2006	09.12.2010	CDD sur contrat UPS	P. Dague
Bogdan-Eugen MARINOIU	01.01.2006	26.06.2009	Bourse BDI CNRS	S. Abiteboul
Yassine MRABET	01.10.2008	12.07.2012	Digiteo	C. Reynaud, N. Pernelle, N. Bennacer
Nicoleta PREDA	01.10.2004	23.05.2008	Alloc. Ministère	S. Abiteboul, I. Manolescu
Cédric PRUSKI	24.04.2006	29.04.2009	autre	C. Reynaud, N. Guelfi
Mouhamadou THIAM	01.12.2006	09.12.2010	ETR	C. Reynaud, N. Pernelle, N. Bennacer
Lina YE	01.10.2007	07.07.2011	Alloc. Ministère	P. Dague
Nadjet ZEMIRLINE	15.11.2007	12.07.2011	ETR-EGIDE	C. Reynaud, Y. Bourda
Spyros ZOUPANOS	01.10.2006	09.12.2009	Bourse CORDI INRIA	S. Abiteboul, I. Manolescu

Thesis in progress			
Name	Start	Funding	Advisor
Céline ALEC	01.10.2013	Alloc. Ministère	C. Reynaud, B. Safar
Camille BOURGAUX	01.10.2013	CDD sur contrat UPS	M. Bienvenu, F. Goasdoué
Julio Cesar DOS REIS	19.09.2011	FNR Luxembourg	C. Reynaud, C. Pruski
Hassan IBRAHIM	21.12.2012	ETR	P. Dague, L. Simon
Rania KHEFIFI	15.11.2011	CDD sur contrat UPS	P. Poizat, F. Saïs
Julien LEBLAY	01.10.2010	Alloc. Ministère	F. Goasdoué, I. Manolescu
Martin MORTEROL	01.10.2013	Alloc. Ministère	P. Dague, L. Simon, S. Perez
Alexandra ROATIS	01.09.2011	DIM LSC Digiteo	I. Manolescu, F. Goasdoué, D. Collazzo
Stamatis ZAMPETAKIS	15.10.2012	CDD sur contrat INRIA	I. Manolescu & F. Goasdoué
Danai SYMEONIDOU	01.10.2011	Alloc. Ministère	N. Pernelle, F. Saïs

Self Assessment

During the period 2002-2012, the members of IASI were participating in Gemo and then in Leo INRIA project, composed of specialists in the area of data and knowledge management as well as inference systems. This placed the team in an interesting position to attack in an integrated fashion all issues raised by the specification, deployment, optimization, analysis and diagnosis of distributed applications involving large data sets, rich models for extracting and exploiting knowledge, and formal foundations grounded on logics. Bringing together researchers from knowledge representation and data management backgrounds was not easy and took time. During the period 2008-2013, it was nevertheless really effective leading to four co-advised PhD theses (one defended in 2012 and three ongoing theses).

The composition of the group (in regards to the faculty members) and the implication of its members evolved during the last five years. For many years, the IASI group had no full-time CNRS researchers. As a consequence, the recruitment of M. Bienvenu by CNRS in 2010 was greatly appreciated. While allowing for reinforcement of the fundamental AI aspects in the group, she has developed some fruitful international collaborations acquiring a good visibility at the international level in a very short time. All the other permanent members are faculty members. In addition to research, they teach and several of them have carried out heavy-duty managerial tasks. In particular, P. Dague has been the director of the laboratory since 2010 and P. Chatalic has had a position at a management level in the Computer Science department of the university, corresponding to a very demanding work, during 3 years.

In response to the last evaluation, efforts have been done to more integrate research works and new research has been developed to benefit from complementary competences in the IASI group. We investigated the problem of diagnosing distributed systems in the framework of propositional P2P inference systems, by extending the well-known consistency-based diagnosis framework to a fully distributed inference system, where each peer only knows the existence of its neighbours. We also developed a new area of study, called ontology-based data access (OBDA). This research led to the ANR JCJC project PAGODA (2013-2016) coordinated by M. Bienvenu and including F. Goasdoué. The primary aim is to develop novel OBDA query answering algorithms which are both efficient and robust to data inconsistencies.

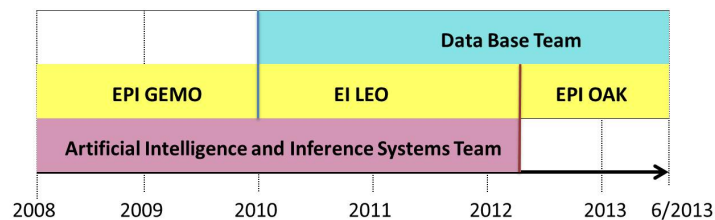
Finally, our group has proved its dynamics by supervising 28 PhD students (among them 18 defended their thesis during the last five years). The theses of five PhD students were supervised in joined direction with colleagues from other groups in France or abroad. Two assistant professors and one junior INRIA researcher defended their HDR. Furthermore, we actively participated to the KIC-EIT ICT Labs during two years and we have been involved in several national projects, often as leaders.

Strategy and five-year project

Self Assessment

The explosive growth in the amount of data created in the world is unparalleled. The data deluge is happening everywhere. Huge volumes of data sets are produced, leading to two main issues that are interoperability and scalability. LaHDAK proposes to work on these problems by providing adequate distributed data and knowledge management infrastructures. The aim is to manage complex-structured, semantically heterogeneous, uncertain, missing and evolving data. We will deal with data coming from any sources, including the internet and the social web with all its complexity. We will take up this challenge by providing efficient, semantically relevant and robust solutions.

The LaHDAK team brings together members of the Artificial Intelligence & Inference Systems group (IASI) and members of the Database group (DB) because of their common interests in data and knowledge management. These researchers have had a previous experience of collaboration within the Inria project Gemo which included all members of the IASI group and after that (from January 2010 to March 2012) within the team Leo which included the IASI group and members of the DB group (see the figure below).



The members of the Database group are specialists in the area of data management with a particular focus on formal models for complex data (semistructured, annotated, graph data), Web data management optimization (query processing and optimization for XML and RDF), management of distribution (P2P and Cloud platforms), and complex data transformations. The members of the Artificial Intelligence and Inference Systems team are specialists in the area of information integration. They address problems raised by modern information and knowledge management systems that deal with numerous, highly heterogeneous, and distributed information such as Ontology-based Data and Document Management (query answering and semantic annotation), Data and Knowledge Integration (integration of data and schemas or ontologies), and Reasoning over distributed systems (P2P inference systems, diagnosis systems).

Strengths: The LaHDAK group brings complementary expertizes together which is particularly important in order to meet the massive data and knowledge challenges (*Making sense of Data*).

The culture of the group is well balanced between theory/foundations and developments of innovative systems with experimentations connected to real applications.

Both former parts of LaHDAK have a strong publication record and a high academic recognition in their respective field, which is reflected by the participation to numerous program committees of both international and national conferences.

Dissemination of its former members and mobility of its actual members result in many collaborations at the national and international levels leading to a high number of publications.

The LaHDAK group is strongly committed in the Labex Digicosme project. It actively participated to the proposal and the group is involved in two tasks of the action line *DataSense: Data intelligence*: (1) Scalable, expressive and secure tools for large-scale data, and (2) Making sense of complex, heterogeneous data.

Weaknesses: LaHDAK has only two full-time researchers, 1 DR INRIA coming from the Database community and 1 CR CNRS coming from the AI community. All the other permanent members (11 out of 13) are faculty members who are busy teaching and with highly demanding managerial tasks. We have to intensify our efforts to be attractive wrt recruiting junior researchers at CNRS or INRIA. Another difficulty is that, in our field, private company R&D departments offer quite attractive jobs wrt to research challenges and salary.

Opportunities: Data and knowledge are ubiquitous and thus their management raises highly challenging issues not only from the side of computer science but also coming from other fields such as e-science, bioinformatics, SHS, ... As a consequence, we are frequently asked for academic and industrial collaborations.

The UPSay project is an opportunity for scientific collaborations. In particular, LaHDAK will naturally tighten its relationships with Télécom ParisTech (TPT) initiated for instance by the last recruitment of B. Cautis at UPSud working on social data management aspects and that of F. Suchanek, recruited at TPT in 2013, working on semantic Web, information extraction, and ontologies.

It is also expected that UPSay will be attractive for students and will bring highly educated Master Students allowing to increase locally recruited PhD students. Mélanie Herschel is leading the group working on the future computer science Master on Very Large Data and Knowledge.

Threats: The creation of UPSay offers potential opportunities wrt research, teaching, innovation. It would be naive to hide that the creation and up coming massive transformations related to UPSay are swallowing up work forces since more than three years at least and will require major efforts in the next five years at least. Senior members are of course contributing and assistant professors too which may weaken the research potential.

In September 2013, three assistant professors left the group (promotions). They were key members of the IASI and BD group and highly active especially wrt to the research activities at the intersection of Database and AI. Collaborations are of course going to continue. It is important to carefully manage the next recruitments in order to strengthen the LaHDAK group.

Scientific Programme

Research activities of the LaHDAK team are organized in 5 axes: Data and knowledge integration, Automated Reasoning, Web data management, Algorithms for very large distributed data sets, Complex and evolving data transformations.

Integration of data and knowledge

Scientific coordinator: N. Pernelle; Permanent members: N. Pernelle, C. Reynaud, B. Safar, F. Saïs
Key words: data linking, knowledge extraction, ontology alignment, semantic annotation, ontology enrichment

We will pursue our work on ontology-based approaches that aim to facilitate data integration. The evaluation of the quality of the results that can be obtained by such approaches stays a challenging issue. We will develop models and methods to evaluate the quality of declared (or automatically-generated) identity links between data items. Furthermore, we will also investigate how linking rules can be discovered and exploited when datasets contain erroneous data, or when data are poorly described. Much of this work will be done in the setting of the ANR project Qualinca, in collaboration with the Graphik group of the LIRMM (Montpellier) and the HADAS group of the LIG (Grenoble).

We will also pursue our work on the problem of maintaining semantic correspondences between heterogeneous ontologies in collaboration with the research center Henri Tudor (Luxemburg). The aim is to define appropriate adaptation strategies to apply to existing mappings in order to keep their validity over time. In the continuation of the work undertaken in semantic annotation, we will investigate approaches that aim to exploit semantically rich ontologies to enrich or refine annotations that are proposed by existing tools. A crucial point is that we are interested in developing data integration methods for real-world applications. Thus, we will continue to work with data provided by industrial partners or institutions such as ABES (Agence Bibliographique de l'Enseignement Supérieur), INA (Institut National de l'Audiovisuel) or the start-up WEPINGO. Besides, we have obtained a grant to promote the technologies developed in this activity in the setting of the IASI-Tools project which starts in October 2013. This project aims to develop a framework to integrate these tools and make them accessible.

Automated Reasoning

Scientific coordinator: M. Bienvenu; Associate members: F. Goasdoué; Permanent members: M. Bienvenu, P. Chatalic, P. Dague, N. Pernelle
Key words: Reasoning in description logic, reasoning in propositional logic, model-based reasoning, diagnosis, diagnosability, distributed reasoning

Within this activity, we will continue our work on automated reasoning in propositional logic and description logic.

In the propositional setting, we will pursue work related to diagnosis / diagnosability with an emphasis on distributed systems: from diagnosability to predictability analysis of distributed discrete-event systems; joint and complementary analysis of diagnosability and testability in distributed and concurrent systems (STIC AmSud project with VALS group) with emphasis on compositionality properties; use of (parallel) SAT solvers for diagnosis and diagnosability analysis of (distributed) systems after propositionalization (co-supervised thesis with LaBRI); advanced methods in propositional logic (BDD, SAT solvers), abductive, explanation-based and qualitative reasoning applied to metabolic paths analysis in metabolic networks (co-supervised thesis with BioInfo group and LaBRI).

Our research on description logics will mainly center on the problem of ontology-based data access and will seek to address two important challenges: scalability of query answering algorithms and robustness to inconsistencies. Specifically, we intend to develop novel querying algorithms which demonstrate improved scalability and applicability, and to perform detailed complexity analyses to explain what makes reasoning hard (or easy) and to help guide the selection of algorithms for particular applications. Much of the work will be carried out within the ANR JCJC project PAGODA and will involve collaborations with other project participants (LIRMM, LIG, IRISA) as well as researchers from foreign universities (Univ. of Bremen, Univ. of Liverpool, Univ. of Rome La Sapienza, Technical Univ. of Vienna).

Web data management

Scientific coordinator: B. Cautis; Permanent members: N. Bidoit, B. Cautis, M. Herschel, I. Manolescu, F. Saïs, E. Waller; Associate members: D. Colazzo, F. Goasdoué

Key words: Uncertain data, information extraction, semi-structured data, crowdsourcing, social networking, query optimization, materialized views, top-k, personalisation, updates and dynamic constraints

In this axis, we will continue our work in several key areas.

An important part of Web content and applications is created and exploited in a social fashion. Users' needs in real personalized and social-aware search require richer data models, for instance, capturing semantic annotations over semi-structured or unstructured data, or having multiple important facets such as recency, geo-location, social context and textual relevance. We also intend to focus on discovering and continuously refining user profiles in user centric applications (including crowdsourcing). Profiles are a cornerstone of successful applications, as they help better personalize content provided to users (collaborations with Xerox RCE, LIG, and industrial partners such as Skyrock).

Semistructured data is currently experiencing a comeback which cuts across many applications and is strongly connected to the "NoSQL" and "BigData" trends. In such applications, data is heterogeneous, complex-structured, may have errors and missing information, and thus may require probabilistic models. Classic database problems such as query optimization and query answering using views must be revisited in this context. We intend to broaden our study to richer models for probabilistic semi-structured data.

Concerning semantic Web data, a historic gap of expressive power and efficiency persists between database-style query evaluation (as commonly supported by DBMSs) and query answering (as considered in the KM and AI communities). The problem of efficiently answering (as opposed to merely evaluating) queries on Semantic Web data is still open, and we will continue working in this area. Other advanced languages and algorithms for semantic-rich semistructured data will be investigated as part of the joint Inria-UC San Diego team OakSaD (notably A. Deutsch).

Massively distributed algorithms for complex data

Scientific coordinator: I. Manolescu; Permanent members: N. Bidoit, B. Cautis, M. Herschel, I. Manolescu

Key words: distributed data bases, parallel data bases, massively parallel data management, cloud, Map/Reduce

The increasingly large volumes of complex digital data raised a need for scaling up of data management algorithms and systems. Promising avenues for attaining this scale-up are provided by large-scale distribution of data, for instance within clusters or in a cloud context, and parallel processing both across and within machines by exploiting multiple cores. Such parallel and distributed processing of data raises numerous challenges, because complex processing is often hard to decompose and parallelize across many computing units; further, the intricate nature of data itself makes it difficult to devise a good partitioning. We will work on distributed algorithms for efficiently processing complex data, in particular in a cloud computing context, with a focus on Big Data analytics. The algorithms we envision will build upon novel massively parallel computing frameworks, based on Map/Reduce but going well beyond. Another particularly important aspect is the need for indexing techniques that are flexible and generic enough, in order to help identifying fast not only the data that is required for a given task, but also the data sources that are the most useful. These research directions involve collaborations with the Technical University of Berlin, U. Dauphine, the LIG, the LIFL, U. Montpellier, UC San Diego and industrial players (Business et Decision).

Complex and evolving data transformations

Scientific coordinator: M. Herschel; Permanent members: N. Bidoit, B. Cautis, M. Herschel

Key words: data transformation analysis, provenance, re-writing of transformations, quality, business processes, workflow

We will pursue our objective of supporting developers during the development of complex data transformations that evolve over their lifecycle in three main directions that essentially correspond to extensions in technology, functionality, and scalability. Thus, the proposed solutions will benefit a wide variety of actors, including scientists whose results depend on the correctness and tuned configuration of scientific workflows, business analysts whose decisions rely on data output by complex and parameterized data transformations, or Web developers devising mash-up or more complex data integration applications.

First, we will extend to more complex data models (XML or RDF) and transformation specification paradigms (XSLT, scientific workflows, or data centric processes). Second, we will devise algorithms and methods to support further phases of transformation development, including the semi-automatic suggestion of transformation corrections and modifications upon requirement change specification and the computation of modification impact on transformation results (useful for instance for what-if analysis or tuning of scientific workflows). Finally, we will study how to efficiently apply our methods in a scalable way in real-world applications. Our solutions will target different applications domains where we plan to collaborate with national and international partners, i.e., domains of business analytics (IBM, UC Santa Cruz), business processes (UC San Diego), and scientific workflows (BioInfo group, Humboldt University Berlin).



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Journal articles

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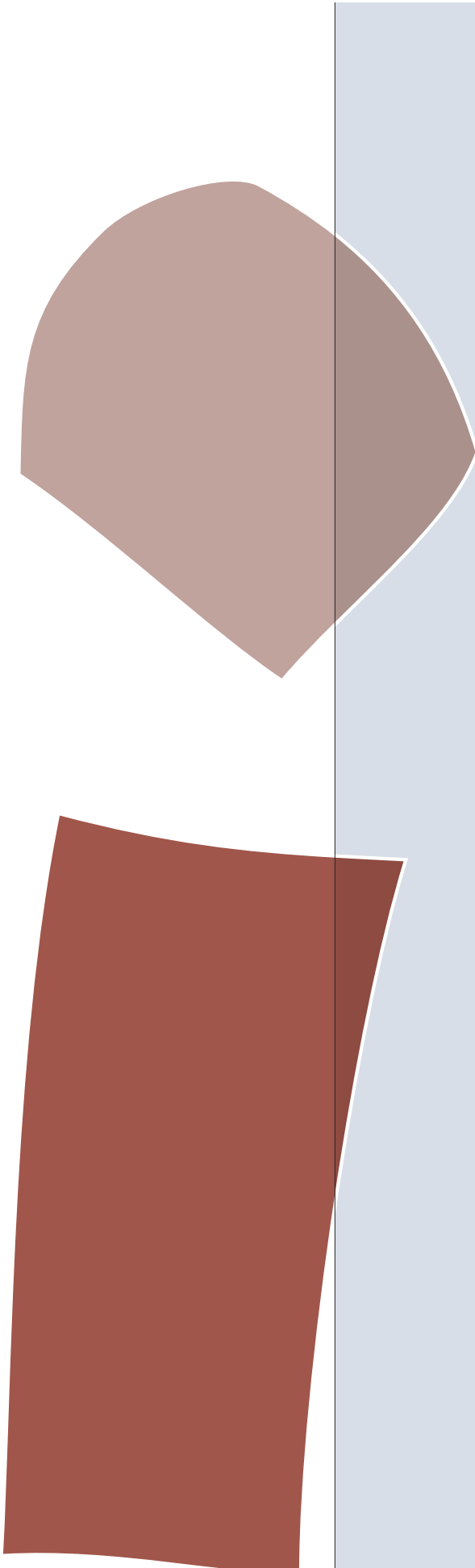
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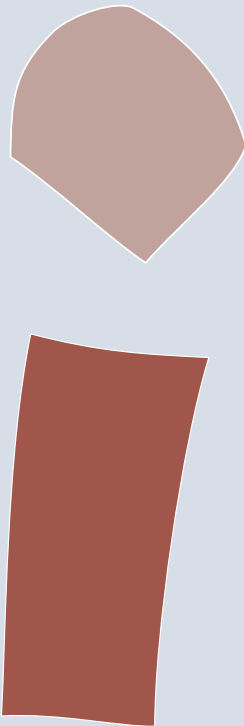
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7/ ParSys

Parallel Systems



équipe **Systèmes Parallèles**

Responsable: Marc Baboulin, Joël Falcou

L'équipe ParSys est un groupe de recherche qui comprend des chercheurs de l'Université Paris-Sud et de l'Inria Saclay. Elle est spécialisée dans la conception et l'amélioration d'algorithmes parallèles et distribués ainsi que dans la configuration et la programmation des architectures matérielles les plus récentes.

L'objectif scientifique majeur de l'équipe ParSys est donc la description, la compréhension, l'évaluation et le contrôle des phénomènes qui concernent les environnements parallèles et distribués, allant des concepts aux expérimentations sur architectures hétérogènes et massivement parallèles.

Les principaux domaines de recherche étudiés par ParSys sont: les algorithmes distribués et les protocoles de population, le calcul scientifique haute-performance et les bibliothèques logicielles numériques, les langages dédiés et la programmation générative, la compilation et l'optimisation de codes.



Parallel Systems

Head: Marc Baboulin, Joël Falcou

The ParSys team is a research group that involves researchers from University Paris-Sud and Inria Saclay. ParSys specializes in designing and improving parallel and distributed algorithms and in customizing and programming the most recent hardware architectures.

The major scientific goal of the ParSys team is thus the description, understanding, evaluation and control of the phenomena that occur in distributed or parallel environments, ranging from concepts to experiments on heterogeneous and massively parallel architectures.

The main research areas addressed par ParSys include: distributed algorithms and population protocols, high-performance scientific computing and numerical software libraries, domain specific languages and generative programming, compilation and code optimization.

Research Group members

The PARSYS team includes 11 permanent members (1 DR-INRIA, 4 Professors, 1 CR-INRIA, 5 Assistant Professors), 13 doctoral students.

The new team is directed by Marc Baboulin, aside with Joël Falcou as co-director.

Permanent Members (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
BABOULIN	Marc	PR	PARIS SUD
BEAUQUIER	Joffroy	PR	PARIS SUD
BURMAN	Janna	MCF	PARIS SUD
EISENBEIS	Christine	DR	INRIA
ETIEMBLE	Daniel	PR	PARIS SUD
FALCOU	Joël	MCF	PARIS SUD
FURSIN	Grigori	CR	INRIA
GRUAU	Frédéric	MCF	PARIS SUD
LACASSAGNE	Lionel	MCF	PARIS SUD
ROSAZ	Laurent	MCF	PARIS SUD
ROZOY	Brigitte	PR	PARIS SUD

Doctoral Students (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Funding</i>	<i>Institution</i>
BAGNERES	Lénaïc	CDD sur Contrat	INRIA
BLANCHARD	Peva	Alloc. Ministère	PARIS SUD
CABARET	Laurent	salarié	PARIS SUD
ESTERIE	Pierre	Alloc. Ministère	PARIS SUD
FERREIRA LEITE	Alessandro	ETR	PARIS SUD
KRUSE	Michael	Alloc. Ministère	PARIS SUD
LAGUZET	Florence	Alloc. Ministère	PARIS SUD
MARTSINKEVICH	Tatiana	Contrat	INRIA
MASLIAH	Ian	Alloc. Ministère	PARIS SUD
QU	Long	Alloc. Ministère	PARIS SUD
REMY	Adrien	Alloc. Ministère	PARIS SUD
TRAN TAN	Antoine	Alloc. Ministère	PARIS SUD
WANG	Yushan	Contrat	PARIS SUD

The ParSys team results from the merging of the former Parall and Archi teams.

Archi: Synthetic presentation

Nom du responsable de l'équipe : **Daniel ETIEMBLE**

Effectifs de l'équipe

Au premier janvier 2008, 9 permanents; enseignants-chercheurs: 3 MdC, 1 PREx, chercheurs INRIA: 2 CR1, 3 DR1. Au 30 juin 2013, 6 permanents; enseignants-chercheurs: 3 MdC, 1 PREx, chercheurs INRIA: 1 CR1, 1 DR1

Personnels ayant quitté l'équipe pendant le contrat en cours: 4

- Hugues Berry (CR1 Inria), Albert Cohen (DR Inria) and Olivier Temam (DR Inria), anciens membres du projet INRIA ALCHEMY ont quittés l'équipe en 2011
- Cedric Bastoul, (MCF Paris Sud), recruté en tant que Professeur à Strasbourg en septembre 2013.

Nombre de recrutements réalisés au cours de la période considérée et origine des personnels: 1

- Lionel Lacassagne (MCF-HDR Paris Sud), transféré de l'IEF au LRI en 2012

Production scientifique au cours de la période écoulée

1. Générateur de code CLoog intégré à la version publique du compilateur GCC depuis la version 4.4.0 (bibliothèque externe). CLoog est aussi intégré au compilateur LLVM et les compilateurs de haut niveau Pluto et PoCC.
2. MILEPOST GCC : Compilateur auto-adaptable fondé sur le " machine learning ".
3. cBench : Archive publique de connaissances en ingénierie informatique et mise à disposition de benchmarks et de jeux de données.
4. Boost.SIMD : bibliothèque C++ simplifiant l'utilisation du matériel SIMD dans un modèle de programmation standard C++.
5. Création de l'entreprise Metascale en mars 2012 : éditeur de logiciel d'aide au développement d'applications de calcul haute performance.

Bilan quantitatif des publications de l'équipe

• Article de revues: majeure internationale: 23, autre: 3	• Livres et chapitres de livres: 1
• Article de conférences: majeure internationale: 78, autre: 16	• Édition de livres: 0

5 publications majeures

- LN Pouchet, C Bastoul, A. Cohen and S. Cavazos, " Iterative optimization in the polyhedral model: Part 2, multidimensional time. In Proceedings of the ACM Sigplan conference on Programming Language Design and Implementation (PLDI'08), pages 90-100, Tucson, Arizona, June 2008.
- F. Gruau, C. Eisenbeis and L. Maignan, "The foundation of self-developing blob machines for spatial computing", in Physica : Non linear Phenomena", volume 237, number 9, pages 1282-1301, 2008.
- G. Fursin et al, "MILEPOST GCC: machine learning enabled self-tuning compiler" in International Journal of Parallel Programming (IJPP), June 2011, Volume 39, Issue 3, pages 296-327
- K. Hamidouche, F.M. Mendonca, J. Falcou, ACMA de Melo and D. Etienne, " Parallel Smith Waterman Comparison of Multicore and Manycores Computing Platforms with BSP++ ", in International Journal of Parallel Programming (IJPP), 2012, pages 1-26.
- H. Ye, L. Lacassagne, D. Etienne, L. Cabaret, J. Falcou, A. Romero and O. Florent, " Impact of high level transforms on high level synthesis for motion detection algorithm " in Signal and Image Processing (DASIP) conference, 2012, pages 1-8.

5 (max) documents majeurs (autres que publications)

- Générateur de code CLoog intégré à la version publique du compilateur GCC depuis la version 4.4.0 (bibliothèque externe). CLoog est aussi intégré au compilateur LLVM et les compilateurs de haut niveau Pluto et PoCC.
- MILEPOST GCC : Compilateur auto-adaptable fondé sur le " machine learning ".
- cBench : Archive publique de connaissances en ingénierie informatique et mise à disposition de benchmarks et de jeux de données.
- Boost.SIMD : bibliothèque C++ simplifiant l'utilisation du matériel SIMD dans un modèle de programmation standard C++.

- Livre : G. Dowek, JP Archambaud, E. Bacceli, C. Cimelli, A. Cohen, C. Eisenbeis, T. Viéville, B. Wack, " Informatique et Sciences du Numériques - Spécialité ISN en Terminale S ", 2012

5 (max) faits illustrant le rayonnement ou l'attractivité académique

- Membres de HiPEAC (European Network of Excellence on High Performance and Embedded Architecture and Compilation) : C. Bastoul, C. Eisenbeis, G. Fursin
- Membres du Comité de normalization C/C++ ISO/IEC JTC1/SC22/WG21 : J. Falcou, L. Lacassagne

5 (max) faits illustrant les interactions de l'équipe avec son environnement socio-économique ou culturel

- Création de l'entreprise Metascale en mars 2012 : éditeur de logiciel d'aide au développement d'applications de calcul haute performance.

Principales contributions de l'équipe à des actions de formation

- Responsabilité de la Licence Professionnelle par apprentissage de Sécurité des Systèmes et Réseaux Informatiques à l'IUT d'Orsay : C. Bastoul (2008 à 2011)
- Responsabilité de la Licence Professionnelle par apprentissage de Développement en Environnement Réparti à l'IUT d'Orsay : C. Bastoul depuis 2012
- Responsabilité du Master Informatique de l'UFR d'Orsay : D. Etiemble depuis 2012
- Responsabilité de la filière informatique par apprentissage de Polytech Paris Sud : J. Falcou

Research Group Members and evolution since 2008

Permanent Members (June 30th, 2013)

<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
BASTOUL	Cédric	MCF	PARIS SUD
EISENBEIS	Christine	DR2	INRIA
ETIEMBLE	Daniel	PREX	PARIS SUD
FALCOU	Joël	MCF	PARIS SUD
FURSIN	Grigori	CR2	INRIA
GRUAU	Frédéric	MCF	PARIS SUD
LACASSAGNE	Lionel	MCF	PARIS SUD

Group evolution

- Hugues Berry (CR1 Inria), Albert Cohen (DR Inria) and Olivier Temam (DR Inria), former members of the INRIA Alchemy project, left the group in 2011.
- Cedric Bastoul, (MCF Paris Sud), has been promoted Professor in Strasbourg starting in September 2013.
- Lionel Lacassagne (MCF-HDR Paris Sud) has moved from IEF laboratory to LRI in 2012

The Parallel Architecture group has been reorganized in October 2012 after the completion of the Alchemy project by regrouping some INRIA people of this group, members of the ancient LRI architecture group and some members of the LRI parallel group. In this report, we present the overall results in "Architectures and Compilers" that have been obtained from 2008 to 2013 without distinguish the different periods and the affiliation of the "compiler and architecture" researchers during this period. However, to keep the presentation simple, we focus on the presentation of the research program, activities and results of the group as it was organized from 2012 to 2013. Obviously, it is a 5-year research report, even when some part was realized within another LRI group (Parallel group for D. Etiemble and J. Falcou) or another CNRS laboratory (L. Lacassagne). The contributions of H. Berry, A. Cohen and O. Temam are not described in this report. They are very significant, as it can be observed in the bibliography.

Research Description

The gap between "peak performances" and "sustained performances" of computer systems has always been an issue. In the last decade, the arrival of multi-core processors has made the issue even more critical for any type of systems: personal computers, servers, massively parallel machines and high-end embedded systems. Both "memory wall" and "heat wall" must be addressed. The parallel architecture group focuses on program optimization according to the architectural features of multi-cores and hardware accelerators to reduce the gap between peak and sustained performances. The main goal is to provide non expert users that are familiar with standard sequential coding with tools that generate codes with performance close to hand-written code performance by expert programmers. Program optimization is addressed at different levels:

- Compilation techniques and tools
- Optimization of algorithms and source code
- Development of high level libraries

The efficiency of these different approaches is evaluated through intensive benchmarking on benchmarks and applications from HPC and image processing domains. As program optimization is strongly dependent upon the predictable or possible changes in hardware technologies and computation models, the group is also involved in green computing and new computing models such as spatial computing or reverse computing.

Compilation

Participants: C. Bastoul, G. Fursin

The group has a long experience in research and development on polyhedral compilation techniques for automatic optimization and parallelization. In the last period, new methods have been developed for code generation for hardware accelerators, iterative compilation in the polyhedral model and parametric tiling published at top conferences on compilation, including PLDI, PoPL or SC. The contributions involved an important technology transfer to production compilers, including to GNU GCC (GCC 4.4.0 published in 2009 included the "GRAPHITE" polyhedral framework initiated in the team) and to Reservoir Labs Inc. R-Stream. The group has also made innovative research and development based on machine learning techniques to produce the first world's first machine learning based self-tuning compiler (MILEPOST GCC). It is based on the novel concept of crowd sourcing analysis, modeling, design and auto-tuning of computer systems and led to a compiler community (cTuning.org and Collective Mind). This work has also initiated a new publication model where experimental results are continuously shared, validated, systematized, and extended by the community.

Highlights

- The CLoog code generator has been integrated to the public version of GCC since the 4.4.0 version as an external library. CLoog is also integrated within LLVM compiler and Pluto and PoCC high level compilers.
- - MILEPOST GCC is an auto-tuning compiler based on machine learning techniques.
- cBench is a public repository of knowledge in computer engineering and releasing collaborative benchmarks and datasets.
- A novel publication model in computer engineering has been initiated, where experimental results, tools and data sets are shared, validated and improved by the community (cTuning.org and <http://ctuning.org/making-computer-engineering-a-science-2013>)

Optimization of algorithms and source code

Participants: D. Etiemble, L. Lacassagne

Optimizing source codes according to the architectural features of the processors (SIMD instructions, memory hierarchy) can lead to significant performance gains, according to different possibilities:

- Defining new versions of algorithms, specifically for irregular algorithms
- Fusing different operators and/or loop nests to limit the effect of the cache hierarchy
- Optimizing for a better and easier use of SIMD instructions
- Modifying data formats: for signal and image processing, either floating point or integer representations can be used, and non standard representation can be considered for embedded applications (FPGA).

Optimizing source codes can also contribute to reduce power consumption.

Highlights

- Processor customization with Catapult-C. In a common research work with ST-Microelectronics, High Level Transforms (HLT) have been applied to signal processing algorithms (FIR, IIR) and image processing algorithms (motion detection, morphological filtering). The different versions have been synthesized with Catapult-C for a 65-nm CMOS technology. The HLTs can reduce the energy consumption by a factor x5.

- Two real-time multi-target tracking algorithms have been developed. The first one is a robust color mean-shift tracking with automatic color space switch. The second one implements a real-time co-variance tracking algorithm. The algorithms have been parallelized and vectorized (Intel SSE and ARM Neon) to reach real-time on dual Cortex A9 systems. This algorithm is used in the European project ITEA2 SPY.
- The Light Speed Labeling (LSL) algorithm is the fastest one for connected component labeling in image processing. Compared to other labeling algorithms, it is less sensitive to the processed data.

High level libraries

Participants: J. Falcou, L. Lacassagne

During the last decade, parallel computing systems evolved drastically. The simple multi-processor system has been superseded by machines exposing multiples, hierarchical and heterogeneous levels of parallelism. The group research focused on providing new software tools to address the complexity of modern parallel architecture while maintaining a high level of abstraction and minimizing disruptions in the development process of users. To fulfill both of these goals, we investigated the applicability of Generic and Generative Programming to the development of C++ parallel computing tools. Those techniques allowed to developing various so called « Active Libraries » - i.e. libraries that can reconfigure themselves at compile time – based on high level, domain specific programming models. Those libraries, backed up by an architecture description layer, were shown to be portable across a wide set of parallel systems (ranging from the Cell processor to large scale HPC clusters) and demonstrated performances within the range of expert code. The main scientific achievements are:

- Adapting the Generative Programming idioms to support architecture-based code generation process by using an architecture description system and adapting it to work with heterogeneous system like GPGPU, enabling multi-stage programming to be a feasible technique in C++.
- Showing that high levels of abstractions and performances can coexist in a tool as simple as a C++ library. Efficiency of 80 or 90 % was achieved on system ranging from GPGPU to 6000+ cores clusters without needing non-standard compilers.
- Developing various demonstrators of such technologies on various application domains like Fluid Simulation, Linear Algebra or Image Processing.
- A tech start-up (Metascale) has been launched in March 2012. MetaScale mission is to assist businesses in the exploration and the mastery of high-performance computing systems. It provides a range of versatile software tools that allow to quickly making the most of modern machines while still ensuring the durability and portability of the source code.

Highlights

- BSP++ is a C++ library based on the BSP model.
- Boost.SIMD is a C++ library that simplified the coding with SIMD instructions in a standard C++ programming model.
- NT2 is a library based on a C++ Embedded Domain Specific Language using generic and generative programming

Transversal research activities: new computing models

Participants: C. Eisenbeis, F. Gruau

spatial computing

The objective is to achieve high performance, general purpose, programming of uniform spatial computing media. Such a medium is a homogeneous assembly of computing units with local neighbour-to-neighbour communication. On one hand, this locality principle enables to consider very large media;

on the other hand, spatial consideration turns the programming into a very difficult task. A programming model called Self Developing Systems (SDS) has been proposed to alleviate the programming issues. An SDS is a Finite State Automaton (FSA) with specific output action that let an initial automaton duplicate and create links, thus developing a network of automata. When implemented in a distributed manner, an SDS layer is like a distributed operating system, managing the placement of light threads (the FSA) and communication channels, as they duplicate or delete. Thus, an SDS layer transforms the spatial computing medium into a higher level, virtual machine, which is easier to program because placement is handled at the hardware level. An environment has been developed for 2D complex cellular automata (more than 20,000 logic gate per automaton). It includes the object description, a compiler, an optimizer and a debugger.

reverse computing

Reversible computing is a model of computing where the computational process to some extent is reversible, i.e., time-invertible. Theoretical aspects have been addressed by evaluating the spatial complexity of reversible computable Direct Acyclic Graph (DAG). Practical applications have been investigated through rematerialization in register allocation (recomputing values instead of spilling them in memory when registers run out). An algorithm has been written to perform reverse register materialization for the high memory demanding LQCD (Lattice Quantum Chromo Dynamics) application that demonstrates important gains on register pressure.

7/ Archi

Collaborations

Participation to national and international collaborative research projects

- ANR MARS, ANR, Coordinator: L. Torres, LIRMM. Partners: LIRMM, IEF, LRI, CEA-LIST, SPINTEC, EADS
- SPY (www.itea2-spy.org), ITEA2, coordinator: E. Munier (EADS). Partners: Arc Informatique, Aselsan, Cassidian (EADS), CogVis, C2Tech, ENSTA ParisTech, Eolane, IEF, Institut Telecom, Kilosoft, Mirasys, PPSL, Roger-GPS, VTT
- Oparus, ANR, coordinator: S. Le Berre (CEA). Partners: CEA, EADS, EDF, M2M, IEF (Univ. Paris-Sud), CAPS Entreprise
- ITOC, Digiteo, coordinator: S. LE GOUPIL (CEA). Partners: CEA, Univ. Paris-Sud, LIX
- FLUCTUS, Digiteo, coordinator: L. PASTUR (LIMSI). Partners: LIMSI, Univ. Paris-Sud
- MANY, ITEA2 program funded by DGCIS (2011-2014), Coordinator: XDIN. European consortium with industrial emphasis, see <http://www.eurekamany.org/>
- OpenGPU, Paris-Area Systematics Research Project (2010-2012), Coordinator: Wallix. Large French academic and industrial consortium, see <http://www.opengpu.net/>
- PetaQCD, ANR (2008-2012), Coordinator: LAL (Laboratoire de l'Accélérateur Linéaire).
- MILEPOST, FP6 (2008-2010), EU, Coordinator: M. O'Boyle, technical coordinator: G. Fursin. Partners: INRIA, University of Edinburgh, IBM, ARC, CAPS Entreprise Large French academic and industrial consortium, see <https://www.petaqcd.org/>
- ACOTES, FP6 (2006-2009), Coordinator: Philips Research. Partners: Philips, IBM, Inria, NOKIA, STMicroelectronics, UPC.

Collaborations with other laboratories

- A. Cristina de Melo, Université de Brasília, Brésil : Parallel biological sequence comparison on heterogeneous high performance computing platforms with BSP++; K. Hamidouche, F. Machado Mendonca, J. Falcou, D. Etiemble, A. C. de Melo
- A. Manzanera, ENSTA ParisTech, Journal of RealTime Image Processing (JRTIP) 2008 "High Performance Motion Detection: Some trends toward new embedded architectures for vision systems" L. Lacassagne, A. Manzanera, J. Denoulet, A. Mérigot, ICIP 2009 "Motion Detection: Fast and robust algorithms for embedded systems", L. Lacassagne, A. Manzanera, A. Dupret. IEEE International Conference on Image Processing, 2009, 2009, pp. 3265-3268.
- M. Gouiffès, LIMSI, Journal of Real Time Image Processing, "Color tracking with contextual switching: Real-time implementation on CPU" F. Laguzet, A. Roméro, M. Gouiffès, L. Lacassagne, D. Etiemble, 2013, to be published. ICIP 2013 "Total Bregman divergence for multiple object tracking", A. Roméro, M. Gouiffès, L. Lacassagne, IEEE International Conference on Image Processing, 2013. Mirage 2013 "Enhanced Local Binary Covariance Matrices (ELBCM) for texture analysis and object tracking", A. Roméro, M. Gouiffès, L. Lacassagne, International Conference on Computer

Vision / Computer Graphics Collaboration Techniques and Applications, ACM International Conference Proceedings Series, 2013

- L. Cabaret, Ecole Centrale de Paris, DASIP 2012 "Impact of High Level Transforms on High Level Synthesis for motion detection algorithm", H. Ye, L. Lacassagne, D. Etiemble, L. Cabaret, J. Falcou, A. Romero, O. Florent, IEEE International Conference on Design and Architectures for Signal and Image Processing, 2012.
- S. Sadayappa's group at Ohio State University: optimizing compilation (12, ?, ?, 95)
- Reservoir Labs Inc. on automatic parallelization in the polyhedral model (?, ?, 70, 105)

Other Collaborations

- L. Rauchwerger, Texas A&M, USA: STAPL Library
- H. Kaiser, Louisiana State University, USA: HPX Library
- S. Thiria and F. Badran, LOCEAN Institut Pierre-Simon Laplace: optimizing codes for data assimilation
- M. Amini, B. Creusillet, SILKAN: pertinent high level information for optimizing compilers
- Multimedia Division Group, ARM (UK): collaborative auto-tuning and machine learning for ARM-based heterogeneous architectures using cTuning framework
- Compiler Division, STMicroelectronics (France): machine-learning based compiler tuning for customer applications using cTuning framework

Participation to national and international networks

- Thematic sessions in EU HiPEAC network of excellence on cTuning-based reproducible, collaborative and systematic research in computer engineering: G. Fursin, organizer 2011-current.
- GDR ISIS, L. Lacassagne, C. Benchmarking, in charge of animation
- HiPEAC European Network of Excellence, C. Bastoul and L. Lacassagne, member
- French compilation association, L. Lacassagne, member
- GDR GPL - LAHMA: J. Falcou, 2009-2013, member
- IFIP WG 10.3, C. Eisenbeis, 2008-2013, member

Participation to "investissement d'avenir" program

7/ Archi

Volunteer Professional Service

Management Positions in Scientific Organisations

- CS Paris Sud , C. Eisenbeis, member (2008-2013)
- Intel/Exascale Computing Research Lab: G. Fursin, one of the founders, group manager and director of research (2010-2011)
- CEVU Paris Sud, D. Etiemble, member (2004-2010)
- CA INRIA , C. Eisenbeis, member (2006-2010)
- Vice-chair of IFIP TC-10, D. Etiemble (2002-2009)
- IEEE Computer Society representative within IFIP-TC10, D. Etiemble (1999-2009)

Organisation of Conferences and Scientific Events

- ADAPT'13, *3rd International Workshop on Adaptive Self-Tuning Computing Systems*, Germany, 2013, G. Fursin, workshop organizer

- cTuning'13, *HiPEAC thematic session on making computer engineering a science at ACM FCRC*, France, 2013, G. Fursin, thematic session organizer
- EXADAPT'12, *2nd International Workshop on Adaptive Self-Tuning Computing Systems for the Exaflop Era*, UK, 2012, G. Fursin, workshop organizer
- cTuning'12, *EU HiPEAC thematic session: Collective characterization, optimization and design of computer systems*, Sweden, 2012, G. Fursin, thematic session organizer
- EXADAPT'11, *ACM SIGPLAN 1st International Workshop on Adaptive Self-Tuning Computing Systems for the Exaflop Era*, USA, 2011, G. Fursin, workshop organizer
- IMPACT, *International Workshop on Polyhedral Compilation Techniques*, Chamonix, 2011: C. Bastoul, organizer and co-chair
- SMART'11, *5th Workshop on Statistical and Machine learning approaches to ARchitecture and compilaTion*, France, 2011: G. Fursin, workshop organizer
- SMART'10, *4th Workshop on Statistical and Machine learning approaches to ARchitecture and compilaTion*, Italy, 2010: G. Fursin, workshop organizer
- GROW'10, *International Workshop on GCC Research Opportunities co-located with HiPEAC*, Italy, 2010: G. Fursin, workshop organizer
- SMART'09, *3rd Workshop on Statistical and Machine learning approaches to ARchitecture and compilaTion*, Cyprus, 2009: G. Fursin, workshop organizer
- SMART'08, *2nd Workshop on Statistical and Machine learning approaches to ARchitecture and compilaTion*, Sweden, 2008: G. Fursin, workshop organizer

Working Groups

- IFIP WG 10.3 : C. Eisenbeis, member, 2008-2013
- EU commission workgroup to prepare joint call with Russia within EU FP7 program (related to GPGPU, programming models, performance and power tuning): G. Fursin, invited EU expert 2011

Participation to editorial committees

- Preparing EU HiPEAC roadmap for 2012-2020: G. Fursin, contributor and reviewer

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Honors

Prizes and Awards

- C. Bastoul, *HiPEAC European Network of Excellence Paper Award for Loop Transformations: Convexity, Pruning and Optimization at ACM PoPL* (2011)
- C. Eisenbeis, *SBAC-PAD best paper award for High Performance by Exploiting Information Locality through Reverse Computing*(2011)
- G. Fursin, *HiPEAC paper award for the ACM PLDI'10 paper "Evaluating Iterative Optimization across 1000 Data Sets"* (2010)
- C. Bastoul, *HiPEAC European Network of Excellence Paper Award for Iterative Optimization in the Polyhedral Model: Part II, Multidimensional Time at ACM PLDI* (2008)

Keynote Addresses

International

- C. Bastoul, *Innsbruck Computer Science Colloquium*, 2010: Automatic Parallelization in the Polyhedral Model

- G. Fursin, *Conference on Advanced Topics and Auto Tuning in High Performance Scientific Computing in NTU, Taiwan, 2013*: Statistical crowdsourcing of auto-tuning
- G. Fursin, *International Workshop on Automatic Performance Tuning co-located with International Conference on Computational Science in Barcelona, Spain, 2013*: Crowdsourcing auto-tuning: challenges and possible solutions

France

- L. Lacassagne, *Canum*, Mini-symposium CANUM 2010 "Modélisation et calcul scientifique : les enjeux en génération d'images". Parallélisation d'opérateurs de TI : multi-coeurs, Cell ou GPU

Other Honors

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Evaluation of Research

Editorial Boards

International

- IJPP, *International Journal of Parallel Programming*, Springer: C. Eisenbeis

National

Program Committees

Chair

- IMPACT, *International Workshop on Polyhedral Compilation Techniques*, C. Bastoul (2011)

Member (international events)

- PACT, *International Conference on Parallel Architectures and Compilation Techniques*, C. Bastoul (2013)
- IPDPS, *IEEE International Parallel and Distributed Processing Symposium*, G. Fursin (2013)
- CC, *International Conference on Compiler Construction*, G. Fursin (2013)
- IMPACT, *International Workshop on Polyhedral Compilation Techniques*, C. Bastoul (2012-2013)
- MUCOCOS, *International Workshop on Multi-/Many-core Computing Systems*, G. Fursin (2012-2013)
- NPC, *International Conference on Network and Parallel Computing*, C. Eisenbeis (2012)
- UCNC, *International Conference on Unconventional Computation*, C. Eisenbeis (2012)
- HiPEAC/ACM TACO, *International Conference on High-Performance and Embedded Architectures and Compilers*, G. Fursin (2012)
- PARMA, *International Workshop on Parallel Programming and Run-Time Management Techniques for Many-core Architectures*, C. Bastoul (2011-2012)
- CGO, *International Symposium on Code Generation and Optimization*, G. Fursin (2011)
- *Computing Frontiers*, C. Bastoul (2009)
- DATE, *International Conference on Design, Automation and Test in Europe*, C. Bastoul (2009)
- SSS, *International Symposium on Stabilization, Safety and Security of Distributed Systems*, C. Bastoul (2009)
- SCOPES, *Software and Compilers for Embedded Systems*, C. Eisenbeis, (2009)
- ICPADS, *International Conference on Parallel and Distributed Systems*, G. Fursin (2009)
- iWAPT, *International Workshop on Automatic Performance Tuning*, G. Fursin (2009)
- IPDPS, *IEEE International Parallel and Distributed Processing Symposium*, G. Fursin (2008)

Member (national events)

- Institut Telecom call "Futur et Ruptures": C. Bastoul (2012)
- SympA, Symposium en Architectures Nouvelles de Machines, D. Etiemble(2008-2013)

Evaluation Committees and Invited Expertise

International

- Open grant competition of the Russian Federation to attract leading scientists to Russian universities with a total budget of around 300,000,000 euros, G. Fursin (2011)

National

- AERES visiting committee : D. Etiemble, chair for LCOMS (Metz, 2011)
- AERES visiting committee : D. Etiemble, member for LIP6 (Paris, 2008 and 2012, LITA (Metz, 2008), LISIC (Calais, 2008), IRIT (Toulouse, 2009), Verimag (Grenoble, 2010), IRISA (Rennes, 2010), ICube (Strasbourg, 2011).

Other evaluation activities

- CNU27 (University National Board - computer science): D. Etiemble, chair(2008-2011)
- CNU-specific group : D. Etiemble, vice-chair(2008-2009), chair (2010-2011)

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Interactions with the social, economic and cultural environment

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
DIGITEO	GALEE	INRIA	12.2007 / 36 mo.	93.60 k€
Contrat européen	OMP	INRIA	01.2008 / 24 mo.	197.51 k€
	PRA INRIA-ICT-CAS	INRIA	01.2007 / 24 mo.	13.00 k€
Contrat européen	TERAFLUX	INRIA	01.2010 / 48 mo.	813.45 k€
ANR	Cosinus-PETAQCD	INRIA	01.2009 / 36 mo.	123.14 k€
ANR	archi2Neu	INRIA	12.2009 / 36 mo.	149.76 k€
Contrat européen	HiPEAC 2	INRIA	02.2008 / 48 mo.	295.00 k€
Private contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
Pole de compétitivité	OPEN GPU	INRIA	12.2009 / 1 mo.	158.79 k€

Piplib - Parametric Integer Programming Library

<http://www.piplib.org/>

Contact: BASTOUL

CandI - Chunky Dependence Analyzer

<http://www.lri.fr/~bastoul/~bastoul/#DEVELOPMENT>

Contact: BASTOUL

CLooG - Chunky Loop Generator

<http://www.cloog.org>

Contact: BASTOUL

Clay - Clay

Contact: BASTOUL

FM - FM: the Fourier-Motzkin library

<http://www-rocq.inria.fr/~pouchet/software/fm/fm.html>

Contact: BASTOUL

Clan - Chunky Loop Analyzer

<http://www.lri.fr/~bastoul/development/clan/>

Contact: BASTOUL

PoCC - the Polyhedral Compiler Collection

<http://www-roc.inria.fr/~pouchet/software/pocc>

Contact: BASTOUL

LeTSeE - LeTSeE: the LEGal Transformation Space Explorer

<http://www-rocq.inria.fr/~pouchet/software/letsee/>

Contact: BASTOUL

OpenScop - OpenScop

<http://repo.or.cz/w/openscop.git>

Contact: BASTOUL

NT2 - The Numerical Template Toolbox

<http://nt2.lri.fr>

Contact: FALCOU

Metaphore - Metaphore

Contact: FALCOU

BSP++ - The C++ Bulk Synchronous Parallelism Library

<http://www.github.com/jfalcou/bsppp>

Contact: FALCOU

Quaff - Quaff: Dataflow EDSL for Parallel Programming

<https://github.com/MetaScale/quaff>

Contact: FALCOU

CELL-MPI - MPI Framework for the CELL Processor

<http://cell-mpi.lri.fr>

Contact: FALCOU

GCC ICI - GCC Interactive Compilation Interface

<http://ctuning.org/ici>

Contact: FURSIN

Polyhedral Transformation in Open64 - Polyhedral Transformation in Open64

Contact: TEMAM

CAPSULE - CAPSULE

<http://alchemy.futurs.inria.fr/capsule>

Contact: TEMAM

Unisim - UNISIM: UNited SIMulation environment

<http://unisim.org>

Contact: TEMAM

Patents

FR1059649 - Cell-MPI brevet - Procédé de synchronisation et de transfert de données entre des processeurs reliés par des canaux DMA

Contact: FALCOU

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Training and Education

Graduate Courses

- M2R NSI, Univ. Paris-Sud, *Architectures matérielles pour les systèmes embarqués et la haute performance* : D. Etiemble, L. Lacassagne
- M2R NSI, Univ. Paris-Sud, *Calcul Haute Performance* : J. Falcou
- M2R NSI, Univ. Paris-Sud, *Optimisations et compilation* : C. Eisenbeis
- M2R Informatique, Univ. Paris-Sud, *Future Computer Systems* : G. Fursin

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Thesis

Habilitation à Diriger des Recherches	
Name	Defense
Lionel LACASSAGNE	05.2010
Cédric BASTOUL	12.2012

Defended thesis				
<i>Name</i>	<i>Start</i>	<i>Defense</i>	<i>Funding</i>	<i>Advisor</i>
Mouad BAH	01.09.2007	21.12.2011	CDD sur contrat INRIA	EISENBEIS
Charly BECHARA	15.01.2009	08.12.2011	Alloc. CEA	ETIEMBLE
Olivier CERTNER	01.09.2007	15.12.2010	CIFRE	TEMAM
Boubacar DIOUF	01.10.2007	15.12.2011	Alloc. Ministère	COHEN
Khaled HAMIDOUCHE	01.09.2008	10.11.2011	Alloc. Ministère	ETIEMBLE
Taj Muhammad KHAN	01.09.2007	06.05.2011	CDD sur contrat INRIA	TEMAM
Zheng LI	01.10.2006	13.12.2010	CDD sur contrat INRIA	TEMAM
Luidnel MAIGNAN	01.10.2007	08.12.2010	Alloc. Ministère	EISENBEIS
Pierre PALATIN	01.10.2004	05.09.2008	bdl CNRS	TEMAM
Stéphane PISKORSKI	01.10.2005	12.10.2009	Alloc. Ministère	ETIEMBLE
Louis-Noël POUCHET	01.10.2006	18.01.2010		COHEN
Benoît SIRI	00.00.0000	18.12.2008		BERRY
Guangye TIAN	01.10.2007	28.06.2011	Alloc. ENSTA	ETIEMBLE
Konrad Iwo TRIFUNOVIC	01.09.2007	04.07.2011	CDD sur contrat INRIA	COHEN
Ramakrishna UPADRASTA	01.01.2009	13.03.2013	Alloc. Ministère	COHEN

Thesis in progress			
<i>Name</i>	<i>Start</i>	<i>Funding</i>	<i>Advisor</i>
Lénaïc BAGNERES	01.10.2012	CDD sur contrat INRIA	EISENBEIS
Laurent CABARET	01.12.2012	salarie	LACASSAGNE
Pierre ESTERIE	01.10.2010	Alloc. Ministère	ROZOY
Alessandro FERREIRA LEITE	01.10.2012	ETR	EISENBEIS
Michael KRUSE	13.09.2010	Alloc. Ministère	EISENBEIS
Florence LAGUZET	01.10.2009	Alloc. Ministère	ETIEMBLE
Antoine TRAN TAN	01.10.2012	Alloc. Ministère	ETIEMBLE

Parall: Synthetic presentation

Nom du responsable de l'équipe : **Marc BABOULIN**

Effectifs de l'équipe

Au 1er janvier 2008, l'équipe comprenait 8 enseignants chercheurs (2 PR, 6 MdC), 2 chercheurs INRIA (1 DR, 2 CR), 5 post-doctorants, 12 doctorants, 2 ingénieurs.

Personnels ayant quitté l'équipe pendant le contrat en cours

8 membres permanents : 5 MdC (217 mois), 2 DR INRIA (72 mois), 1 CR INRIA ; 18 doctorants (586 mois) ; 5 post-doctorants (50 mois) ; 1 ingénieurs (8 mois).

Nombre de recrutements réalisés au cours de la période considérée et origine des personnels

1 MdC: Marc Baboulin, MdC Univ. Paris-Sud, Chaire Inria, Sept. 2010, auparavant Université de Coimbra, Portugal.

1 Post-doctorant: Janna Burman, INRIA Saclay, auparavant post-doctorante INRIA - Sophia-Antipolis

Production scientifique au cours de la période écoulée

1. Avec le développement important des architectures multicœurs et l'utilisation d'accélérateurs (e.g. GPU), le coût des mouvements de données dans le temps de calcul est devenu critique pour les applications parallèles. Pour pallier à cela, nous avons développé des algorithmes novateurs pour minimiser les communications dans les solveurs linéaires (heuristiques "communication-avoiding" (SIMAX 2011) et techniques de randomisation (IPDPS 2012)).
2. Dans la perspective de l'apparition des systèmes Exascale à partir de 2018 et avec le niveau extrême de parallélisme qui en résulte, nous avons obtenu des avancées majeures dans le domaine de la tolérance aux défaillances, permettant de s'appliquer à des applications sensibles du HPC (ACM Computing Frontiers 2009).
3. Nous avons étendu le modèle de protocole de populations avec l'introduction de la notion de "vitesse" sous la forme de temps de couverture. Cela a permis la modélisation de façon naturelle de la mobilité des populations dans une zone finie ainsi qu'une étude analytique déterministe de la complexité des temps de convergence. Dans ce modèle étendu nous avons développé des algorithmes auto-stabilisants et efficaces en temps (PODC 2010, OPODIS 2012).

Bilan quantitatif des publications de l'équipe

- Articles de revue : internationales majeures 11 ; autres revues 12
- Articles dans des conférences et workshops : internationaux majeurs 10 ; autres conférences et workshops 82

5 publications majeures

- M. Baboulin, D. Becker, J. Dongarra. A parallel tiled solver for dense symmetric indefinite systems on multicore architectures. Proceedings of IPDPS 2012.
- L. Grigori, J. Demmel, H. Xiang. CALU, a communication optimal LU factorization algorithm. SIAM Journal on Matrix Analysis and Applications, 32:1317-1350, SIMAX 2011.
- T. Herault, M. Jan, T. Largillier, S. Peyronnet, B. Quetier, F. Cappello. High Accuracy Failure Injection in Parallel and Distributed Systems Emulation. ACM Computing Frontiers, 2009.
- J. Beauquier, J. Burman, J. Clement, and S. Kuttan, "On utilizing speed in networks of mobile agents". PODC 2010.
- J. Beauquier, J. Burman, L. Rosaz, B. Rozoy. Non-deterministic Population Protocols. OPODIS 2012.

5 (max) documents majeurs (autres que publications)

- Contribution to parallel libraries **MAGMA** and **PLASMA**, open source HPC libraries managed at University of Tennessee (Marc Baboulin).
- **MIDAPACK**, library for Cosmic Microwave Background data analysis in astrophysics in the framework of the ANR project MIDAS (Laura Grigori).
- **Hydee**, implementation in MPICH2 of the hierarchical fault tolerance protocol for Send-Determinist application (developed by Amina Guermouche and Thomas Ropars under supervision of Franck Cappello).

5 (max) faits illustrant le rayonnement ou l'attractivité académique

- Marc Baboulin: Invited plenary speaker at 20th High Performance Computing Symposium (HPC 2012), Orlando, USA, March 26-29, 2012.

- Joffroy Beauquier: Editorial board of Parallel Processing Letters.
- Franck Cappello: Technical paper co-chair IEEE/ACM SC 2011.
- Laura Grigori: Invited plenary speaker, SIAM Conference on Parallel Processing for Scientific Computing 2012.
- Sylvain Peyronnet: Co-organizer at CSDM 2010-11.

5 (max) faits illustrant les interactions de l'équipe avec son environnement socio-économique ou culturel

- F. Cappello, EDF contract : This contract with EDF is supposed to provide EDF several deliverables: participate at the Industry-NCSA workshop, participate at the workshop of the INRIA-Illinois joint-laboratory on petascale computing, reports on the joint-laboratory workshop, preprint of the joint-lab publications and a series of reports on the evolution of the HPC technology.

Principales contributions de l'équipe à des actions de formation

- M. Baboulin, J. Beauquier, F. Cappello, L. Grigori, B. Rozoy : enseignement dans Master 2 NSI.
- B. Rozoy : Directrice du département d'informatique à Polytech Paris-Sud.

Research Group Members and evolution since 2008

Permanent Members (June 30th, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
BABOULIN	Marc	MCF	PARIS SUD
BEAUQUIER	Joffroy	PR	PARIS SUD
DELAËT	Sylvie	MCF	PARIS SUD
ROSAZ	Laurent	MCF	PARIS SUD
ROZOY	Brigitte	PR	PARIS SUD

Doctoral Students** (June 30th, 2013)			
<i>Name</i>	<i>First name</i>	<i>Funding</i>	<i>Institution</i>
BLANCHARD	Peva	alloc. ministère	PARIS SUD
MARTSINKEVICH	Tatiana	Contrat	INRIA
QU	Long	alloc. ministère	PARIS SUD
REMY	Adrien	alloc. ministère	PARIS SUD
WANG	Yushan	Contrat	PARIS SUD

Temporary Personnel** (June 30th, 2013)					
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>	<i>Arrival</i>	<i>Departure</i>
BURMAN	Janna	Post-doc	INRIA, UPS	11.2011	08.2013

** past and current PhD students are listed in Annexe Thèses

Group evolution

Arrivals (permanent members): Marc Baboulin (MCF Univ. Paris-Sud, Chaire Inria, Sept. 2010).

Departures (permanent members): Franck Cappello (DR Inria, Univ. Illinois - USA, 2009), Sylvie Delaët (MCF Univ. Paris-Sud, joined the Algo team at LRI, Jan. 2013), Gilles Fedak (CR INRIA, ENS Lyon), Laura Grigori (DR Inria, Inria Rocquencourt, Déc. 2012), Thomas Hérault (MCF Univ. Paris-Sud, Univ. Tennessee - USA, Sept. 2010), Colette Johnen (MCF Univ. Paris Sud, nominated Prof. Univ. Bordeaux 1 in Sept. 2008), Stéphane Messika (MCF Univ. Paris-Sud, left the team, Déc. 2012), Sylvain Peyronnet (MCF Univ. Paris-Sud, nominated Prof. Univ. Rouen, Sept. 2012).

Research Description

The members of the Parall team have followed three main topics of research, which can be seen as three subprojects. The first subproject focuses on fault tolerance and involved also members of the team physically located in USA. The second subproject focuses on high performance scientific computing, and the research in this context was performed by the members of the team physically located at Saclay. The third subproject concerns distributed algorithms and population protocols. These three main research topics are described below.

Fault tolerance for extreme scale systems

Participants: A. Borghi, F. Bouabache, E. Brunet, F. Cappello, A. Guermouche, T. Hérault, T. Largillier, B. Nicolae, J. Oudinet, S. Peyronnet, A. Rezmerita

Our research in this field focuses on fault tolerance which is a major concern for the high-performance computing community. For instance the CRAY Jaguar system at Oak Ridge National Laboratory RNL (Jaguar has been updated as Titan at the end of 2012), that is the largest system using commodity components, is experiencing multiple failures per day. In a recent I2PC seminar, a distinguished speaker from Cray Inc., responsible for the design of the Gemini network, presented the results of a failure modeling analysis for a Cray system in the Top 10 in 2012. This analysis concludes with a MTI (Mean Time To Interrupt) of an MPI application of less than 5 hours. Efforts in this area lag behind the other areas because the scale of the fault tolerance problem emerged only recently. However in comparison with other concerns (e.g., scalability, performance, power) fault tolerance accepts no compromise: either the application completes producing correct results or it fails and with executions lasting several hours on more than 100,000 cores this would be a huge loss of energy and computational resources. This issue is a major problem for computing platforms in Europe, Asia and USA. The most popular approach for fault tolerance is checkpoint/restart. The objective of our research is to push checkpoint/restart to its limits and reduce as much as possible the resulting overhead in terms of performance (in fault free execution and recovery) as well as in terms of energy consumption.

The strategy that we apply to address this issue is to adopt a holistic approach combining all complementary aspects of checkpointing: - Fault tolerance protocols - High performance checkpointing - Process clustering for fault and recovery confinement - Checkpoint performance modeling and checkpoint interval calculation - Fault tolerance and energy consumption - Failure prediction for proactive checkpointing/migration. The main drivers for the fault tolerance research in Parall are applications and systems. The main applications considered are CM1, CESM and SPECfem-3D. We also use benchmarks like the NAS Benchmarks, the SEQUOIA Benchmarks and sets of applications from NERCS. Our main scientific achievements in the field are the characterization of communication patterns in parallel HPC applications, the introduction of new hierarchical fault tolerant protocols, the use of multilevel checkpoint restart, and failure log analysis and failure prediction.

High-performance scientific computing

Participants: M. Baboulin, S. Donfack, R. Fezzani, L. Grigori, S. Gupta, J. Hermann, M. Jacquelin, A. Khabou, A. Kumar, P. Kumar, R. Lacroix, Q. Long, S. Moufawad, M. Sharify, M. Szydlarski, A. Rémy, K. Wang, Y. Wang

Our common objective is to propose efficient numerical algorithms and software for linear algebra calculations which are at the heart of high-performance scientific computing. This goal is achieved by using several research directions. A direction of research addresses the challenging technological trend which shows that there is an exponentially increasing gap between the time it takes to perform floating point operations and the time it takes to communicate data between either different levels of the memory hierarchy or between different processors. Our approach to this problem leads to the introduction of so-called communication avoiding algorithms, a new class of algorithms that reduce the number of communication instances to a minimum. These new algorithms promise to supersede previous approaches to the communication problem based either on scheduling or tuning solutions, and will be made available in public libraries as Lapack or Scalapack. The group develops also an important expertise in sparse solvers for numerical linear algebra based on iterative methods. One of the main concerns in this area is the scalability problem of many highly used preconditioners as incomplete LU factorizations, often due to the presence of several low frequency modes that hinder the convergence of the iterative method. By using preconditioners called direction preserving (or filtering) preconditioners, it is possible to alleviate the effect of low frequency modes on convergence. This method was validated on real applications from IFP, CEA, in particular on the simulation of compositional multiphase flow in porous media with different type of applications in reservoir modeling, bassin modeling, nuclear waste disposal, and geological CO₂ underground storage.

Another research activity of the team is related to fast solvers based on randomized algorithms. Randomized algorithms represent an innovative approach to accelerate linear algebra computations. More generally this is a major research area in high-performance computing. The class of randomized algorithms developed in the team have the advantage of reducing the amount of communication in dense

factorizations (by removing completely the pivoting phase) and to reduce significantly the number of arithmetic operations in estimating condition numbers. The randomized solvers are being integrated into standard linear algebra libraries and take advantage of current multicore+GPU architectures. Finally significant effort have been made to address the issue of numerical quality in HPC applications. In particular we studied the sensitivity analysis of linear algebra problems by considering condition numbers of problem solutions (e.g., least square problems). For these quantities, our research focuses on deriving formulas or estimates but also on designing efficient algorithms for state-of-the-art parallel architectures.

Distributed algorithms and population protocols

Participants: J. Beauquier, P. Blanchard, J. Burman, S. Delaët, S. Messika, L. Rosaz, B. Rozoy

In this research topic, we address large scale networks of resource-limited and passively mobile sensors using a communication model of Population Protocols (2004, Angluin et al.). This model proposes a formalism to study the convergence of distributed algorithms based on a succession of interactions between the network nodes. The sensors are assumed to be cheap, involving limited resources, short range communication and poor reliability. They are intended to be deployed on large areas, involving issues of scalability. One of the goals of studying the population protocol model was to determine what is computable with minimal assumptions on a mobile ad-hoc network. For that reason, like in their real counterparts, the agents are asynchronous, anonymous, dispose of a small memory and no assumptions are made on the size of the population or on the way they move, except for a fairness assumption ensuring that any infinitely often reachable global configuration is eventually reached.

One of our main contributions in this area was to add to the population protocol model a notion of "speed" to the agents, providing some natural restrictions on the asynchronous mobility of agents. First, this extension made it possible to model more accurately the populations of agents mobile in a finite area. Second, it allowed to construct fast converging deterministic protocols and deterministically evaluate their time complexities. In this newly extended model, we have started our study with a major task in sensor networks, the data collection. In this task, an unknown number of anonymous agents have constant values they should deliver to the base station. We developed efficient data collection protocols step by step, adding properties such as fault tolerance or adapting to the size of the available memory. We have proved that one of the proposed protocols is optimal in time. Later, with the help of a new model, we have performed an analytical study of the real data collection protocol used in the ZebraNet project for the wild life tracking of zebras in a reserve in central Kenya.

Fault tolerance is a crucial issue when networks of numerous unreliable agents are under consideration. One of the classical frameworks for fault tolerance is self-stabilization. Self-stabilizing algorithms adjust themselves automatically to any topological changes or memory corruption of the network components. This type of algorithms are considered in our work for two reasons. First, mobile agents are generally fragile, subject to failures and hard to initialize. Second, systems of mobile agents are by essence dynamic, some agents may leave the system while new ones are introduced. Self-stabilization is a well adapted framework for dealing with such unreliable and dynamic systems. Developing self-stabilizing solutions is considered to be more challenging and complicated than developing classical ones where a proper initialization of the variables can be assumed. Hence, to ease the task of the developer, we have proposed an automatic self-stabilizing protocol transformer.

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Collaborations

Participation to national and international collaborative research projects

- Digiteo project CALIFHA, Coordinator: M. Baboulin
- PEPS CNRS project QUARENUM, Coordinator: M. Baboulin
- Digiteo project DISCOVER, Coordinator: J. Beauquier

- ANR project HIPCAL, Coordinator: F. Cappello
- ANR Blanc project RESCUE, Coordinator: F. Cappello
- ANR ARPEGE project MAP-REDUCE, Coordinator: F. Cappello
- ACI SESAME (région IdF), Coordinator: F. Cappello
- ANR project SOGEA, Coordinator: S. Delaët
- ANR project DSLlab, Coordinator: G. Fedak
- ANR Cosinus project PETAL, Coordinator: L. Grigori
- ANR Cosinus project MIDAS, Coordinator: L. Grigori
- ANR Cosinus Project PETALh, Coordinator: L. Grigori
- ANR Arpège project SPADES, Coordinator: S. Peyronnet

Collaborations with other laboratories

- INRIA associated team COALA with UC Berkeley (USA), development of communication avoiding algorithms for linear algebra, Coordinators: L. Grigori and Prof. J. Demmel, UC Berkeley, 2010-2013
- Collaboration with University of Tennessee - Innovative Computing Laboratory (Prof. J. Dongarra), M. Baboulin member of the MAGMA project (<http://icl.cs.utk.edu/magma/>)
- Collaboration with LIMSI Université Paris-Sud (O. Le Maître, Y. Fraigneau) in the Digitéo project.
- Collaboration with LIP6, LIP/ENS Lyon, LIRMM in PEPS project QUARENUM
- Collaboration with C. Delparte-Gallet and H. Fauconnier, University Paris 7, LIAFA: "Byzantine Eventual Agreement in Mobile Networks of Finite State Agents"
- Collaboration with L. Rodrigues and O. Denysyuk, Distributed Systems Group, INESC-ID, and Departamento de Engenharia Informática, Instituto Superior Técnico (IST), Universidade Técnica de Lisboa: "Byzantine Eventual Agreement in Mobile Networks of Finite State Agents"
- Collaboration with N. Nisse, COATI (MASCOTTE) project, INRIA, I3S (CNRS/UNS), Sophia-Antipolis: "Exclusive Graph Searching"

Other Collaborations

- Collaboration of M. Baboulin with Prof. A. Laub, University of California Los Angeles, USA, and Prof. M. Sasonkina, Old Dominion University, USA
- Collaboration of J. Beauquier and J. Burman with Prof. S. Kutten, Technion, Israel
- Collaboration of S. Delaët and J. Beauquier with Prof. S. Dolev, Ben Gourion University, Israel

Volunteer Professional Service

Management Positions in Scientific Organisations

- Laboratory council member, LRI: M. Baboulin, member
- Laboratory council member, LRI: J. Beauquier, member
- Hiring committee member, Université Paris Sud: J. Beauquier, chair
- Inria project team Grand-Large: F. Cappello, team leader from 2008 to 2009
- Inria project team Grand-Large: B. Rozoy, team leader from 2009 to 2012
- Inria project team Grand-Large: M. Baboulin, team leader in 2013
- Inria Saclay: M. Baboulin, member of the scientific committee
- Polytech Paris-Sud, B. Rozoy, head of computed science department

Organisation of Conferences and Scientific Events

- SIAM CSE'11, Mini-symposium "Innovative algorithms for dense linear algebra", Reno, USA, 2011: M. Baboulin, organizer
- SIAM ALA'12, Mini-symposium "Application of statistics to numerical linear algebra algorithms", Valencia, Spain, 2012: M. Baboulin, organizer
- SIAM CSE'13, Mini-symposium "Numerical and reliability issues in high performance computing", Boston, USA, 2013: M. Baboulin, organizer
- PMAA'12, Mini-symposium "Scientific applications of heterogeneous CPU/GPU computing", London, 2012: M. Baboulin, organizer
- Dagstuhl Seminar on Fault tolerance for HPC, 2009: F. Cappello co-organizer
- PMAA'10, Mini-symposium on Combinatorial Scientific Computing at PMAA 2010 Conference: L. Grigori, organizer
- SIAM PP'10, Mini-symposium on "Communication-Avoiding Linear Algebra", Seattle, USA, 2010: L. Grigori, organizer
- CSC, 5th SIAM Workshop on Combinatorial Scientific Computing: L. Grigori, member
- CSDM, 2010-11: S. Peyronnet, co-organizer

Honors

Keynote Addresses

International

- M. Baboulin: Invited plenary speaker, Summer school "e-science with many-core CPU/GPU processors", Braga, Portugal, 2010; 20th High Performance Computing Symposium (HPC 2012), Orlando, USA, 2012; Workshop on "Recent developments in the solution of indefinite systems", TU Eindhoven, Netherlands, 2012.
- F. Cappello: Keynote talk, IEEE Cluster, Beijing, 2012 - SPAC-PAD, New York, 2012 - IEEE/ACM SC11/Scala workshop, 2011 - IEEE IPDPS/ - PDP 2011, Cyprus, 2011 - Intel Exascale Leadership Conference, 2011 - Invited talk : Toward Exascale Climate Simulation, Exeter, UK, 2012 - I2PC, UIUC, 2012 DPDNS11, Anchorage, 2011 - HiPC workshop "Reaching Exascale in this Decade", 2010.
- L. Grigori: Invited plenary speaker, SIAM Conference on Parallel Processing for Scientific Computing 2012; High Performance Scientific Software , workshop in conjunction with EuroPar 2011, "Parallel Matrix Algorithms and Architectures PMAA'10", July 2010, University of Basel, Switzerland; Big Bang, Big Data, Big Computers Workshop, September 2012.

Evaluation of Research

Editorial Boards

International

- PPL, Parallel Processing Letters: J. Beauquier
- International Journal of Grid Computing, Kluwer Academic Publishers: F. Cappelto
- International Journal of Cluster Computing, Kluwer Academic Publishers: F. Cappelto

Program Committees

Chair

- F. Cappelto, Chair of "Most influential papers" award for the 25th anniversary of IEEE/ACM SC conference, 2013, Tutorial co-chair IEEE/ACM SC 2012, Technical Paper co-chair IEEE/ACM SC 2011, co-chair IEEE NCA 2010, chair HiPC2010, Area co-chair IEEE/ACM SC 2009, co-chair IEEE CCGRID 2009.

Member (international events)

- M. Baboulin: Steering committee of High Performance Computing Symposium (HPC) 2012-2013
- J. Beauquier: Program committee of SIROCCO (International Colloquium on Structural Information and Communication Complexity) 2009-2010, SSS (International Symposium on Stabilization, Safety, and Security of Distributed Systems) 2009-2010
- F. Cappelto: Steering Committee of IEEE HPDC 2006-2010 - Steering Committee of IEEE/ACM CCGRID. Committees member: ACM ICS 2012-2008, IEEE HPDC 2012-2008, IEEE/ACM SC (Super Computing Conference) 2010-2008, IEEE/ACM CCGRID 2012-2008
- L. Grigori: Program Committee of IEEE/ACM SC (Super Computing Conference) 2009-2010-2012, IPDPS (IEEE International Parallel and Distributed Processing Symposium) 2011, HiPC (IEEE International Conference on High Performance Computing) 2012
- S. Peyronnet: Program Committee of ICCP 2008, ISVC 2008-2012, CSDM 2012

Evaluation Committees and Invited Expertise

National

- Expertise for Région Aquitaine, call of projects funding: Marc Baboulin, 2011

Interactions with the social, economic and cultural environment

Popularisation of Research Results

F. Cappelto, EDF contract : This contract with EDF is supposed to provide EDF several deliverables: participate at the Industry-NCSA workshop, participate at the workshop of the INRIA-Illinois joint-laboratory on petascale computing, reports on the joint-laboratory workshop, preprint of the joint-lab publications and a series of reports on the evolution of the HPC technology.

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
DIGITEO	CALIFHA	Université Paris XI	10.2011 / 36 mo.	102.20 k€
Subvention	CONVENTION DE DELEGATION MARC BA	INRIA	09.2010 / 60 mo.	50.00 k€
Subvention	QUARENUM	CNRS	04.2013 / 8 mo.	5.00 k€
DIGITEO	DISCOVER	Université Paris XI	09.2011 / 36 mo.	102.20 k€
ANR	ANR MAPREDUCE	INRIA	01.2010 / 51 mo.	81.48 k€
ANR	FF2A3	INRIA	01.2008 / 36 mo.	52.47 k€
Contrat européen	GRID4ALL	INRIA	06.2006 / 30 mo.	178.00 k€
ANR	HIPCAL	INRIA	01.2007 / 42 mo.	187.00 k€
ANR	MIDAS	INRIA	12.2009 / 36 mo.	232.98 k€
	OPENGPU	INRIA	12.2009 / 30 mo.	111.14 k€
ANR	PETAL	INRIA	01.2009 / 24 mo.	91.15 k€
Contrat européen	Rex CoreGrid	INRIA	09.2004 / 42 mo.	65.00 k€
Region IDF	SESAME GRID 5000	INRIA	05.2005 / 92 mo.	450.00 k€
DIGITEO	X-SCALE-N	INRIA	09.2008 / 36 mo.	106.12 k€
ANR	SOGEA	CNRS	12.2005 / 43 mo.	163.68 k€
DIGITEO	FLUCTUS	Université Paris XI	09.2010 / 36 mo.	51.80 k€
DIGITEO	ITOC	Université Paris XI	10.2009 / 24 mo.	107.60 k€
ANR	Dsslab	INRIA	12.2005 / 42 mo.	115.60 k€
Contrat européen	EDGeS	INRIA	01.2008 / 24 mo.	230.00 k€
ANR	Cosinus MIDAS	INRIA	12.2009 / 36 mo.	232.98 k€
ANR	Cosinus PETALh	INRIA	01.2010 / 24 mo.	134.19 k€
ANR	SAFE-OS	Université Paris XI	01.2008 / 36 mo.	122.00 k€
DIGITEO	SARDYN	Université Paris XI	09.2008 / 37 mo.	103.00 k€
ANR	Spades	INRIA	01.2009 / 36 mo.	0.00 k€
ANR	ANR ECS	INRIA	01.2011 / 39 mo.	199.99 k€
ANR	ANR FP3C	INRIA	09.2010 / 43 mo.	138.90 k€
ANR	ANR PETAL-H	INRIA	01.2011 / 33 mo.	134.19 k€
ANR	ANR RESCUE	INRIA	12.2010 / 48 mo.	161.66 k€
	ITEA MANY	INRIA	09.2011 / 36 mo.	306.83 k€
Contrat européen	QOSCOSGRID	INRIA	09.2006 / 30 mo.	178.50 k€
Subvention	FRAGILE	CNRS	10.2004 / 48 mo.	110.00 k€

Private contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
Industriel	CARRIOCAS	INRIA	09.2006 / 36 mo.	280.00 k€
Industriel	CIFRE EADS	INRIA	04.2005 / 36 mo.	31.00 k€
CIFRE	THESE CIFRE A.BALDACCI	INRIA	11.2009 / 36 mo.	30.00 k€
Industriel	AIMA METASCALE (OSEO)	Université Paris XI	08.2011 / 15 mo.	24.30 k€

Software Licensing and Distribution

Fast linear system solvers - in public domain libraries

Contact: BABOULIN

CALU - for multicore architectures

Contact: GRIGORI

PVC - Private Virtual Cluster

<http://ralyx.inria.fr/2006/Raweb/grand-large/uid64.html\#uid64>

Contact: CAPPELLO

OpenWP - OpenWP

Contact: CAPPELLO

XtremWeb - Open Source Platform for Desktop Grid Computing

<http://www.xtremweb.net/>

Contact: CAPPELLO

V-DS - Virtualization environment for large-scale Distributed Systems

<http://v-ds.lri.fr/>

Contact: CAPPELLO

BitDew - Middleware for Large Scale Data Management and Distribution

<http://www.bitdew.net/>

Contact: FEDAK

ctuning - public repository and tools for collaborative and statistical program and architecture characterization and optimization

<http://ctuning.org>

Contact: FURSIN

Parallel Solvers - for Solving Linear Systems of Equations

Contact: GRIGORI

YML - Large-Scale Workflow Computing

<http://yml.prism.uvsq.fr>

Contact: PETITON

SPIN - Scientific Programming InterNet

Contact: PETITON

APMC - Approximate Probabilistic Model Checker

<http://apmc.berbiqui.org/>

Contact: PEYRONNET

Training and Education

Graduate Courses

- Master Nouveaux Systèmes Informatiques, Université Paris-Sud, *Calcul haute-performance*: M. Baboulin, F. Cappello, L. Grigori
- Master Nouveaux Systèmes Informatiques, Université Paris-Sud, *Tolérance aux défaillances dans les systèmes répartis*: J. Beauquier

Thesis

Habilitation à Diriger des Recherches

Name	Defense
Laura GRIGORI	01.2009
Marc BABOULIN	12.2012

Defended thesis

Name	Start	Defense	Funding	Advisor
Asim ALI	01.09.2006	10.09.2010	ETR-BGF	TIXEUIL
Alexandre BORCHI	01.09.2008	10.10.2011	Alloc. Ministère	PEYRONNET
Fatiha BOUABACHE	01.10.2006	16.12.2010	Alloc. Ministère	CAPPELLO
Julien CLEMENT	01.10.2006	19.10.2009	COLL TERR	ROZOY
Camille COTI	01.10.2006	10.11.2009	CDD sur contrat INRIA	CAPPELLO
Simplice DONFACK	09.01.2008	07.03.2012	CDD sur contrat INRIA	GRIGORI
Amina GUERMOUCHE	01.10.2008	06.12.2011	Alloc. Ministère	CAPPELLO
William HOARAU	01.10.2004	21.03.2008	Alloc. Ministère	TIXEUIL
Amal KHABOU	01.10.2009	11.02.2013	Alloc. Ministère	GRIGORI
Pawan KUMAR	01.09.2007	20.09.2010	Cordis	GRIGORI
Thomas LARGILLIER	01.10.2007	29.11.2010	Alloc. Ministère	BEAUQUIER
Paul MALECOT	01.01.2006	29.01.2010	CDD sur contrat INRIA	CAPPELLO
Fouzi MEKHALDI	01.10.2008	12.12.2011	Digiteo	JOHNEN
Olivier PERES	01.10.2005	24.09.2008	Alloc. Ministère	BEAUQUIER
Benjamin QUETIER	01.09.2004	12.09.2008	Alloc. Ministère	CAPPELLO
Ala REZMERITA	01.10.2005	28.09.2009	ATER	CAPPELLO

Thesis in progress

Name	Start	Funding	Advisor
Peva BLANCHARD	01.09.2011	Alloc. Ministère	BEAUQUIER
Tatiana MARTSINKEVICH	07.04.2012	CDD sur contrat INRIA	CAPPELLO
Long QU	01.10.2010	Alloc. Ministère	GRIGORI
Adrien REMY	01.10.2011	Alloc. Ministère	BABOULIN
Yushan WANG	01.10.2011	CDD sur contrat UPS	BABOULIN

Self Assessment

In fault-tolerance for HPC systems the strong points are an outstanding visibility and impact (publications, software, education, etc.) and excellent international collaborations (Joint-Lab, G8, etc). However a weak point is related to uneven funding resources across the years that makes the project difficult to manage financially. Due to the departure of the members of the Parall team working in this area, this activity will not be continued during the coming years.

In high-performance scientific computing, the results obtained in numerical linear algebra software have an important impact in the scientific computing community and we have many international collaborations (UC Berkeley, University of Tennessee, UCLA...). However, the communication avoiding or randomized algorithms that we propose are developed for dense linear algebra and we plan to extend our research in this subject to sparse linear solvers.

In our research in distributed algorithms, we have obtained significant results with for instance publications in the best conference in the domain (PODC) and a very good journal (TCS). However, due to the departure of several members of the team working on this topic, the activity group "Distributed Algorithms" is now small (4 permanents).

Strategy and five-year project

In June 2013, the members of the Parall and Archi teams are merging into a new LRI team entitled “Parallel Systems” (PARSYS). The research topics addressed by PARSYS will be:

- Parallel architectures (compilation, code optimization),
- High-performance scientific computing (numerical linear algebra software),
- Distributed algorithms (population protocols and self-stabilization).

PARSYS will also collaborate with other LRI teams (e.g., ROCS in combinatorial algorithms) and other entities of Paris-Saclay like for instance Maison de la Simulation and LIMSI. We also point out that LRI will hire most probably in 2014 a new assistant-professor with research profile in high-performance scientific computing. This new researcher will be integrated in the PARSYS team. Moreover a new INRIA project team has been submitted in June 2013 in the area of HPC, architecture and compilation. This project will focus on providing software and hardware means to help programmers to deal with the ever growing complexity of programming state-of-the-art parallel and distributed architectures and to develop optimized HPC applications. In the following we describe the main research topics that will be addressed by the PARSYS team during the next five years.

The activity in parallel architectures will consist of optimizing programs and applications according to the dominant architectural features of the high-end and embedded systems, with the following research tracks:

- In the area of compilation, the machine-learning based approach for self-tuning compilers will be further investigated and the efforts to strengthening the c-tuning community will be pursued.
- Our research in optimization of algorithms and source codes will focus on the trade-off between execution times and power consumption, either for high-end “green” computing or for embedded systems. We will investigate hardware customization (data formats, new instructions) on reconfigurable architectures. HPC and image processing applications are the targets.
- The high level libraries that we developed, backed up by an architecture description layer, were shown to be portable across a wide set of parallel systems (ranging from the Cell processor to large scale HPC clusters) and demonstrated performance within the range of expert code. They will be extended by integrating new computing paradigms using “futures/promises” for asynchronous computations

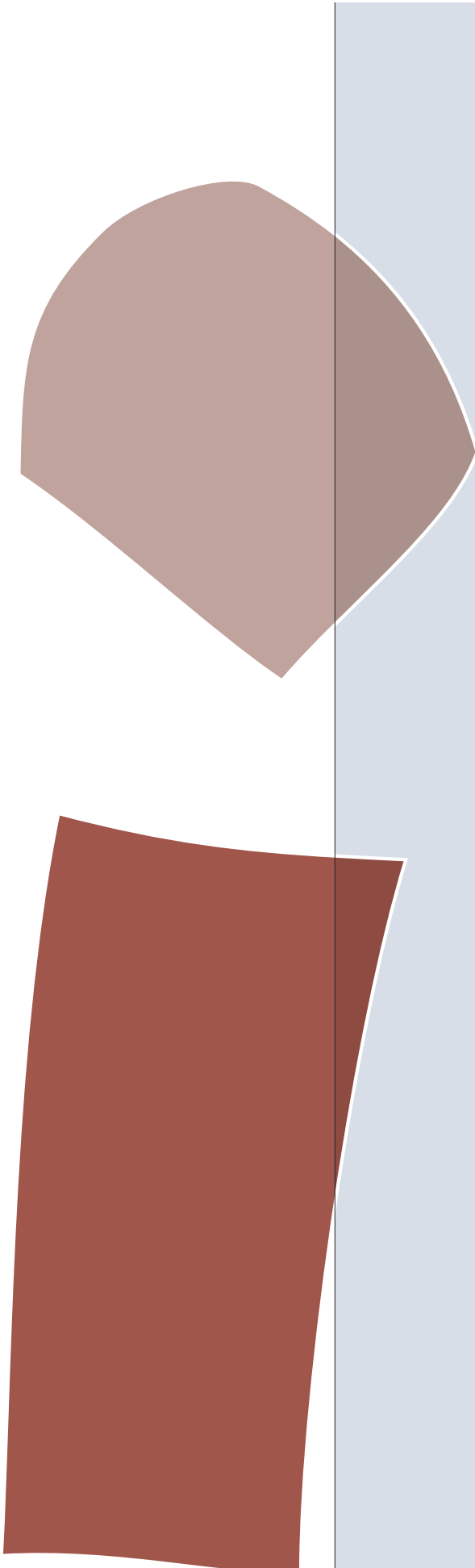
The activity in high-performance computing will continue to investigate new approaches, sometimes non conventional in numerical libraries in order to minimize data-communication costs in heterogeneous architectures. Due to the increasing demand for high-resolution simulations and extremely accurate solutions, our research will focus on two fronts:

- Develop innovative hybrid algorithms that take advantage of recent advances in hardware (e.g., Xeon Phi processor),
- Propose new results regarding numerical quality of results and reproducibility of parallel computations (an ANR project will be submitted on this subject in collaboration with LIP6, LIP, LIRMM and EDF).

With this respect, efforts in designing new randomized algorithms for linear algebra computations will be continued. We will also develop generative programming techniques for numerical software. Our objective using this approach is to propose a generic description of the linear problems to be solved in order to exploit numerical and structure properties of matrices to get a fast and accurate solutions with respect to the type of problem. Information about targeted architecture and resources available will be also taken into account so that the most appropriate routine should be used or generated. An application of this generative approach is the possibility of prototyping new algorithms or new implementations of existing algorithms for various hardware.

In the area of distributed algorithms, we will intensify our efforts on fault-tolerance algorithms by strengthening existing national and international collaborations et develop new ones. In particular we plan to investigate fault-tolerance in the framework of iterative linear algebra algorithms (collaboration with the INRIA team Alpines). Our national collaborations will be mainly with LIAFA (C. Delporte, H. Fauconnier) and INRIA Sophia (N. Nisse) with whom we have an ongoing work and joint papers. In the context of Paris-Saclay we will develop existing contacts with the LIX laboratory (B. Charron-Bost). Our international

collaborations concern mainly Technion University (Idit Keidar, Shay Kutten) with whom we recently submitted a project on cloud computing. We have also ongoing work with University of Lisbon (L. Rodrigues, O. Denysyuk) and EPFL (R. Guerraoui).



ARCHI team publications

Journal articles

Major international journals

- (1) F. Bodin, E. Bonilla, G. Fursin, B. Mendelson, M. Namolaru, M. O'Boyle, O. Temam, and A. Zaks. Milepost gcc: A machine learning enabled self-tuning compiler. *International Journal of Parallel Programming (IJPP)*, 39(3):296–327, 2011.
- (2) P. Carribault, S. Zuckerman, A. Cohen, and W. Jalby. Deep jam: Conversion of coarse-grain parallelism to fine-grain and vector parallelism. *Journal of Instruction-Level Parallelism*, 2008.
- (3) F. Gruau, C. Eisenbeis, and L. Maignan. The foundation of self-developing blob machines for spatial computing. *Physica D: Nonlinear Phenomena*, 237(1):1282–1301, July 2008. Special issue: "Novel Computing Paradigms: Quo Vadis?".
- (4) S. Liu, C. Eisenbeis, and J.-L. Gaudiot. Value prediction and speculative execution on gpu. *International Journal of Parallel Programming*, 39(5):533–552, 2011.
- (5) M. Szydlarski, P. Esterie, J. Falcou, L. Grigori, and R. Stompor. Parallel spherical harmonic transforms on heterogeneous architectures (graphics processing units/multi-core cpus). *Concurrency and Computation: Practice and Experience*, 2013.

Other journals

- (6) C. Bechara, N. Ventroux, and D. Etiemble. A tlm-based multithreaded instruction set simulator for mp soc simulator environment. *3rd Workshop on Rapid Simulation and Performance Evaluation: Methods and Tools (RAPIDO 2011), Held in conjunction with the 6th International Conference on High-Performance and Embedded Architectures and Compilers (HiPEAC)*, 2011.
- (7) Y. Chen, S. Fang, Y. Huang, L. Eeckhout, G. Fursin, O. Temam, and C. Wu. Deconstructing iterative optimization. *ACM Transactions on Architecture and Code Optimization (TACO)*, 9(3):21, 2012.
- (8) P. Esterie, M. Gaunard, J. Falcou, et al. Exploiting multimedia extensions in c++: A portable approach. *Computing in Science & Engineering*, 14(5):72–77, 2012.
- (9) K. Hamidouche, F. Mendonca, J. Falcou, A. de Melo, and D. Etiemble. Parallel smith-waterman comparison on multicore and manycore computing platforms with bsp++. *International Journal of Parallel Programming*, pages 1–26, 2012.
- (10) L. Maignan and F. Gruau. Gabriel graphs in arbitrary metric space and their cellular automaton for many grids. *ACM Trans. Auton. Adapt. Syst.*, 6:12:1–12:14, June 2011.
- (11) H. Munk, E. Ayguadé, C. Bastoul, P. Carpenter, Z. Chamski, A. Cohen, M. Cornero, P. Dumont, M. Duranton, M. Fellahi, R. Ferrer, R. Ladelsky, M. Lindwer, X. Martorell, C. Miranda, D. Nuzman, A. Ornstein, A. Pop, S. Pop, L.-N. Pouchet, A. Ramirez, D. Rodenas, E. Rohou, I. Rosen, U. Shvadron, K. Trifunović, and A. Zaks. ACOTES project: Advanced compiler technologies for embedded streaming. *International Journal of Parallel Programming*, 39(3):397–450, jun 2011. Published online : 20 April 2010.
- (12) E. Park, J. Cavazos, L.-N. Pouchet, C. Bastoul, A. Cohen, and P. Sadayappan. Predictive modeling in a polyhedral optimization space. *International Journal of Parallel Programming*, 2012. Accepted for publication. 39 pages. Classement ARC : A.
- (13) B. Siri, H. Berry, B. Cessac, B. Delord, and M. Quoy. A mathematical analysis of the effects of hebbian learning rules on the dynamics and structure of discrete-time random recurrent neural networks. *Neural Computation*, 2008.
- (14) S.-A.-A. Touati, F. Brault, K. Deschinkel, and B. Dupont De Dinechin. Efficient Spilling Reduction for Software Pipelined Loops in Presence of Multiple Register Types in Embedded VLIW Processors. *ACM Transactions in Embedded Computing Systems*, 10(4):25, nov 2011.
- (15) Y. Wang, M. Baboulin, J. Dongarra, J. Falcou, Y. Fraigneau, and O. Le Maître. A parallel solver for incompressible fluid flows. *Procedia Computer Science*, 18:439–448, 2013.
- (16) W. Zhao, L. Torres, L. Cargnini, R. Brum, Y. Zhang, Y. Guillemenet, G. Sassatelli, Y. Lakys, J. Klein, D. Etiemble, et al. High performance soc design using magnetic logic and memory. *VLSI-SoC: Advanced Research for Systems on Chip*, pages 10–33, 2012.

Invited conferences

- (17) A. Cohen. Polyhedral compilation runs out of (static) control! In *Taiwan Compiler workshop (CTHPC'11)*, Taichong, Taiwan, jun 2011. Keynote presentation.

Conference articles

Major international conferences and workshops

- (18) O. Certner, Z. Li, P. Palatin, and O. Temam. A practical approach for reconciling high and predictable performance in non-regular parallel programs. In *DATE 2008*, Munich, Germany, march 2008.
- (19) A. Hashmi, H. Berry, O. Temam, and M. Lipasti. Automatic abstraction and fault tolerance in cortical microarchitectures. In *ACM/IEEE, International Symposium on Computer Architecture (ISCA)*, San Jose, CA, June 2011.
- (20) F. Jiang, H. Berry, and M. Schoenauer. Supervised and unsupervised evolutionary learning of echo state networks. In *10th International Conference on Parallel Problem Solving From Nature, PPSN-2008*, Dortmund, Germany, sep 2008.
- (21) F. Jiang, H. Berry, and M. Schoenauer. Supervised and unsupervised evolutionary learning of echo state networks. In *Parallel Problem Solving from Nature (PPSN'08)*, 2008. to appear.
- (22) F. Jiang, H. Berry, and M. Schoenauer. Unsupervised learning of echo state networks: Balancing the double pole. In *Genetic and Evolutionary Computation Conference, GECCO-2008*, Atlanta, GA, USA, July 2008.
- (23) D. Nuzman, S. Dyshel, E. Rohou, I. Rosen, K. Williams, D. Yuste, A. Cohen, and A. Zaks. Vapor simd – auto-vectorize once, run everywhere. In *International Symposium on Code Generation and Optimization (CGO'11)*, Chamonix, France, apr 2011.
- (24) E. Park, L.-N. Pouchet, J. Cavazos, A. Cohen, and P. Sadayappan. Predictive modeling in a polyhedral optimization space. In *International Symposium on Code Generation and Optimization (CGO'11)*, Chamonix, France, apr 2011.
- (25) L.-N. Pouchet, U. Bondhugula, C. Bastoul, A. Cohen, J. Ramanujam, P. Sadayappan, and N. Vasilache. Loop transformations: Convexity, pruning and optimization. In *38th ACM SIGACT-SIGPLAN Symposium on Principles of Programming Languages (POPL'11)*, Austin, Texas, jan 2011.
- (26) L.-N. Pouchet, C. Bastoul, A. Cohen, and J. Cavazos. Iterative optimization in the polyhedral model: Part II, multidimensional time. In *ACM SIGPLAN Conference on Programming Language Design and Implementation (PLDI'08)*, Tucson, Arizona, jun 2008.
- (27) L.-N. Pouchet, U. Bondhugula, C. Bastoul, A. Cohen, J. Ramanujam, and P. Sadayappan. Combined iterative and model-driven optimization in an automatic parallelization framework. In *ACM Supercomputing Conf. (SC'10)*, New Orleans, Louisiana, nov 2010. 11 pages.
- (28) S. Verdoolaege, A. Cohen, and A. Beletskia. Transitive closures of affine integer tuple relations and their overapproximations. In *Int. Symp. on Static Analysis*, LNCS, Venice, Italy, sep 2011. Springer-Verlag.

Other conferences and workshops

- (29) M. Bachir, F. Brault, S.-A.-A. Touati, and A. Cohen. Loop unrolling minimisation in the presence of multiple register types: a viable alternative to modulo variable expansion. In *High Performance Computing and Simulation Conference (HPCS 2011)*, Istanbul, Turkey, jul 2011.
- (30) M. Bachir, S.-A.-A. Touati, and A. Cohen. Decomposing meeting graph circuits to minimise kernel loop unrolling. In *9th Workshop on Optimizations for DSP and Embedded Systems (ODES'11, associated with CGO)*, Chamonix, France, apr 2011.
- (31) M. Bahi and C. Eisenbeis. High performance by exploiting information locality through reverse computing. In *23rd International Symposium on Computer Architecture and High Performance Computing - SBAC-PAD'2011*, Vitória, Espírito Santo, Brazil, October, 26-29 2011. Best Paper Award for the Architecture Track and Júlio Salec Aude Award - Best Paper SBAC-PAD 2011.
- (32) M. Bahi and C. Eisenbeis. Rematerialization-based register allocation through reverse computing. In *Proceedings of the 8th ACM International Conference on Computing Frontiers, CF '11*, pages 24:1–24:2, New York, NY, USA, 2011. ACM.
- (33) C. Bechara, A. Berhault, N. Ventrux, Y. Lhuillier, R. David, and D. Etiemble. A small footprint interleaved multithread processor for embedded systems. In *IEEE International Conference on Electronics, Circuits and Systems (ICECS)*. IEEE, 2011.
- (34) C. Bechara, N. Ventrux, and D. Etiemble. Ahdam: an asymmetric homogeneous with dynamic allocation manycore chip. In *Facing the multicore challenge II*. Springer Verlag, LNCS 6310, 2011.
- (35) C. Bechara, N. Ventrux, and D. Etiemble. Comparison of different thread scheduling strategies for asymmetric chip multithreading architectures in embedded systems. In *Digital System Design (DSD), 2011 14th Euromicro Conference on*, pages 181–187. IEEE, 2011.
- (36) M. Breughe, Z. Li, Y. Chen, S. Eyerman, O. Temam, C. Wu, and L. Eeckhout. How sensitive is processor customization to the workload's input datasets? In *IEEE, International Symposium on Application Specific Processors (SASP)*, San Diego, CA, June 2011.
- (37) O. Certner, Z. Li, A. Raman, and O. Temam. A very fast simulator for exploring the many-core future. In *IEEE, International Parallel and Distributed Processing Symposium (IPDPS)*, Anchorage, Alaska, May 2011.
- (38) O. Certner, Z. Li, and O. Temam. A practical approach for reconciling high and predictable performance in non-regular parallel programs. In *First Workshop on Programmability Issues for Multi-Core Computers (MULTIPROG), within HiPEAC International Conference*, Göteborg, Sweden, Jan 2008.
- (39) H. Esmaeilzadeh, S. Girbal, K. McKinley, O. Temam, and S. Yehia. Programming heterogeneous hardware components with software components. In *Workshop on SoC Architecture, Accelerators and Workloads (SAW), in conjunction with International Symposium on High-Performance Computer Architecture (HPCA)*, San Antonio, Texas, February 2011.
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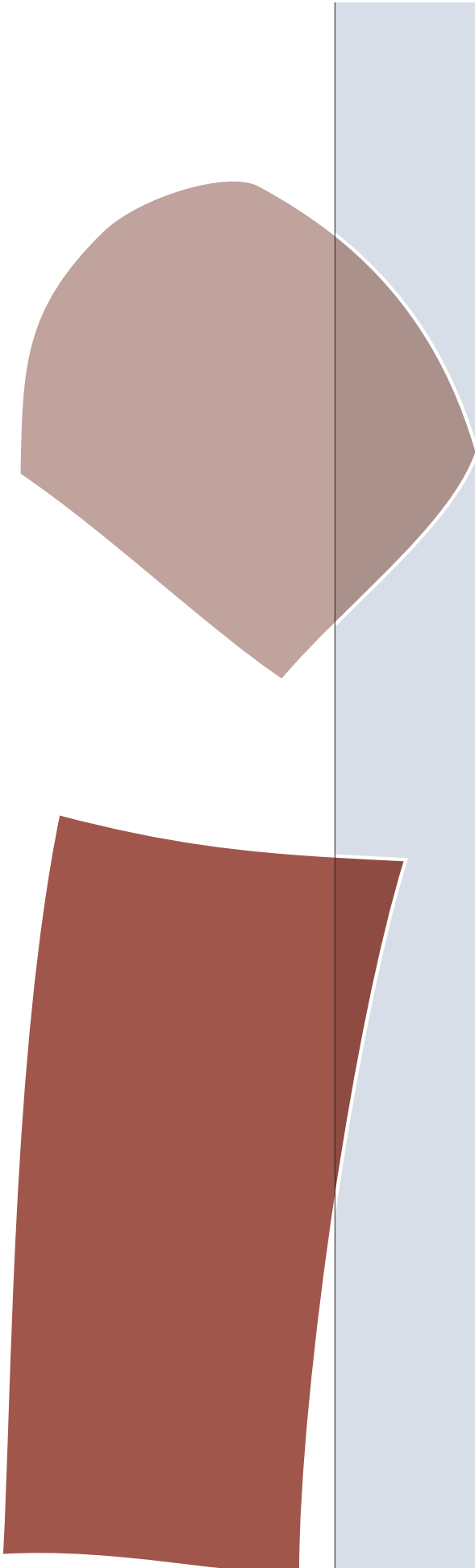


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8/ ROCS

Networking and Stochastic Combinatorial Optimization



équipe Réseaux et Optimisation Combinatoire Stochastique

Responsable: Steven Martin, Dominique Quadri

L'équipe ROCS est composée de chercheurs en Réseaux et en Optimisation Combinatoire Stochastique. La partie "réseaux" traite des problèmes liés à la qualité de service, principalement dans les réseaux sans fil, avec ou sans infrastructure. De nouvelles solutions sont étudiées pour améliorer les performances, que ce soit en termes de capacité, de débit, de robustesse, de consommation énergétique ou encore de sécurité.

Ces solutions conduisent à la définition d'algorithmes et de protocoles efficaces. La partie "optimisation combinatoire stochastique" utilise le paradigme de l'optimisation comme composante fondamentale de la méthodologie de recherche, reposant sur la conception, la modélisation et l'évaluation de performances des solutions optimisées proposées. Cette recherche est liée à l'optimisation combinatoire déterministe et à l'optimisation stochastique.

L'objectif principal de ROCS est de traiter de sujets cruciaux et de développements futurs, en particulier dans le domaine des réseaux mobiles et sans fil, en développant des collaborations fortes pour résoudre des problèmes complexes d'optimisation dans les réseaux.



Networking and Stochastic Combinatorial Optimization

Head: Steven Martin, Dominique Quadri

ROCS team gathers researchers working in the Networking and Stochastic Combinatorial Optimization fields. The ultimate aim of the Networking part is to deal with research related to quality of service mainly over wireless communication networks regardless their types, i.e. with or without infrastructure. New solutions are investigated for enhancing performance in terms of capacity, throughput, robustness, energy consumption, security, etc.

These solutions lead to the definition of efficient algorithms and protocols. The Stochastic Combinatorial Optimization part is using optimization paradigm as a fundamental component of research methodology which is mainly built on the combined design, modeling, and performance evaluation of the proposed optimized solutions. The main research is related to deterministic combinatorial optimization and stochastic optimization.

The core objective of ROCS is to deal with crucial topics and future developments especially in wireless and mobile networks by developing strong collaborations to solve complex network optimization problems.

Research team members

The new team ROCS is directed by Steven Martin, aside with Dominique Quadri as co-director.

Permanent Members (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
ALI-YAHIYA	Tara	MCF	IUT d'Orsay
BOUKHATEM	Lila	MCF HDR	Univ. Paris-Sud
GICQUEL	Céline	MCF	IUT d'Orsay
LISSER	Abdel	PR	Univ. Paris-Sud
MARTIN	Steven	MCF HDR	Univ. Paris-Sud
QUADRI	Dominique	MCF	Univ. Paris-Sud

PhD Students (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Funding</i>	<i>Institution</i>
CHENG	Jianqiang	ETR	Univ. Paris-Sud
EXCOFFIER	Mathilde	ANR	Univ. Paris-Sud
HUSSEIN	Soran	ETR	Univ. Paris-Sud
KURDA	Reben	ETR	Univ. Paris-Sud
LI	Guangyu	ETR	Univ. Paris-Sud
WANG	Chen	ETR	Univ. Paris-Sud
XU	Chuan	ETR	Univ. Paris-Sud

Post-Doc & Engineers (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
BOURGUIBA	Manel	Post-doc	Univ. Paris-Sud
HOUDA	Michal	Post-doc	Univ. Paris-Sud
NOURA	Hassan	Post-doc	Univ. Paris-Sud
YANG	Kai	Post-doc	Univ. Paris-Sud

Associate members (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
AL AGHA	Khaldoun	CEO	Green Comm.
CAVALLARI	Nicolas	Research Engineer	Green Comm.
CLAVEIROLE	Thomas	Research Engineer	Green Comm.
GAWEDZKI	Ignacy	Research Engineer	Green Comm.
GORGE	Agnès	Researcher	EDF
LETOURNEL	Marc	Associate Professor of Mathematics	Orsay

ROCS consists of members from two former LRI teams, namely NETWORKING and GRAPHCOMB. The following sections present the results of each of these two teams and the perspectives of the new one, ROCS.

Networking: Synthetic presentation

Nom du responsable de l'équipe : **Steven MARTIN** depuis juin 2013 (Khaldoun AL AGHA jusqu'en mai 2013).

Effectifs de l'équipe

Au 1^{er} janvier 2008, l'équipe Réseaux comprenait 3 EC (1 PR et 2 MCF), 7 doctorants, 1 post-doc.

Personnels ayant quitté l'équipe pendant le contrat en cours

1 PR et 1 MCF ont rejoint une autre équipe fin 2012 ; 9 doctorants ont soutenu leur thèse.

Nombre de recrutements réalisés au cours de la période considérée

2 MCF en 2009 et 1 PR en 2011.

Production scientifique au cours de la période écoulée

- De nouvelles méthodes d'allocation de ressources et de réduction des interférences ont été développées dans les réseaux sans fil de 4^{ème} génération, l'objectif étant d'améliorer la qualité du service offerte aux utilisateurs dans différents scénarios : femtocell, macro-cellules et les réseaux LTE multi-cellulaires. Par ailleurs, un nouveau mécanisme a été proposé pour les réseaux à modulation de type OFDMA, mécanisme basé sur une approche inter-couches (cross-layer) pour réduire les échanges de signalisation entre la station de base et les utilisateurs.
- Dans le cadre des réseaux sans fil hétérogènes, des solutions et des architectures originales ont été proposées pour mettre en place des réseaux autonomes, ainsi que des algorithmes pour assurer la qualité et la continuité de service durant la mobilité des utilisateurs.
- Pour permettre une meilleure utilisation des ressources dans les réseaux sans fil multi-sauts, des optimisations ont été réalisées. En particulier, une gestion dynamique des interférences a été proposée, fonction notamment du trafic présent dans le réseau et de la précision des modèles utilisés. En associant ce mécanisme de gestion à un contrôle efficace de topologie, nous avons montré que des améliorations significatives pouvaient être obtenues en termes de réutilisation spatiale et donc de capacité, y compris avec des solutions distribuées.
- Le codage réseau a été un axe de recherche important pour améliorer les performances dans les réseaux sans fil et notamment ceux sans infrastructure. Au cours de la période écoulée, plusieurs solutions ont été développées pour répondre à des problèmes de diffusion, de débit ou encore de contraintes temps-réel. En appliquant par exemple un codage de type GBNC (Generation-Based Network Coding) et en ajustant convenablement et dynamiquement les principaux paramètres que sont la taille de la génération et la redondance, il est possible de garantir à la fois des délais stables de bout-en-bout tout en maintenant des débits maximaux. Notre cadre applicatif a été la diffusion d'applications vidéo dans les réseaux de domicile.
- L'énergie est un facteur limitant pour les réseaux sans fil multi-sauts. Une partie de nos travaux s'est portée sur les contraintes énergétiques et la mise en place de mécanismes pertinents pour la conservation d'énergie dans de tels réseaux, et ce à différents niveaux de la pile protocolaire (MAC, routage, transport, ...). Parmi les solutions proposées, le mécanisme Start & Stop, ou SaS (qui a été breveté) permet d'économiser efficacement l'énergie dans un réseau ad hoc ou mesh, sans remettre en cause le fonctionnement de ce dernier. SaS ne nécessite aucune synchronisation entre les nœuds et est complètement distribué.

Bilan quantitatif des publications de l'équipe

- Journals: major international (10), others (14).
- Conference papers: major international (28), others (27).
- Books and book chapters (8).

5 publications majeures

- Youghourta Benfattoum, Steven Martin, Khaldoun Al Agha. A generation-based network coding with delay QoS for reliable multicasting. In Computer Networks Journal, Vol. 57(6): 1488-1502, Elsevier, 2013.
- Kehao Wang, Lin Chen, Quan Liu, Khaldoun Al Agha. On Optimality of Myopic Sensing Policy with Imperfect Sensing in Multi-channel Opportunistic Access. In IEEE Transactions on Communications, 2013.
- S. Paris, C. Nita-Rotaru, F. Martignon, A. Capone. Cross-layer metrics for reliable routing in wireless mesh networks. In IEEE/ACM Transactions on Networking, December 2012.

- Mauricio Iturralde, Tara Ali-Yahiya, Anne Wei, André-Luc Beylot. A real-time services performance and interference mitigation for femtocell scenarios in LTE networks. In IEEE LCN'12: Conf. on Local Computer Networks, Clearwater, FL, USA, October 2012.
- Mohammed Abdul Awal, Lila Boukhatem, Lin Chen. An integrated cross-layer framework of adaptive feedback with prediction for OFDMA systems. In Computer Networks Journal, Vol. 56(7): 1863-1875, Elsevier, 2012.

5 (max) documents majeurs (autres que publications)

- Khaldoun Al Agha. *Le codage en réseau*. Traité Hermes, 2012.
- Tara Ali-Yahiya. *Understanding LTE and its Performance*. Springer, 2011.
- Khaldoun Al Agha. Start and Stop for Internet Routers. FR-INPI 09 58890, 2011.
- Commission d'évaluation AERES de l'INRIA SA-M, 2011.
- Ignacy Gawedzki and Khaldoun Al Agha. Procédé de routage qualitatif dans un réseau de communication multi-sauts, équipement de gestion de nœud de réseau. FR-INPI 09 58 890, 2009.

5 (max) faits illustrant le rayonnement ou l'attractivité académique

- Présidence de congrès (IEEE/IFIP Med-Hoc-Net, IEEE/IFIP Wireless Days, ...), membre de comités de pilotage (NGN, WSN, WD), d'organisation (IEEE/IFIP Med-Hoc-Net 2013, ACM MOBIHOC 2011) et de programme (GLOBECOM, PIMRC, CC workshop in INFOCOM, ICC, WCNC, ...).
- Organisation d'une école d'été européenne "Citizen Safety" à Trento (Italie), 2013.
- Principales collaborations internationales : University of Kyoto (Japan), Universidad Tecnica Federico Santa Maria (Chile), University of Siena (Italy), TU Darmstadt (Germany), University of Trento (Italy), University of Twente (Netherlands), University of Istanbul (Turkey), Federal University of Parana (Brazil), Universitat Politècnica de Catalunya (Spain).
- Participation active au groupe WEED de l'action CNRS inter-GDR AFSEC (Approches Formelles des Systèmes Embarqués Communicants).
- Principaux exposés dans le cadre d'invitations : Steven Martin. Personal safety in the city. Universidad Tecnica Federico Santa Maria, Chile, March 2013 / Tara Ali-Yahiya. Resource allocation issue in LTE networks. University of Siena, Italy, February 2012 / Lila Boukhatem. Mobility and Routing solutions for ITS systems. Imperial College, London, August 2011 / Lila Boukhatem. Mobility in the Digital Cities of the Future. Krusenberg Workshop, Sweden, November 2011 / Steven Martin. Quality of service in multi-hop wireless networks. Kyoto University, Japan, July 2011 / Khaldoun Al Agha. Energy consumption in wireless networks. Kyoto University, Japan, June 2011 / Lila Boukhatem. Feedback reduction in OFDMA systems. Kyoto University, Japan, July 2010 / Lila Boukhatem. Allocation des ressources dans les systèmes OFDMA. Telecom ParisTech, Paris, June 2010 / Steven Martin. Formal methods: the trajectory approach. ENS, Lyon, France, June 2010 / Khaldoun Al Agha. Routing protocols in ad hoc networks. Universidad Tecnica Federico Santa Maria, Chile, April 2009 / Steven Martin. Deterministic guarantees in industrial networks. ENSEEIHT, Toulouse, February 2009.

5 (max) faits illustrant les interactions de l'équipe avec son environnement socio-économique ou culturel

- Responsabilités européennes : Ligne d'action "Digital Cities of the Future" au sein de l'EIT (European institute of Innovation and Technology) / Activité "Citizen safety" de l'EIT ICT Labs / Activité IMS - Intelligent Mobility and Transportation Systems de l'EIT ICT Labs.
- Réseaux internationaux : FP7 network of excellence HYCON2 (Highly-complex and networked control systems) / #NEWCOM (Network of Excellence in Wireless COMMunications).
- Projets nationaux : ANR (Fitting, PSN, Connected Cities, TRAFIC, SARAH) / System@tic Paris-Région (RAF, SOAPS) / Digiteo (SWAN, COREPHY, NC2) / CRE (Contrat de Recherche Externalisé) avec Orange Labs / STIC-ASIE (DYNARIS).
- Participation à différents colloques : Futur en Seine / Les rencontres du numérique, ...
- Valorisation : Création d'une structure industrielle (start-up Green Communications).

Principales contributions de l'équipe à des actions de formation

- Responsabilités en lien avec des filières de formation :
 - Responsabilité du Master 2 Recherche en Informatique NSI (Nouveaux Systèmes Informatiques), depuis 2010.
 - Responsabilité du Master 2 Professionnel en Informatique IICI (Ingénierie de l'Information, de la Communication et de l'Interaction), 2008-2012.
- Responsabilités pédagogiques d'enseignements niveau master :
 - Responsabilité de l'ensemble des modules liés aux enseignements en réseaux (TCP/IP, mobiles, sans fil, ad hoc, véhiculaires, de capteurs, etc.) pour le L3 Informatique, le M1 informatique, le M1 Miage, le M1 Miage CFA, le M2Pro CCI, le M2R NSI, le M2Pro IICI, une partie du M2Pro RESTEL et Polytech Paris-Sud.
- Enseignements dispensés à l'étranger :
 - TCP/IP and ad hoc networks, Kyoto University, 2008-2009.
 - Mobile Networks, Ha Noi College of Technology, Viet Nam, 2007-2009.
- Conception d'outil pédagogique :
 - Intranet du M2Pro IICI (<http://m2pro.lri.fr>).

Research Group Members and evolution since 2008

Permanent Members (June 30th, 2013)

<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
AL AGHA	Khaldoun	PR1	Univ. Paris-Sud
ALI-YAHIYA	Tara	MCF	IUT d'Orsay
BOUKHATEM	Lila	MCF	Univ. Paris-Sud
CHEN	Lin	MCF	Univ. Paris-Sud
MARTIGNON	Fabio	PR2	Univ. Paris-Sud
MARTIN	Steven	MCF	Univ. Paris-Sud

PhD Students (June 30th, 2013)

<i>Name</i>	<i>First name</i>	<i>Funding</i>	<i>Institution</i>
HUSSEIN	Soran	ETR	Univ. Paris-Sud
KURDA	Reben	ETR	Univ. Paris-Sud
LI	Guangyu	ETR	Univ. Paris-Sud
MANGILI	Michele	Allocation	Univ. Paris-Sud
MEDLEJ	Sara	CIFRE	Univ. Paris-Sud

Post-Doc & Engineers (June 30th, 2013)

<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
BOURGUIBA	Manel	Post-doc	Univ. Paris-Sud
ITURRALDE	Mauricio	Post-doc	Univ. Paris-Sud
NOURA	Hassan	Post-doc	Univ. Paris-Sud

Visitors (2008-2013)

<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>	<i>Arrival</i>	<i>Departure</i>
Kaneko	Megumi	MCF	Kyoto University, Japan	05/2012	06/2012
Takahashi	Yutaka	PR	Kyoto University, Japan	09/2009	10/2009
Arredondo Vidal	Tomás	MCF	USM, Chile	09/2008	09/2008
Grote	Walter	PR	USM, Chile	09/2009	09/2009
Grote	Walter	PR	USM, Chile	09/2008	09/2008
Stojmenovic	Ivan	PR	Univ. of Ottawa, Canada	06/2008	09/2008
Labioud	Houda	MCF	Télécom ParisTech	01/2008	05/2008

Group evolution

- September 2009: Lin Chen joined the team as Assistant Professor.
- October 2009: Tara Ali-Yahiya joined the team as Assistant Professor.
- September 2011: Fabio Martignon joined the team as PR2.
- June 2013: Lin Chen left the team to join GALAC.
- June 2013: Fabio Martignon left the team to join GALAC.

Research Description

Wireless networks have experienced tremendous changes over the past decade and they are now indispensable through the use of multiple applications in our daily live. Wireless network infrastructure

(see Figure 12.1, on the left) is naturally the focus of the attention of operators and research community as many aspects of wireless communication have already been resolved. Nowadays, the bandwidth available for users in such networks are competing already those of wired networks and wireless networks are starting to pave the way for the future.

Beside this type of architecture, a class of infrastructureless wireless networks was developed; the multi-hop networks (see Figure 12.1, on the right), in which nodes can communicate directly or indirectly via intermediate ones. This area has also attracted a large research activity in different contexts of deployment such that ad hoc, mesh, vehicular and sensor networks.

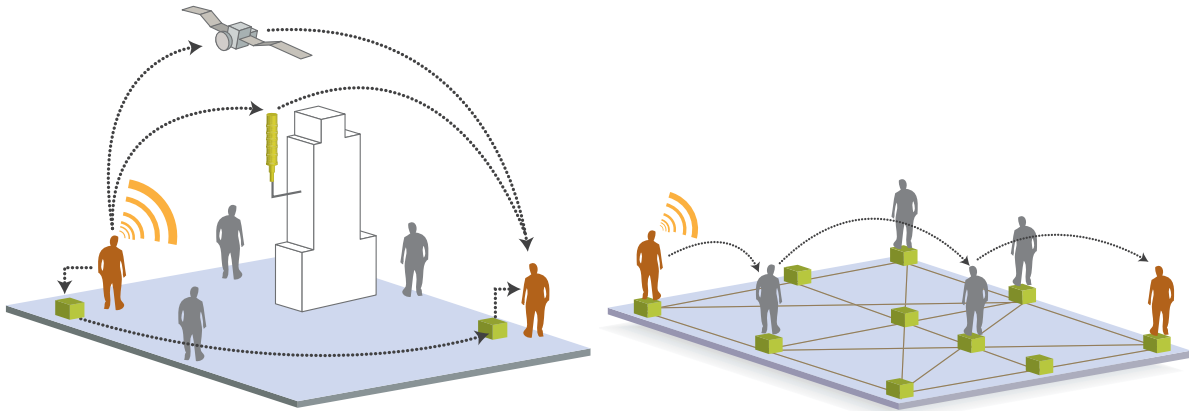
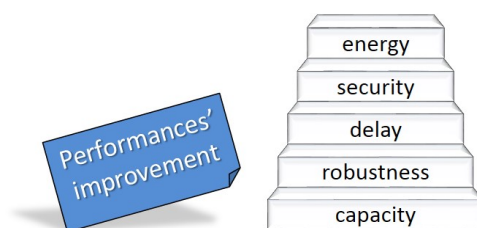


Figure 8.1: A wireless network with (on the left) and without (on the right) infrastructure.

The ultimate aim of Networking team is to deal with research related to user mobility and quality of service, mainly over wireless communication networks regardless their types i.e. infrastructure and infrastructureless. The team has investigated new solutions for optimizing several networking parameters, such as routing, energy, security, scheduling and resources. These solutions lead to the definition of algorithms and protocols that must achieve high performance results. The common approach is based on theoretical proofs (performance evaluation, convergence, mathematical bounds, etc.), simulation studies (scalability, system dynamics, mobility patterns, etc.), and also implementation (concrete case studies, test bed platforms). This cross-validation approach provides robust, high-performance, and competitive solutions.

The major interest of Networking team is to consider problems related to different types of networks especially 4G, multi-hop and networks of the future. The methodology used by the team is to study the key performance related to the most important factors that play a great role in the way of the functioning of these networks.



The capacity increase of the network is imperative since it ensures that the network is operating on the highest capacity; this would mean that each user is satisfied in terms of throughput. Furthermore, the degree of robustness is one of the crucial factors that make the network works without any failure and have good degree of maintenance. While the different applications increasing day by day particularly the real-time one, the delay parameter is starting to get an important part, as it is one of the most important parameter to be ensured for guarantying the quality of service. Security represented by integrity, confidentiality and privacy is another issue that the team is dealing with in order to reinforce the network and make it protected better and better. To cope with the requirements for higher data rates, lower latency, higher spectral efficiency and security, the gap between network complexity and battery capacity is increasing year by year, leading to limited and continually decreasing battery lifetime. This is why energy consumption is a hot topic that the team is dealing with.

The team proposes algorithms that take into consideration the implementation constraints in existing networks or future one for the previous parameters. Performance analysis as theoretical work and modeling and simulations as a tool of evaluation are the most important expertise of the team.

Multi-hop Wireless Networks

A multi-hop network is a network where each node is able to join each others transparently. In such networks, two distant nodes cannot communicate directly and use intermediate nodes to relay information. This ability makes this kind of networks very popular since they can easily cover a wide area for a low cost. But in the same time, this ability makes them complex. The Networking team has strived to provide solutions in this area to improve performances of such networks in terms of capacity, robustness, security or energy consumption.

One of the major issue to investigate in multi-hop wireless networks is interference, since a node shares the medium with all its neighbors. Even if two paths have no node in common, interference can occur between them consequently reducing their throughput. This is known as inter-flow interference. Besides, when a link interferes with another one of the same path, the interference is said to be intra-flow. Unlike most of the routing algorithms with QoS consideration, the Networking team has proposed to take into account inter-flow interference during the routing process, based on the model of cliques to find the exact sets of mutually interfering links in the conflict graph (58).

Then, the team has proposed an accurate theoretical estimation for idle channel time in a multi-hop environment based on a probabilistic model (45). This estimation was enabled to develop a new admission control algorithm with dynamic constraints for multi-hop networks (44). As long as these constraints are satisfied, flows are accepted. Unlike existing approaches based on either necessary constraints (tending to overload the network) or sufficient constraints (where a significant part of the bandwidth remains unused), our results allow efficient use of network resources.

In the same way, to optimize the global energy consumption while maximizing the aggregate throughput, the Networking team has proposed to dynamically compute the transmission powers of nodes depending on the network. Indeed, the best allocation vector for the transmission powers varies according to the amount of the traffic: for a given set of flows, we could choose an optimal allocation while it represents the worst case for another set of flows. To address this issue, we developed traffic-based topology control algorithms based on optimization or heuristics for a limited computation cost (22).

In terms of security, multi-hop wireless networks are vulnerable to a variety of potential attacks (active and passive). However, the characteristics of such networks (limitations of power, computation and memory) impose specific solutions, the conventional ciphers suffering from these limitations. The Networking team has proposed a new cipher technique to ensure the data confidentiality with a significant reduction of computational complexity, energy cost, and communication overhead (?).

Green Networks

Energy is a limiting factor for mobile ad hoc networks. In many use cases, MANET (Mobile Ad hoc NETWORK) nodes rely on battery power, because they are mobile or have limited access to an infrastructure. This leads to energy-constraints regarding how network devices should use their resources (CPU, radio, etc.) A straightforward way of dealing with this issue is to provide batteries with higher capacities: this increases node lifetime, hence, network lifetime. This solution is however expensive. Another way is to find efficient mechanisms for energy conservation. One may achieve significant power savings by incorporating energy aware strategies into network protocol designs. Existing research works investigated energy conserving mechanisms at various layers of the protocol stack, including medium access control (MAC), routing, or transport layer. The importance of the problem encouraged the IEEE 802.11 standard to develop energy conservation solutions in ad-hoc networks.

The Networking team proposes the Start-and-Stop (SaS) algorithm, a distributed mechanism for saving energy in mobile ad-hoc and mesh networks. SaS' main objective is to save as much energy as possible without disturbing network operation (that is, keeping the network connected and not interrupting existing

data flows). The principle basis of SaS is to detect when a node is “useless” to the network in order to switch it off for a given duration, and then to switch it back on (thus the algorithm’s name). A very important feature of SaS is that each node computes its on/off state independently, and cannot switch other nodes off. Note that, contrary to other schemes, SaS focuses on switching off (or putting to sleep) the whole node, and not just its radio. Another specific feature of SaS is that it requires no synchronization among nodes.

The SaS was patented and transferred under a license agreement to the company Green Communications a spinoff of the Networking team.

Network Coding

Traditionally in a network, the intermediate nodes involved in routing a flow from a source to a destination forwards the data packets without any processing. Network coding allows the nodes to mix packets for improving the network performance. However, this improvement is dependent on the number of packets to combine, the way of combining them and the amount of knowledge that needs a node about the network topology and state in order to process the right coding.

Figure 12.2 shows the number of transmissions required (3 instead of 4 without network coding) in a wireless environment with a basic coding scheme based on a simple XOR of packets received on the relay node. To manage the bandwidth optimization using network coding in multi-hop wireless networks, the Networking team has developed an efficient interference- and coding-aware routing algorithm. The solution uses this “Alice & Bob” scheme and a clique-based model to take into account all the mutually interfering links (30, 32).

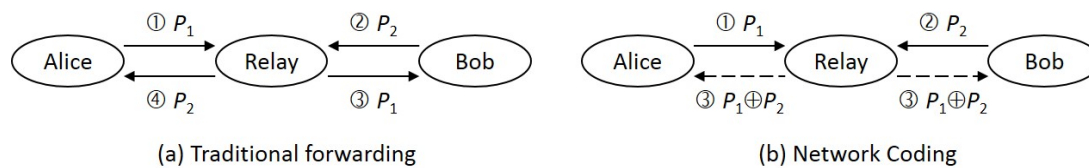


Figure 8.2: Basic coding scheme improving the network performance.

Naturally, there exist more sophisticated coding schemes to maximize the benefits of network coding. Generation-based network coding (GBNC), for instance, deals with generations of packets and allows time and space coding. It further increases the throughput and brings more robustness to the network. Addressing notably the problem of context awareness in Home Area Networks (HANs) for real-time services, the Networking team has proposed an approach to adjust the generation size according to the network variations (network size, congestion, losses) for multicast flows to keep the delay steady while maximizing throughputs (3).

Moreover, one of the major issue to investigate in network coding is how to encode packets in order to satisfy two criteria: maximizing the performance of the network (more bandwidth and less overhead) while reducing the complexity of the decoding. A way to reduce the complexity of decoding is to use digital fountain codes. Fountain codes provide high performance only if the distribution that we select for the degree of the encoded packet (number of native packets encoded together) is robust enough to avoid a slow decoding.

The Networking team proposed a new distribution that mix together robust soliton and exponential degrees dynamically. Switching from one distribution to another depends on the percentage of the encoded packets sent by the source. The distribution was following the fact that the degree should be small when the number of native packets at the receiver is small and vice versa to maximize the coding gain. This mechanism was applied to optimize the broadcast in ad hoc networks. Results were very promising in terms of improving the bit rates and the delivery delays (21, 42).

Heterogeneous Wireless Networks

The next generation network will be seen as a new initiative to bring together all heterogeneous wireless and wired systems under the same framework, to provide connectivity anytime and anywhere using any available technology (13). Network convergence is therefore regarded as the next major challenge in the evolution of telecommunication technologies and the integration of computer and communications. One of the most important points in this context is the development of mechanisms that are able to support transparent service continuity across different integrated networks through the use of appropriate inter-working architecture, handover decision algorithms, context adaptation strategies, etc. The reason is that wireless networks differ in their key functionalities like quality of service (QoS) support and service differentiation, access control, or signaling for authentication, authorization and accounting (AAA), etc. (29, 53). The network team is dealing with problems related to the cohabitation of different types of networks including macrocell, femtocell, pico-cells, etc. The Networking team has the aim to provide a guaranteed QoS to mobile nodes moving from one network coverage to another while dealing with the interference issue and taking benefit from their mobility information (54).

VANET

Vehicular Ad hoc Networks (VANETs) pose many challenges, such as large network size, rapid topology changes, and channel capacity limitations which can play a significant role in communications performance degradation and even links failure. In the Networking team, we are mainly interested in developing efficient routing protocols that can handle the dynamics of VANETs communications context. A first developed strategy is to take benefit of the travelling vehicles to help in a proactive control data dissemination that facilitates routing decisions. As multi-criteria routing in VANET is NP-hard, we make use of heuristics based on Ant Colony Optimization (ACO). ACO concepts fit perfectly the idea of the opportunistic propagation of routing information through the pheromone dissemination (see Figure 12.3).

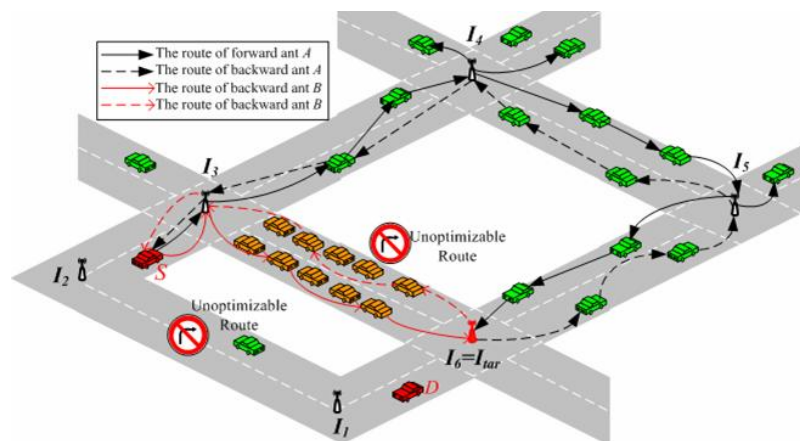


Figure 8.3: VANET routing scenario.

The key feature of the developed protocol is to rely on a periodically estimated road segment relaying quality which is expressed in terms of combined QoS parameters such as latency, bandwidth, and delivery ratio. Routing decision is then realized dynamically at intersections to opportunistically select best next intersection based on a pheromone routing table. We are also studying MAC layer issues in order to achieve cross-layer optimizations and provide more priority for security messages which have stringent delivery and loss rate constraints.

OFDMA Systems

To face the rapid growth in broadband data usage, OFDMA-based (Orthogonal Frequency Division Multiple Access) 4G networks provide a large range of new data and multimedia services with low costs,

high reliability and quality. OFDMA is a multiple-access/multiplexing technique that provides multiplexing operation of data streams from multiple users onto the downlink sub-channels. A first issue in this context addressed by the Networking team concerns feedback reduction. As the wireless channel is dispersive by nature, the users need to inform the base station about their channel quality indicator (CQI) information to increase the reliability and achieve multiuser diversity gain. However, the available radio spectrum is scarce and energy consumption is limited. If the base station receives CQI feedbacks from all users, large feedback overhead exhausts the limited uplink capacity and users will need to compete for CQI feedback resources. We analyzed and developed advanced methods to reduce the CQI feedback overhead by the means of a prediction tool and proposed original schemes to schedule the CQI feedbacks under CQI budget and QoS constraints. An analysis of the feedback resource allocation in multiuser multiple access with delay constrained (i.e. real-time) applications was realized. The exploitation of the physical and MAC layer information such as doppler frequency, adaptive modulation and coding scheme, ARQ acknowledgements were included in the derived feedback resource optimization schemes (2, 26, 27, 28, 56, 57).

Another issue in an OFDMA system is how to ensure the quality of service while having diverse kind of channels, in order to guarantee the quality of service requirements for applications by taking into account the quality of channel, the best way is to propose some solution of cross-layer design that takes into account information from different level of the network conception layers (38, 39, 40, 41).

Real-time networks

In a real-time constrained network, some of the applications coexisting in the network require temporal guarantees to have a behavior compliant with their specifications (e.g. voice over IP, control-command applications, multimedia applications, distributed interactive games). To be certified as secure, a hard real-time network such as in nuclear power plants or on board airplanes have to verify several properties, especially the following: In normal functioning, every transmitted packet reaches the right destination in a bounded time. To provide deterministic guarantees on these times, we developed an approach, called "trajectory approach", based on flow scheduling. More precisely, assuming that flows are scheduled in each node according to fixed and/or dynamic priorities, our worst case analysis allows establishing upper bounds on the real-time constraints. These results address many applications. They enable to derive, for example, a simple admission control in charge of deciding whether a new flow can be accepted or not, by verifying that the new flow will not experiment a worst case response time greater than its end-to-end deadline and that the acceptance of this new flow will not compromise real-time guarantees given to the already accepted flows. A scalable version has also been proposed to compute bounds in large networks with low complexity, without significant loss of precision.

Cognitive Radio Networks

Cognitive radio networks are a very promising framework, since they provide the capability to share the wireless channel with licensed (primary) users in an opportunistic manner. In this context, we first studied the spectrum access problem from a game theoretical perspective. The problem is modeled as a non-cooperative spectrum access game where secondary users access simultaneously multiple spectrum bands left available by primary users, optimizing their objective function which takes into account the congestion level observed on the available spectrum bands. As a key innovative feature with respect to existing works, we modeled accurately the interference between SUs, capturing the effect of spatial reuse. Furthermore, we considered both non-elastic and elastic user traffic, to model real-time as well as data transfer applications. Finally, we introduced replicator dynamics to study players which adjust dynamically their strategies, deriving convergence conditions to Nash equilibrium points. We further focused on the pricing and network selection problem in cognitive radio networks, using a game theoretical formulation where Primary and Secondary operators set the network subscription price to maximize their revenue. Then, users perform the network selection process, deciding whether to pay more for a guaranteed service, or use a cheaper, best-effort secondary network, where congestion and low throughput may be experienced. We derived optimal stable price and network selection settings, using the Nash and Wardrop equilibrium concepts to characterize the equilibria for the price setting and network selection games (63, 6).

Radio Access Networks

In this activity, we focused on the resource allocation problem in mobile networks, focusing mainly on the Radio Access Network (RAN) infrastructure, which represents the most critical part for capacity planning, which usually accounts for peak traffic conditions. A promising approach to increase the RAN capacity is represented by the opportunistic utilization of third party WiFi access devices. In order to foster the utilization of unexploited Internet connections, we proposed a new and open market, where a mobile operator can lease the bandwidth made available by third parties (residential users or private companies) through their access points to increase the network capacity and save large amounts of energy. We formulated the offloading problem as a reverse auction considering the most general case of partial covering of the traffic to be offloaded. We discussed the conditions (i) to offload the maximum amount of data traffic according to the capacity of third party access devices, (ii) to foster the participation of access point owners (individual rationality), and (iii) to prevent market manipulation (incentive compatibility). We presented an innovative payment rule, which extends the classical Vickrey-Clarke-Groves (VCG) scheme, and demonstrated that it guarantees both individual rationality and incentive compatibility (i.e., truthfulness). To the best of our knowledge this is the first payment rule that considers explicitly the trade-off between the total cost and the gain of offloading data connections. Since the optimal reverse auction is NP-hard, we further proposed a greedy algorithm that solves in polynomial time the allocation problem for large network instances (46).

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Collaborations

Participation to national and international collaborative research projects

- Action Line IMS (Intelligent Mobility and transportation Systems), EIT ICT-Labs, Coordinator: C. Muller. Partners: DFKI, Imperial College of London, Institut Télécom, LRI.
- Citizen Safety, EIT ICT Labs activity, Coordinator: Steven Martin. Partners: Cassidian-EADS, LRI, Siemens, TU Darmstadt, University of Trento, University of Twente.
- COREPHY, DIGITEO, Coordinator: Mohamed Kamoun. Partners: CEA, L2S, LRI, Supélec, UCP
- Dependable and secure VANETs for intelligent transportation systems, CONICYT-IRD, Coordinator: Khaldoun Al Agha. Partners: Federal University of Paraná (Brazil), LRI, Universidad Técnica Federico Santa María (Chile).
- Eco-HetNet: Cross-layer Protocol Design for Eco-friendly Heterogeneous Wireless Networks, PHC Sakura, Coordinator: L. Boukhatem. Partners: Graduate School of Informatics-Kyoto University, LRI.
- FITTING, ANR, Coordinator: Serge Fdida. Partners: ALU, INRIA, LIP6, LRI.
- French management committee substitute in information and communication technologies COST Action IC0906, Wireless Networking for Moving Objects (WiNeMO): Tara Ali-Yahiya.
- Green-Dyspan, ANR, Coordinator: Lin Chen. Partners: LRI, Zhejiang University (China).
- NC2, DIGITEO, Coordinator: Khaldoun Al Agha. Partners: AUTH (Grèce), INRIA, L2S, LRI, MIT (USA).
- OCARI, ANR, Coordinator: Tuan Dang. Partners: DCNS, EDF, INRIA, LATTIS, LIMOS, LRI, Telit-RF Technologies.
- OnDemand, FEDER, Coordinator: Ibrahim Hajjeh. Partners: EtherTrust, Green Communications, Inéovation, Télécom Paristech, Université Paris-Sud, UPMC.
- Quality of service issues in multi-hop wireless networks, CONICYT-IRD, Coordinator: Khaldoun Al Agha. Partners: LRI, Universidad Técnica Federico Santa María (Chile).
- RAF, SYSTEM@TIC, Coordinator: Serge Hethuin. Partners: Alcatel-Lucent, Bluwan, Cassidian, LRI, Martec, Supélec, Thales communications & security SAS.
- Personal Safety in the City, EIT ICT Labs activity, Coordinator: Steven Martin. Partners: Green Communications, LRI, TU Darmstadt, University of Twente.
- SARAH, ANR, Coordinator: Hassnaa Moustafa. Partners: France Telecom, INRIA, LRI, Télécom SudParis, Ucopia, UPMC.
- SOAPS, SYSTEM@TIC, Coordinator: Guy Philippe. Partners: Altran, Cassidian-EADS, CNAM, LRI, LS Telcom SAS, Sequans communications, Silicom, Supélec, Thales, Télécom SudParis, UVSQ.
- TRAFIC, ANR, Coordinator: Arion. Partners: Arion Entreprise, IRSEEM-ESIGELEC, LRI, Télécom ParisTech.
- WiMAX, DIGITEO, Coordinator: Steven Martin. Partners: INRIA, LRI.

Collaborations with other laboratories

- Eitan Altman, INRIA Sophia Antipolis-Méditerranée: Game theory (6, 63).
- André-Luc Beylot, ENSEEIHT: OFDMA Systems (38, 39, 40, 67).
- Aline Carneiro Viana, INRIA: Multi-hop wireless networks (24, 43).
- Hakima Chaouchi, Télécom Sud Paris, Heterogeneous wireless networks (29, 78).
- Marceau Coupechoux, Telecom ParisTech: Cognitive radio networks (17, 34).
- Walter Grote, Universidad Técnica Federico Santa María (Chile): Wireless networks (65, 74).
- Jean Leneutre, Telecom ParisTech: Network security (4, 5, 35).
- Lavy Libman, University of Sydney (Australia): Opportunistic cooperative communication (5).
- Quan Liu, Wuhan University of Technology (China): Cognitive radio networks (8, 10).
- Guy Pujolle, University Pierre et Marie Curie: Green networks (22, 75).
- Anne Wei, Conservatoire National des Arts et Métiers (CNAM) de Paris: OFDMA systems (38, 39, 40, 67).

Other Collaborations

- Nadia Boukhatem, Telecom ParisTech: Vehicular networks.
- Giovanni Giambene, University of Siena (Italy): OFDMA systems.
- Megumi Kaneko, Kyoto University (Japan): Heterogeneous wireless networks.
- Houda Labiod, Telecom ParisTech: Vehicular networks.
- Yutaka Takahashi, Kyoto University (Japan): Network coding.

Participation to national and international networks

- HYCON 2 : Highly-complex and networked control systems - FP7 Network of Excellence: L. Boukhatem, Participation, 2010-2014.
- NEWCOM FP7 Network of Excellence in Wireless COMMunications: L. Boukhatem, K. Al Agha, S. Martin, T. Ali Yahya, Participation, 2013-2016.

Participation to “investissement d’avenir” program

- Labex DigiCosme (Action line ComEx, Intelligent network structures): member.
- IRT SystemX: participation in the project design.

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Volunteer Professional Service

Management Positions in Scientific Organisations

- EIT ICT Labs, Action line “Digital cities of the future”: Khaldoun Al Agha, leader (2009-2013).
- Board of the Faculty of Science (Orsay): Steven Martin, elected member (since 2011).
- Board of the lab (LRI): Khaldoun Al Agha, nominated member (2009-2013).
- Board of the lab (LRI): Steven Martin, elected member (2009-2013).
- Board of the lab (LRI): Lila Boukhatem, elected member (2008-2009).
- CCSU - sections 27, 60-61-62: Khaldoun Al Agha, nominated member (since 2010).
- CCSU - section 27: Steven Martin, elected member (since 2010).

Organisation of Conferences and Scientific Events

- *First Summer School in Citizen Safety*, Trento, 2013: Tara Ali-Yahiya, organizer and chair of the summer school.
- Med-Hoc-Net, *IFIP/IEEE Mediterranean Ad Hoc Networking Conference*: Khaldoun Al Agha, member of the steering committee.
- NGN, *Next Generation Network Workshop*: Khaldoun Al Agha, member of the steering committee.
- WD, *IFIP/IEEE Wireless days*: Khaldoun Al Agha, member of the steering committee.
- *Workshop of the working group WEED/AFSEC*, Paris, France, 2010 and 2011: Steven Martin, organizer and chair.

Working Groups

- IFIP TC6-W6.8: Khaldoun Al Agha, expert.
- Working Group WEED in AFSEC (Approches Formelles des Systèmes Embarqués Communicants), action à vocation inter-GDR STIC: Steven Martin, member (since 2009).

Other Responsibilities

- Master Recherche NSI, Université Paris-Sud: Khaldoun Al Agha, responsable (2010-2013).
- Master Recherche NSI, Université Paris-Sud: Lila Boukhatem, coresponsable (2011-2013).
- Master Professionnel IICI, Université Paris-Sud: Steven Martin, responsable (2008-2012).

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Evaluation of Research

Editorial Boards

International

- *Journal of Sensors*, special issue on Green Sensor Networking: Khaldoun Al Agha (2013).
- *Annals of Telecommunications Journal*, special issue on Home Networking, Springer: Khaldoun Al Agha (2008).

National

Program Committees

Chair

- IEEE COMPSAC 2013, Smart Cities Track: Khaldoun Al Agha.
- IEEE Med-Hoc-Net 2013, *The 12th Annual Mediterranean Ad Hoc Networking Workshop*, Ajaccio, France: Steven Martin.
- IEEE WCNC 2012, MAC Layer Track: Khaldoun Al Agha.
- *The 2nd Int. Workshop WCTT*, in conjunction with RTSS 2012, San Juan, Porto Rico: Steven Martin.
- ACM Mobihoc 2011, Workshop chair: Khaldoun Al Agha.
- *The 1st Int. Workshop WCTT*, in conjunction with RTSS 2011, Vienna, Austria: Steven Martin.
- ISoLA 2010, *Int. Symposium on Leveraging App. of formal methods*, special track WCTT: Steven Martin.
- EIII 2009, *Réseaux et télécommunications : les choix stratégiques*, Amman, Jordan: Steven Martin.
- IPCCC 2009, *The first Workshop on Broadband Wireless Network Communications Performance (BWNCP)*, Phoenix, Arizona, USA: Tara Ali-Yahiya.

Member (international events)

- BWCCA, *The International Conference on Broadband, Wireless Computing, Communication and Applications*: Lin Chen (2013).
- GLOBECOM, *The IEEE Global Communications Conference*: Khaldoun Al Agha (2008, 2009), Steven Martin (2013).
- ICAIT, *The IEEE International Conference on Advanced Infocomm Technology*: Tara Ali-Yahiya (2012), Lila Boukhatem (2012).
- ICC, *The IEEE International Conference on Communications*: Lin Chen (2013).
- INFOCOM, *The IEEE International Conference on Computer Communications*: Fabio Martignon (2013).
- InveNet, *The IEEE MASS Workshop on Intelligent Vehicular Networks*: Lila Boukhatem (2010).
- Med-Hoc-Net, *The IEEE Annual Mediterranean Ad Hoc Networking Workshop*: Khaldoun Al Agha (2010).
- NETWORKING, *The IFIP Series of Int. Conferences on Networking*: Khaldoun Al Agha (2009-2013).
- NTMS, *The IFIP Int. Conference on New Technologies, Mobility and Security*: Steven Martin (2009, 2011).
- PIMRC, *The IEEE International Conference on Personal, Indoor and Mobile Radio Communications*: Khaldoun Al Agha (2008, 2009, 2012).
- SaCoNet, *The IEEE International Workshop SaCoNet III*, in conjunction with ICC: Steven Martin (2012).
- VTC-Spring, *The IEEE Vehicular Technology Conference*: Fabio Martignon (2013).
- WCNC, *The IEEE Wireless Communications and Networking Conf.*: Khaldoun Al Agha (2008, 2010, 2013), Tara Ali-Yahiya (2012, 2014), Steven Martin (2014).
- WD, *The IFIP/IEEE Wireless Days*: Khaldoun Al Agha (2009-2013), Lila Boukhatem (2009, 2010, 2012).
- WOCN, *IFIP/IEEE International Conference on Wireless and Optical Communications Networks*: Tara Ali-Yahiya (2011), Lila Boukhatem (2011).
- The Broadband Wireless Access Workshop, co-located with GLOBECOM: Tara Ali-Yahiya (2012, 2013).

Member (national events)

- DNAC, *De Nouvelles Architectures pour les Communications*: Khaldoun Al Agha (2008), Tara Ali-Yahiya (2012, 2013), Steven Martin (2008-2013).
- JDIR, *Les Journées Doctorales en Informatique et Réseaux*: Steven Martin (2008).

Evaluation Committees and Invited Expertise

National

- AERES evaluation commission for INRIA SA-M: Khaldoun Al Agha (2011).
- ANR JCJC SIMI 2: Steven Martin (2013).
- ANR programme Blanc International SIMI 2: Steven Martin (2012).
- Reviewer for CIFRE PhD funding: Steven Martin (2012).
- ANR Blanc: Lila Boukhatem (2010).
- Reviewer for CIFRE PhD funding: Lila Boukhatem (2009).
- ANR Jeunes Chercheuses et Jeunes Chercheurs: Fabio Martignon (2013).
- ANR Blanc International II, SIMI 3: Fabio Martignon (2012).
- ANR Blanc International II, SIMI 2: Fabio Martignon (2012).
- ANR Jeunes Chercheuses et Jeunes Chercheurs: Lin Chen (2013).

Other evaluation activities

Hiring Committees

- Full professor positions: Khaldoun Al Agha (2 times: 2011).
- Assistant professor positions: Khaldoun Al Agha (3: 2010-2011), Lila Boukhatem (3: 2010, 2013), Steven Martin (3: 2011, 2013).

PhD and Habilitation Juries

- Khaldoun Al Agha: president (14 PhD, 2 HDR), reviewer (14 PhD, 3 HDR, 1 PhD in Sweden, 1 PhD in Spain), examiner (10 PhD, 4 HDR, 1 PhD in Italy).
- Lila Boukhatem: reviewer (2 PhD), examiner (3 PhD).
- Steven Martin: reviewer (2 PhD), examiner (3 PhD).

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Interactions with the social, economic and cultural environment

Popularisation of Research Results

- Khaldoun Al Agha, Green Communications, *Réseaux low cost très économes en énergie et de haute qualité de service*. Techniques de l'Ingénieur, vol. IN152, July 2012.
- Steven Martin, *Personal safety in digital cities of the future*. Futur en Seine, Paris, France, June 2012.
- Khaldoun Al Agha, *Les réseaux de capteurs*. Techniques de l'Ingénieur, vol. H8500, January 2011.
- http://www.green-communications.fr/IMG/pdf/Green_de_Lemonde20120121_SCH.pdf

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
DIGITEO	COREPHY	Université Paris XI	09.2010 / 36 mo.	53.20 k€
Contrat européen	EIT ICT LABS-KIC 2011	Université Paris XI	01.2011 / 12 mo.	66.38 k€
Contrat européen	EIT ICT LABS-KIC 2012	Université Paris XI	01.2012 / 12 mo.	71.34 k€
Contrat européen	EIT ICT LABS-KIC 2013	Université Paris XI	01.2013 / 12 mo.	77.40 k€
ANR	FITTING	Université Paris XI	07.2011 / 15 mo.	7.08 k€
DIGITEO	NC2	Université Paris XI	10.2008 / 48 mo.	101.70 k€
ANR	OCARI	Université Paris XI	12.2006 / 36 mo.	132.10 k€
Region IDF	ON DEMAND	Université Paris XI	07.2011 / 28 mo.	85.00 k€
ANR	SARAH	Université Paris XI	12.2006 / 36 mo.	125.34 k€
ANR	VNC	Université Paris XI	07.2011 / 12 mo.	36.09 k€
DIGITEO	WIMAX	Université Paris XI	10.2007 / 36 mo.	52.41 k€
Contrat européen	EIT ICT LABS-KIC 2013	Université Paris XI	01.2013 / 0 mo.	5.59 k€
Contrat européen	EIT ICT LABS-KIC 2011	Université Paris XI	01.2011 / 12 mo.	3.75 k€
ANR	TRAFIC	Université Paris XI	12.2006 / 39 mo.	77.57 k€
Subvention	CONVENTION Relations Internation	CNRS	01.2012 / 12 mo.	3.70 k€
ANR	GREEN-DYSPAN	Université Paris XI	03.2013 / 36 mo.	190.00 k€
Subvention	AAP 2013	Université Paris XI	01.2013 / 12 mo.	5.55 k€
Contrat européen	EIT ICT LABS-KIC 2011	Université Paris XI	01.2011 / 12 mo.	101.25 k€
Contrat européen	EIT ICT LABS-KIC 2013	Université Paris XI	01.2013 / 12 mo.	57.62 k€
ANR	PSN	Université Paris XI	07.2011 / 15 mo.	75.40 k€
SYSTEM@TIC	SOAPS.2	Université Paris XI	01.2012 / 36 mo.	185.00 k€

Private contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
CIFRE	CIFRE 998/09	CEPHYTEN	11.2009 / 37 mo.	60.00 k€
Industriel	RAF	Université Paris XI	11.2007 / 36 mo.	152.90 k€
Industriel	TELECOM	CEPHYTEN	01.2010 / 24 mo.	102.50 k€
Industriel	SOAPS.2 (oseo)	Université Paris XI	08.2011 / 50 mo.	63.50 k€

Citizen Safety in the City

Partners: Cassidian-EADS, LRI, Siemens, TU Darmstadt, University of Trento, University of Twente

See <http://www.eitictlabs.eu/innovation-areas/digital-cities-of-the-future/>

Type: EIT ICT LABS-KIC 2013
Amount: 57.62 k€
Duration: 12 months
Scientific director for LRI:
Steven Martin

The activity Citizen Safety in the City aim (in the action line Digital cities of the future in the ICT labs framework) is to offer a novel service for ensuring safety for the citizens in the city, a platform for identifying unfamiliar area or critical situations and attacks using smart phones for detecting critical situation, a platform for analyzing crowd motion with anomaly detection and a platform for intelligent evacuation using infrastructure less wireless networks in the critical area.

NC2 (New Communications with Network Coding)

Partners: AUTH (Grèce), INRIA, L2S, LRI, MIT (USA)

This project aimed to establish collaboration between French and International researchers working in the fields of computer science and information theory in order to provide solutions to optimize the transfer of data on the networks based on shared interfaces. The research studied the possibility to transfer grouped information on the basis of Network Coding to reduce number of transmissions and consequently the forwarding cost.

Type: DIGITEO
Amount: 101.70 k€
Duration: 48 months
Scientific director for LRI:
Khaloud Al Agha

OCARI (Optimization of Communication for Ad hoc Reliable Industrial network)

Partners: DCNS, EDF, INRIA, LATTIS, LIMOS, LRI, Telit-RF Technologies

See <http://en.wikipedia.org/wiki/OCARI>

The project OCARI aimed to contribute to the development of a new generation of network based on the use of wireless infrastructure-type ad hoc industrial environment. OCARI is now a communication protocol for industrial wireless sensor network. It distinguishes from protocols such as ZigBee, WirelessHART and ISA100.11a by a deterministic access method to the RF medium supporting time-constrained packets relay, a proactive energy efficient routing strategy supporting nomadism and an activity scheduling mechanism that is based on a three-hop coloring algorithm helping to reduce interference and thus optimizing node's energy consumption.

Type: ANR
Amount: 132.10 k€
Duration: 36 months
Scientific director for LRI:
Khaloud Al Agha

SARAH (Services Avancés pour Réseaux Ad hoc)

Partners: France Telecom, INRIA, LRI, Télécom SudParis, Ucopia, UPMC

See <http://www.lri.fr/~smartin/Cahier-ANR-1-Nomadisme.pdf>

The project focused on advanced multimedia services in wireless environments through the integration of ad hoc technologies in the operator services network in order to allow for reducing the cost of accessing the fixed network and the commercialization of innovative and contextualized audio-visual applications. The technical contributions concerned the service discovery and supervision, admission control and QoS, and the authentication and services' access control for multimedia applications. The project has been selected by the ANR among the best projects for which a page has been published in a special issue edited by the ANR on the theme of «mobility and ubiquity for the digital nomadism».

Type: ANR
Amount: 125.34 k€
Duration: 36 months
Scientific director for LRI:
Steven Martin

SOAPS.2 (Spectrum Opportunistic Access for Public Safety)

Partners: Altran, Cassidian-EADS, CNAM, LRI, LS Telcom SAS, Sequans communications, Silicom, Supélec, Thales, Telecom SudParis, UVSQ

See <http://www.soaps2.fr>

Type: SYSTEM@TIC
Amount: 185 k€
Duration: 36 months
Scientific director for LRI:
Steven Martin

The SOAPS project targets the radio communication systems for the public safety services. Currently as purely voice-based and low data rate systems, they must now be adapted to the changing society and to the new demands from end-users. These new services require new high speed data transfer radio technology. As the USA public safety community, which has endorsed the 3GPP LTE technology, Europe also considers this technology as a good basis and this is also the technology considered in this project. Several adaptations have nevertheless to be done for the specific Public Safety market and the SOAPS project concentrates on these adaptations.

TRAFIC (Architecture pour réseaux véhiculaires à forte mobilité groupée pour la gestion de services temps-réel)

Partners: ARION Entreprise, IRSEEM-ESIGELEC, LRI, Télécom ParisTech

Type: ANR
Amount: 77.57 k€
Duration: 39 months
Scientific director for LRI:
Lila Boukhatem

The aim of the ANR TRAFIC project was to define a hybrid communication architecture as well as efficient communication mechanisms for vehicular ad hoc networks. Two main achievements were realized by the joint collaborations of the partners: a dynamic and cooperative routing solution which take into account the all heterogeneous communicating elements of the architecture, and an efficient group mobility management mechanism which supports multipoint data exchanges and handles proactively the high dynamics of the communicating nodes.

RAF (Réseaux Ad hoc à Forte efficacité)

Partners: Alcatel-Lucent, Bluwan, Cassidian, LRI, Martec, Supélec, Thales communications & security SAS

Type: SYSTEM@TIC
Amount: 152.90 k€
Duration: 36 months
Scientific director for LRI:
Khalidoun Al Agha

See <http://www.systematic-paris-region.org/fr/projets/raf>

This project aimed at the development of networks of circumstance, with strong efficiency in QoS for data, voice and video services, in fast deployment, based on low-cost radio stations. The foreseen applications, thanks to this ad hoc network type, concerned mainly Public Safety forces (Police, Fire brigades, Emergency medical service) in urban and rural areas, but also civil ones for internet access through relay nodes. The demonstrations of the studied techniques were based on 802.16 WiMAX technology, firstly for illustration of a nomadic infrastructure-based ad hoc network, then for a Mesh network in "white" zones and finally for an ad hoc mobile network with optimized terminals in a Public Safety application.

CIFRE 998/09

Partners: LRI, EDF R&D

See <https://www.lri.fr/these.habilitation.php?ths=665>

Type:
Amount: 60.00 k€
Duration: 37 months
Scientific director for LRI:
Steven Martin

The contract was to obtain accurate deterministic bounds, mathematically calculable, on end-to-end delays for hard real-time applications in large industrial networks. The problem was on the certification of specific architectures with a large number of switches (more than 100) and flows in the network (more than 1000). A formal approach, developed by our team and called trajectory approach was extended to be scalable.

Etude d'une architecture globale et de l'algorithmique network-aware pour l'acheminement de contenu

Partners: LRI, Orange Labs

Type: CRE
Amount: 102.50 k€
Duration: 24 months
Scientific director for LRI:
Khalidoun Al Agha

This project addressed the problem of context awareness in heterogeneous networks of multi-source multi-sink scenario for audio-visual services. In a network made up of devices having various transmission technologies, the links have different properties leading to a multi-path scheme. Moreover, each application has its own requirements in terms of bandwidth, jitter, delay, etc. The research concerned network coding to ensure network-aware content delivery while considering the content and device contexts. This awareness was obtained by varying the network coding parameters (generation length and redundancy factor). An extended home network was an interesting framework to verify the effectiveness of network coding.

Software Licensing and Distribution

Qolyester - implementation from scratch of the OLSR protocol

<http://qolsr.lri.fr/code/>

Contact: AL AGHA

Patents

FR0958890 - A method for quality-based routing in a multi-hop network

Contact: AL AGHA

FR1155729 - Procédé pour l'extinction de routeurs dans un réseau de communications et routeur mettant en oeuvre ce procédé

Contact: AL AGHA

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Training and Education

Graduate Courses

- Master Recherche NSI (Nouveaux Systèmes Informatiques), Université Paris-Sud
 - *Réseaux mobiles et réseaux de capteurs*: Khaldoun Al Agha (25h), Lila Boukhatem (25h).
 - *Outils pour les réseaux*: Steven Martin (10h), Tara Ali-Yahiya (9h), Lin Chen (6h).
- Master Professionnel IICI (Ingénierie de l'Information, de la Communication et de l'Interaction), Université Paris-Sud
 - *Réseaux mobiles et sans fil*: Lila Boukhatem (12h).
 - *Réseaux haut débit*: Lila Boukhatem (12h).
 - *Systèmes et réseaux temps-réel*: Steven Martin (12h).
- Master Professionnel CCI (Compétences Complémentaires en Info.), Université Paris-Sud
 - *Réseaux*: Steven Martin (15h).
 - *Applications et sécurité*: Lin Chen (10h).
- M1 informatique, Université Paris-Sud
 - *Réseaux*: Steven Martin (22h).
- M1 informatique spécialité Miage (Méthodes informatiques appliquées à la gestion des entreprises), Université Paris-Sud
 - *Réseaux et Systèmes*: Lila Boukhatem (17h).
- M1 informatique spécialité Miage CFA (Centre de Formation d'Apprentis), Université Paris-Sud
 - *Réseaux*: Lin Chen (22h).
- Enseignements dispensés à l'étranger
 - TCP/IP and ad hoc networks, Kyoto University: K. Al Agha (2008-2009).
 - Mobile Networks, Ha Noi College of Technology, Viet Nam: K. Al Agha (2007-2009).

Thesis

Habilitation à Diriger des Recherches	
Name	Defense
Lila BOUKHATEM	12.2009
Steven MARTIN	07.2012

Defended thesis				
Name	Start	Defense	Funding	Advisor
Mohammad Abdul AWAL	07.12.2007	26.10.2011	COLL TERR	BOUKHATEM
Youghourta BENFATTOUM	01.10.2009	15.11.2012	Alloc. Ministère	AL AGHA & MARTIN
Ignacy GAWEDZKI	01.10.2004	29.09.2008	Alloc. Ministère	AL AGHA
Nour KADI	01.10.2007	13.12.2010	Alloc. Ministère	AL AGHA
Simon ODOU	01.10.2007	02.11.2010	Bourse CNRS DGA	AL AGHA & MARTIN
Joseph RAHME	16.10.2006	11.05.2010	ETR-EGIDE	AL AGHA
Mohamed RASHEED	01.10.2003	22.02.2008	CIFRE	AL AGHA
Despoina TRIANTAFYLIDOU	01.10.2005	24.09.2009	Alloc. Ministère	AL AGHA
Kehao WANG	01.10.2010	22.06.2012	ETR	AL AGHA & CHEN

Thesis in progress			
Name	Start	Funding	Advisor
Soran HUSSEIN	17.10.2011	ETR	BOUKHATEM
Reben KURDA	17.10.2011	ETR	BOUKHATEM & YAHYA
Guangyu LI	01.09.2011	ETR	BOUKHATEM
Sara MEDLEJ	01.11.2009	CIFRE	AL AGHA & MARTIN

Self Assessment

The networking team witnessed many evolutions during the period 2008-2013 and the situation of a small size team led us to focus on very specific research areas related to hot research topics such as the networks of the future. Our principal research activities concerned mainly (i) network coding with two defended PhD thesis, the recruitment of a post doctoral fellow during the last few years and many projects on this topic, and (ii) quality of service in OFDMA systems especially in 4G networks with one defended PhD thesis, two PhD students and a post doctoral fellow.

As specified in the last report review and as a reply to the remarks issued by the reviewers, the team has published in very well known conferences and high level journals during the last years (IEEE transactions, Computer Networks, Infocom, Globecom, LCN, etc.).

As for the international vision of the team, we initiated a lot of collaborations with international Universities through many publications as well as setting up European projects within the EIT ICT labs framework. The number of projects and publications done with the European and international partners regarding the small size of the team can be appreciated highly.

As far as it concerns the EPI Hipercom, it has been issued that the project would finish in 2012 and wouldn't be extended anymore. Then, the Networking team decided to merge its research efforts with Supélec and the L2S to set up a strong "Networks & Telecommunications" axis within the *Plateau de Saclay*, paving a way for the future in the rich and dynamic local research environment.

It is important to notice that we have already initiated collaborations with Supélec and the L2S through several projects, co-supervision of PhD students, common publications, seminars and meetings. In addition, an ambitious research project involving several partners whom LRI and Supélec, has been submitted

to the call of IDEX Paris-Saclay on “wireless ubiquity (tools for 5G)”.

The Networking team fused in July 2013 with the Optimization members of the GraphComb team to form the new team ROCS. The strategy of the ROCS team can be found in Section 8.20.

Optim: Synthetic presentation

Nom du responsable de l'équipe : **Abdel LISSER**

Effectifs de l'équipe

Au premier janvier 2008: 9 permanents dont 8 enseignants-chercheurs : 3 PRs, 4 MDC et un DR CNRS.

Personnels ayant quitté l'équipe pendant le contrat en cours

- Cédric Bentz, Maître de conférences université de Paris Sud, mutation au CNAM 2012.
- 13 doctorants ont soutenus leur thèse durant cette période.

Nombre de recrutements réalisés au cours de la période considérée et origine des personnels

- Céline Gicquel, Maître de conférences IUT Orsay, recrutée en 2011.

Production scientifique au cours de la période écoulée

- Résolution de problèmes de sac à dos stochastique à l'aide de méthodes de gradient stochastique en utilisant soit des méthodes de convolutions soit des méthodes exactes pour le calcul du gradient de l'espérance.
- Résolution de problèmes combinatoires avec des contraintes en probabilité jointes à l'aide d'approches coniques: méthode conique de second ordre et relaxations semi-définies positives.
- Reformulation complètement positive (approche : optimisation copositive) de problèmes stochastiques avec contraintes en probabilité jointes et variables binaires.
- Relaxations semidéfinies positives pour la résolution de problèmes d'optimisation des arrêts du nucléaire en collaboration avec EDF.

Bilan quantitatif des publications de l'équipe

- Articles de revue : internationales majeures 80 ; autres revues 70

5 publications majeures

- A second-order cone programming approach for linear programs with joint probabilistic constraints, J. Cheng and A. Lisser, Operations Research Letters, Vol. 40, N. 5, pp. 325-328, 2012.
- Céline Gicquel, L. Hege, Michel Minoux, W. van Canneyt: A discrete time exact solution approach for a complex hybrid flow-shop scheduling problem with limited-wait constraints. Computers & OR (COR) 39(3):629-636 (2012).

5 (max) faits illustrant le rayonnement ou l'attractivité académique

2 best student papers dans la conférence internationale ICORES 2012 et 2013:

- STOCHASTIC SHORTEST PATH PROBLEM WITH UNCERTAIN DELAYS, Jianqiang Cheng, Stefanie Kosuch and Abdel Lisser, 2012, Vilamoura, Portugal.
- A DISTRIBUTIONALLY ROBUST FORMULATION FOR STOCHASTIC QUADRATIC BI-LEVEL PROGRAMMING, Pablo Adasme, Abdel Lisser and Chen Wang, 2013, Barcelona, Espagne.

5 (max) faits illustrant les interactions de l'équipe avec son environnement socio-économique ou culturel

- Contrat industriel avec EDF : optimisation semi-définie positive et applications aux problèmes des arrêts du nucléaire.
- Contrat avec HADAMARD/PGMO : optimisation stochastique avec contraintes en probabilité jointes et applications aux problèmes de management de l'énergie.
- Contrat avec Renault : optimisation de la gestion de production.

Principales contributions de l'équipe à des actions de formation

- Organisation de l'école d'hiver d'optimisation stochastique et applications aux problèmes de l'énergie, du 7 au 13 avril 2013, <http://www.iot.ntnu.no/winterschool13/announcement.pdf>
- Cours au Master Recherche en Informatique de l'université de Paris Sud (https://www.dep-informatique.u-psud.fr/formation/lmd/M2R_NSI)

Research Group Members and evolution since 2008

Permanent Members (June 30th, 2013)

<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
GICQUEL	Céline	MCF	PARIS SUD
LISSER	Abdel	PR1	PARIS SUD

Group evolution

- Cédric Bentz left the team
- Céline Gicquel joined the team

Research Description

Stochastic and Combinatorial Optimization

Participants: Abdel Lisser, Cédric Bentz, Céline Gicquel
Collaborators: Minoux, Zorgati, Leung, Gaivoronski, Schultz

Our work focuses mostly on Combinatorial and stochastic optimization. Our research in these topics is driven both by theoretical purposes as well as by several industrial applications, namely telecommunications, operation management, energy planning . . . We present our main research by considering separately deterministic combinatorial optimization, and stochastic optimization.

Deterministic combinatorial optimization. Gicquel main focus is mostly on applications arising in the context of industrial and service operations management. She investigated two applied combinatorial optimization problems: the first one arises in the context of industrial production planning, namely a lot-sizing problem. Gicquel and Lisser considered a variant of lot-sizing problems which can be formulated as a quadratic binary program, and they developed a semidefinite relaxation to compute tight lower bounds for this problem. However the computation time needed to obtain these lower bounds is large compared to linear relaxation one. To avoid this, Gicquel current work focuses on improving the linear relaxation on the problem through the use of a new family of valid inequalities. This work was carried out as part of the project LotRelax funded by the ANR through its program for young researchers. Gicquel and Minoux investigated a complex facility location problem found from a case study in the automotive industry within a project with the Renault company. Her main contributions relate to the modeling of a real-life problem, the development of efficient heuristic solution approaches and to the analysis of the obtained numerical results. Lisser and Gorge studied SDP methods and algorithms for Energy Management collaborating with Electricité de France (EDF for short). They studied SDP relaxations and algorithms for quadratically constrained quadratic problems using adapted SDP cutting plane methods. They also solved several versions of the crucial nuclear outage scheduling problem taking into account different specific related technical nonlinear constraints, e.g., maximal lapping constraints. Lisser and Lopez studied new SDP reformulations for the CDMA mobile networks, namely the multiuser detection problem. They solved this combinatorial problem by coupling SDP for computing the lower bounds, and the metaheuristic Variable Neighborhood Search commonly called VNS. Lisser and Adasme showed that SDP is powerful tool for solving OFDMA networks problems. They studied robust SDP relaxations and showed their efficiency when compared to

linear programming ones. Copositive programming, CP for short, is a relatively recent topic in mathematical optimization. It is well-known that the verification of matrix copositivity is a well-known computationally hard problem. However, CP has many applications in continuous and combinatorial optimization. Lisser and Cheng studied CP reformulations for the quadratic knapsack problems, and come up with better literature reformulations. Bentz research is mainly based on graph algorithms. He studied different graph problems classes, and worked on their complexity or proposed approximation algorithms whenever it is possible. He studied arc multicommodity flows and multicuts problems, partial or multicriteria cuts from the parametric complexity and the approximation points of view; coloring graph problems related to tomography or scheduling problems, and d-blockers and transversals in some graph subclasses.

Stochastic combinatorial optimization. Stochastic programming especially stochastic combinatorial optimization has been the keystone for our optimization team for the last decade. We focused on different topics in stochastic programming, namely two-stage and multi-stage stochastic programming, and probabilistic constraints. Stochastic problems parameters are random variables with different probability distributions. We considered both discrete and continuous distributions, and studied theoretical aspects as well as algorithmic ones. Our research generally driven by real-world applications in production planning, telecommunications and unit commitment problems. Lisser and Kosuch studied and solved two different variants of static knapsack problems with random weights with continuous distributions: The stochastic knapsack problem with simple recourse as well as the stochastic knapsack problem with probabilistic constraint. Special interest is given to the corresponding continuous problems and three different problem solving methods are considered. The resolution of the continuous problems allows to provide upper bounds in a branch-and-bound framework in order to solve the original stochastic combinatorial problems. Lisser and Lopez studied different extensions of the stochastic knapsack problem. They mainly consider discrete distributions. They proposed different model formulations based on the introduction of probability constraints and a two-stage quadratic knapsack model with recourse. They solve these stochastic programming problems using SDP relaxations. Gicquel and Lisser first considered a stochastic lot-sizing problem, *i.e.* a lot-sizing problem where the customer demand is assumed to be known only through some probability distribution. Their current work seeks to develop a multi-stage stochastic programming approach where one of the main difficulties encountered with this kind of approach, namely the nervousness of the production plan, is tackled. Gicquel and Lisser are also currently studying a stochastic shift scheduling problem arising in the context of call center management. It consists in the determination of the number of persons to be assigned to each shift of the scheduling horizon so as to reach the best possible trade-off between cost minimization and customer quality of service. The main novelty of our work lies in the fact that we explicitly take into account in our models the uncertainty in the demand forecasts. A mixed integer bilevel problem with a probabilistic constraint in the first level was studied by Lisser, Kosuch and Leung. A discrete probability distribution is considered which allows a reformulation of the problem as an equivalent deterministic bilevel problem. The problem is transformed into a linear bilevel problem, which in turn yields a quadratic optimization problem, namely the global linear complementarity problem. Based on this quadratic problem, a procedure to compute upper bounds on the initial problem by using a Lagrangian relaxation and an iterative linear minmax scheme is studied and numerically tested to prove the procedure convergence. Lisser and Adasme proposed stochastic binary quadratic programs for the scheduling resource allocation process of a wireless orthogonal frequency division multiple access network. More precisely, They formulated a two-stage stochastic model, then they extended the two-stage model by introducing a knapsack probabilistic constrained approach and proposed a multi-stage stochastic program for this problem. Lisser and Letournel studied a new combinatorial optimization problem, namely the stochastic maximum weight forest problem. They extended the Edmond's glouton algorithm to the case of the two-stage maximum weight forest problem. They proved TDIness, *i.e.* Totally Dual Integrality aspect, for the two stage maximum weight forest problem in the case of two scenarios. They also provided a counter example to prove that the problem is not TDI for more than two scenarios. Lisser and Cheng studied a special case of Linear programs with joint probabilistic constraints (LPPC), where the left-hand side of probabilistic constraints is normally distributed stochastic coefficients, and the rows of the matrix are assumed independent. They proposed new schemes for coming up with lower and upper bounds using second-order cone programming formulations. To the best of our knowledge, this algorithmic frame is pioneered for solving joint probabilistic constraints problems. They extended this to the stochastic combinatorial joint constrained problems by studying 0 - 1 linear programs with joint probabilistic constraints. Their results show this non-convex problem can be approximated by a convex completely positive problem. A stochastic two-person zero-sum game with joint chance constraints with random payoff matrix entries and joint chance constraints was also studied by Lisser and Cheng. They proved for the general stochastic zero-sum game problem that there exists a weak duality between the two players problems. They also showed that there exists a strong duality where their optimal values are

equal. When the probability distribution is not known, an alternative to handle the uncertainty is given by the distributionally robust optimization. GraphComb optimization team studied this approach, and obtained strong results by applying semidefinite programming to solve such problems. Lisser, Cheng and Delage considers a distributionally robust version of a quadratic knapsack problem. Lisser, Gorge and Zorgati provided an application of this approach to a real-life problem, namely the Unit Commitment Problem with uncertainty within an EDF project.

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Collaborations

Participation to national and international collaborative research projects

- Stochastic bilevel programming, Campus France, coordinator: Pr. Abdel Lisser, Partners: Pr. Alexei Gaivoronski (NTNU, Norway)
- Stochastic game theory, Campus France, coordinator: Pr. Abdel Lisser, Partners: Pr. Chun Hung Cheng (CUHK, Hong Kong)
- Stochastic OFDMA networks optimization, CONICYT, coordinator: Pr. Abdel Lisser, Partners: Dr. Pablo Adasme (University of Santiago de Chile)

Collaborations with other laboratories

- Pr. Imai Hiroshi, University of Tokyo: Approximation algorithms.
- Pr. Ruediger Schultz, University of Duisburg-Essen, Germany: Stochastic programming.
- Pr. Franz Rendl, University of Klagenfurt, Austria: Semidefinite programming.
- Dr. Oualid Jouini, Ecole Centrale Paris: Stochastic programming.
- Prs Janny Leung and Chun Hung Cheng, Chinese University of Hong Kong: Stochastic game theory.
- Pr. Alexei Gaivoronski, NTNU, Norway: Stochastic bilevel problems.
- Pr. Ruediger Schultz, University of Duisburg-Essen, Germany: Stochastic combinatorial optimization.
- Pr. Immanuel Bomze, University of Vienna, Austria: Copositive programming.
- Pr. Mirjam Duer, University of Trier, Germany: Copositive programming.
- Dr. Erick Delage, HEC Montreal, Canada: Distributionally robust optimization.
- Dr. Pablo Adasme, University of Santiago de Chile: OFDMA optimization.
- Dr. Rafael de Andrade, Federal university of Fortaleza: Stochastic combinatorial optimization.
- Pr. Nelson Maculan, Federal university of Rio de Janeiro, Brazil: stochastic programming.
- Dr. Riadh Zorgati, EDF R&D Clamart: Energy management and stochastic programming.
- Pr. Michel Minoux, University of Paris 6: Semidefinite programming.
- Dr. Oualid Jouini, ECP: Call center optimization.

Other Collaborations

Participation to national and international networks

- Abdel Lisser is member of Mathematical Programming Society, Stochastic programming society, EURO optimization groups, SMF, SMAI, ROADEF
- Abdel Lisser is an elected member of the Committee of Stochastic Programming (COSP)

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Volunteer Professional Service

Organisation of Conferences and Scientific Events

- Winter School, *Stochastic programming with applications in energy and natural resources*, Tignes, France, 2013: Abdel Lisser, Organizer
- Stochastic programming cluster co-organizer in IFORS'11 conference, 2011 Melbourne
- Stochastic programming cluster co-organizer in EURO-INFORMS conference, 2013 Rome
- Stochastic programming cluster co-organizer in EURO-INFORMS conference, 2012 Lituania
- First European mini conference on stochastic programming, 2013, Paris.

Working Groups

- Stochastic Programming European working group: Abdel Lisser, Member since 2012.

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
ANR	LotRelax	Université Paris XI	11.2011 / 36 mo.	65.00 k€
DIGITEO	OPTIMEO	Université Paris XI	03.2012 / 5 mo.	1.50 k€
DIGITEO	SPACE	Université Paris XI	10.2012 / 36 mo.	102.20 k€

Private contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
Industriel	EDF	CEPHYTEN	01.2009 / 49 mo.	240.60 k€
Industriel	PGMO/IROE	Université Paris XI	09.2012 / 16 mo.	21.00 k€
Industriel	PGMO/IROE	Université Paris XI	12.2012 / 18 mo.	50.00 k€

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Training and Education

Graduate Courses

- Master Informatique, Université Paris Sud, *Optimisation Combinatoire et Stochastiques pour les Systèmes Informatiques*: Abdel Lisser
- PhD Winter School 2013, Tignes, France. *Stochastic programming and applications to energy and natural resources*: Abdel Lisser

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Thesis

Defended thesis				
<i>Name</i>	<i>Start</i>	<i>Defense</i>	<i>Funding</i>	<i>Advisor</i>
Pablo Alberto ADASME SOTO	01.10.2006	30.06.2010	ETR	LISSER
Stefanie KOSUCH	01.10.2007	21.10.2010	Alloc. Ministère	LISSER
Pierre LE BODIC	01.10.2008	28.09.2012	Alloc. Ministère	LISSER
Rafael LOPEZ	15.09.2005	09.11.2009	ATER	LISSER

Thesis in progress			
<i>Name</i>	<i>Start</i>	<i>Funding</i>	<i>Advisor</i>
Jean-François BAFFIER	01.01.2012	ETR	LISSER
Jianqiang CHENG	01.09.2010	ETR	LISSER
Mathilde EXCOFFIER	01.10.2012	Digiteo	LISSER
Agnès GORGE	14.12.2009	autre	LISSER
Marc LETOURNEL	01.09.2008	autre	LISSER
Chen WANG	09.08.2011	ETR	LISSER

Self Assessment

We also developed deep expertise in solving real life optimization problems with uncertainty using new approaches based on conic methods. We solved energy management nuclear scheduling problems in collaboration with EDF R&D at Clamart, applying for the first time at the best of our knowledge semidefinite programming to such problems. This collaboration led to a PhD thesis defended in September 2013. We also worked with EDF within another project funded by HADAMARD/PGMO for solving Unit Commitment Energy problems with joint probabilistic constraints. As far as we know, this is the first time stochastic programming problems with joint chance constraints and integer variables were solved to optimality for medium size instances. Céline Gicquel joined our team in 2011, her main interests are lot-sizing optimization and applications to industrial problems. She is involved in production planning with Renault, and PhD thesis on this topic is defended in October 2013. Moreover, we collaborate with Ecole Centrale Paris within DIGITEO project for solving stochastic call-center problems.

Strategy and five-year project

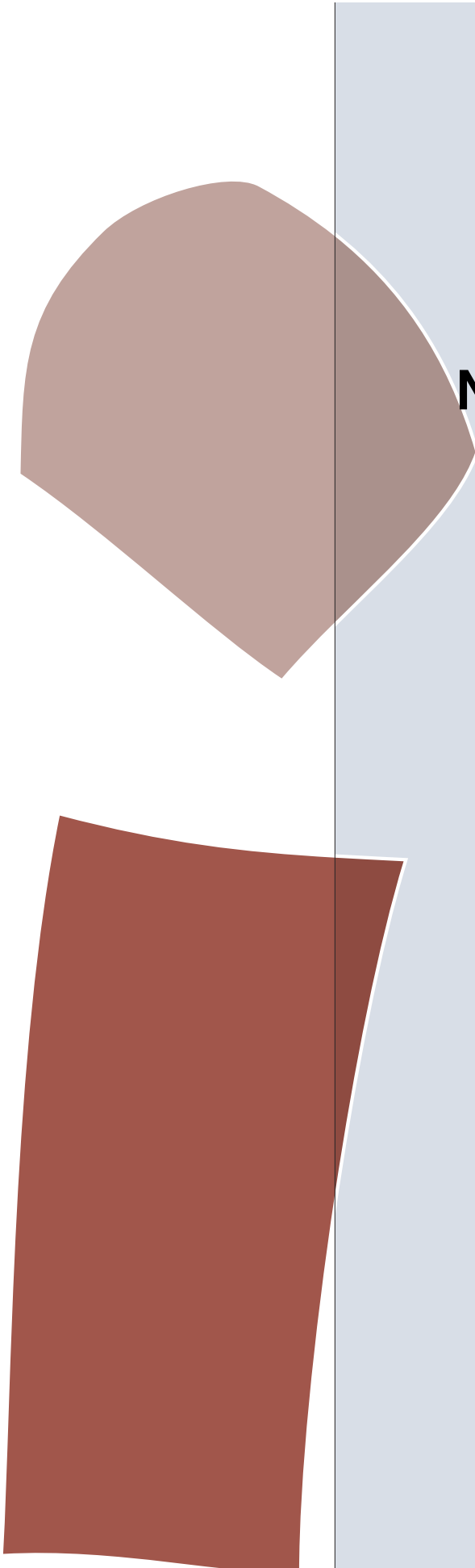
One of our main focus is the design of innovative and advanced solutions for the future mobile and wireless communications systems (5G) which constitute an integrated part of the future Internet and ICT systems. These systems enable a huge number of embedded communicating objects to provide a wide range of innovative applications and services in highly dynamic and complex environments (homes/offices, transport systems, smart cities, etc.). Our key objective is to address the challenging communication issues inherent to these systems such as resource optimization, security and near-zero consumption which are the most critical requirements for the viability of these systems. Our roadmap for the coming five years is to reinforce our research works in these topics and to explore novel techniques and methods to define efficient, optimized, secure and energy-aware communication mechanisms.

Another focus for the coming five years concerns the optimization under uncertainty, namely stochastic combinatorial optimization. We are interested especially in studying and modeling the risk within optimization problems. Our theoretical, algorithmic and methodological researches directions will be driven by real world problems, such that energy planning, health sciences, production planning and telecommunications. Our current results in stochastic optimization with integer variables are amongst the most important in this topic at both international and national levels. Our ambition is to keep and reinforce our position in the coming years. We plan also to develop deep and permanent relationships with the industrial partners both in France, Europe or overseas. Our main objective is to drive research programs in order to be able to solve complex industrial or social/health problems by taking into account different parameters in order to be as close as possible with the field for the different problems. Special interest will be given within our team to telecommunications network problems. This crucial topic and the future developments especially in mobile networks will give us the opportunity to develop strong collaborations inside our team in order to solve complex network optimization problems.

Indeed, the optimization paradigm is a fundamental component of our research methodology which is mainly built on the combined design, modeling, and performance evaluation of the proposed optimized solutions. Therefore, our main objective for the coming years is to develop a strong and close collaboration in the new team. Even if specific common research interests have already been identified (such as OFDMA systems and energy efficiency in multi-hop networks), new mutual actions are planned to embody and reinforce the collaboration.

To realize our objectives, we plan to participate actively in the rich research and development programs, networks and initiatives with both academic and industrial partners at the national, European and international levels to promote research and technology transfer. We will strengthen our active actions and collaborations we already initiated within several programs such as EIT ICT-Labs, competitiveness clusters, ANR, IRT SystemX, Labex (Digicosme), Idex (IPS), etc. Finally, to participate to the effort of bringing

scientific research to the service of education, we are actively investing the Paris-Saclay university project which integrates several higher education establishments. We aim to pursue our commitment in defining attractive and high-quality Masters offers. To realize our projects both in networking and stochastic optimization, and referring to our weak point in terms of researchers' number, we would need support from all concerned institutions for hiring new researchers, assistant/associate and full professors.



NETWORKING team publications

Journal articles

Major international journals

- (1) K. Al Agha, M.-H. Bertin, T. Dang, A. Guitton, P. Minet, T. Val, and J.-B. Violette. Which wireless technology for industrial wireless sensor networks? The development of OCARI technology. *IEEE Transactions on Industrial Electronics*, 63, October 2009.
- (2) M. A. Awal, L. Boukhatem, and L. Chen. An integrated cross-layer framework of adaptive feedback resource allocation and prediction for OFDMA systems. *Computer Networks, Elsevier*, 56(7), May 2012.
- (3) Y. Benfattoum, S. Martin, and K. Al Agha. QoS for real-time reliable multicasting in wireless multi-hop networks using a generation-based network coding. *Computer Networks, Elsevier*, 57(6):1488 – 1502, April 2013.
- (4) L. Chen and J. Leneutre. Fight jamming with jamming - a game theoretic analysis of jamming attack in wireless networks and defense strategy. *Computer Networks, Elsevier*, 55(9):2259–2270, 2011.
- (5) L. Chen, L. Libman, and J. Leneutre. Conflicts and incentives in wireless cooperative relaying: A distributed market pricing framework. *IEEE Transactions on Parallel and Distributed Systems*, 22(5):758–772, 2011.
- (6) J. Elias, F. Martignon, A. Capone, and E. Altman. Non-cooperative spectrum access in cognitive radio networks: a game theoretical model. *Computer Networks, Elsevier*, 55(17), December 2011.
- (7) S. Paris, C. Nita-Rotaru, F. Martignon, and A. Capone. Cross-layer metrics for reliable routing in wireless mesh networks. *IEEE/ACM Transactions on Networking*, 21(3):1003–1016, June 2013.
- (8) K. Wang, L. Chen, K. Al Agha, and Q. Liu. On optimality of myopic policy in opportunistic spectrum access: The case of sensing multiple channels and accessing one channel. *IEEE Wireless Communications Letters*, 1(5):452–455, 2012.
- (9) K. Wang, L. Chen, Q. Liu, and K. Al Agha. On optimality of myopic sensing policy with imperfect sensing in multi-channel opportunistic access. *IEEE Transactions on Communications*, 2013.
- (10) K. Wang, Q. Liu, and L. Chen. Hierarchical reversible data hiding based on statistical information: Preventing embedding unbalance. *Signal Processing, Elsevier*, 92(12):2888–2900, 2012.

Other journals

- (11) K. Al Agha, G. Chalhoub, A. Guitton, E. Livolant, S. Mahfoudh, P. Minet, M. Misson, J. Rahmé, T. Val, and A. V. D. Bossche. Cross-layering in an industrial wireless sensor network: case study of OCARI. *Journal of Networks, Academy Publisher*, 6, December 2009.
- (12) T. Ali-Yahiya and K. Al Agha. Downlink fairness-aware adaptive resource allocation approach for LTE networks. *International Journal of Network Management, Wiley*, 21(4):269–283, July 2011.
- (13) T. Ali-Yahiya, A.-L. Beylot, and G. Pujolle. An autonomic-oriented framework based IEEE 802.21 for mobility management in 4G networks. *ACM SIGMOBILE Mobile Computing and Communications Review*, 15(1):37–51, January 2011.
- (14) T. Ali-Yahiya and H. Chaouchi. Fractional frequency reuse for hierarchical resource allocation in mobile WiMAX networks. *EURASIP Journal on Wireless Communications and Networking*, 2010(7):1831–1844, April 2010.
- (15) L. Boukhatem and L. Friedmann. Multi-sink relocation with constrained movement in wireless sensor networks. *Ad hoc & sensor wireless networks, OCP Science*, 8(3):211–233, 2009.
- (16) M. Bourguiba, K. Haddadou, and G. Pujolle. Packet aggregation based network I/O virtualization for cloud computing. *Computer Communications, Elsevier*, 35(3):309–319, February 2012.
- (17) L. Chen, S. Iellamo, M. Coupechoux, and P. Godlewski. Spectrum auction with interference constraint for cognitive radio networks with multiple primary and secondary users. *Wireless Networks, Springer*, 17(5):1355–1371, 2011.

- (18) A. Fourati and K. Al Agha. Detecting forged routing messages in ad hoc networks. *Telecommunication Systems, Springer*, 39(3-4):205–214, December 2008.
- (19) I. Gawedzki and K. Al Agha. How to avoid packet droppers with proactive routing protocols for ad hoc networks. *ACM International Journal of Network Management, Wiley*, 18(2), April 2008.
- (20) I. B. Hamida and L. Boukhatem. An adaptive resource reservation for vehicular mobile networks. *ACM International Journal of Network Management, Wiley*, 19(5):375–398, 2009.
- (21) N. Kadi and K. Al Agha. Network coding for MPR-based flooding in ad hoc wireless networks under mobility conditions. *Annals of Telecommunications, Springer*, 66(5-6):319–329, June 2011.
- (22) S. Martin, K. Al Agha, and G. Pujolle. Traffic-based topology control algorithm for energy savings in multi-hop wireless networks. *Annals of Telecommunications, Springer*, 67(3-4):181–189, 2012.
- (23) A. Papapostolou, V. Friderikos, T. Ali-Yahiya, and H. Chaouchi. Path selection algorithms for fault tolerance in wireless mesh networks. *Telecommunication Systems, Springer*, 52(4):1831–1844, April 2013.
- (24) J. Rahmé, A. C. Viana, and K. Al Agha. Looking for network functionalities’ extension by avoiding energy-compromised hotspots in wireless sensor networks. *Annals of Telecommunications, Springer*, 63(9-10):487–500, October 2008.

Conference articles

Major international conferences and workshops

- (25) K. Al Agha, N. Kadi, and I. Stojmenovic. Fountain codes with XOR of encoded packets for broadcasting and secure multi-path routing in multi-hop networks using network coding. In *IEEE VTC: Vehicular Technology Conference*, Barcelona, Spain, May 2009.
- (26) M. A. Awal and L. Boukhatem. Analysis of feedback prediction error on the downlink performance of OFDMA systems. In *IEEE PIMRC: International Conference on Personal, Indoor and Mobile Radio Communications*, Tokyo, Japan, September 2009.
- (27) M. A. Awal and L. Boukhatem. Dynamic CQI resource allocation for OFDMA systems. In *IEEE WCNC: Wireless Communication and Networking Conference*, Cancun, Quintana-Roo, Mexico, March 2011.
- (28) M. A. Awal and L. Boukhatem. Opportunistic periodic feedback mechanisms for OFDMA systems under feedback budget constraint. In *IEEE VTC: Vehicular Technology Conference*, Budapest, Hungary, May 2011.
- (29) Z. G. Aydin, T. Ali-Yahiya, H. Chaouchi, and H. Zaim. QoS mobility-aware algorithm using early update for host identity protocol. In *IEEE PIMRC: International Conference on Personal, Indoor and Mobile Radio Communications*, Istanbul, Turkey, September 2010.
- (30) Y. Benfattoum, S. Martin, and K. Al Agha. IROCX: Interference-aware routing with opportunistically coded exchanges in wireless mesh networks. In *IEEE WCNC: Wireless Communications and Networking Conference*, Cancun, Mexico, March 2011.
- (31) Y. Benfattoum, S. Martin, and K. Al Agha. DYGES: A network-aware generation-based network coding for multicast flows. In *IEEE VTC: Vehicular Technology Conference*, Quebec, Canada, September 2012.
- (32) Y. Benfattoum, S. Martin, and K. Al Agha. TC-IROCX: Network coding with topology control and interference awareness. In *IEEE WCNC: Wireless Communications and Networking Conference*, Paris, France, April 2012.
- (33) L. Chen. A distributed access point selection algorithm based on no-regret learning for wireless access networks. In *IEEE VTC: Vehicular Technology Conference*, Taipei, Taiwan, May 2010.
- (34) L. Chen, S. Iellamo, M. Coupechoux, and P. Godlewski. An auction framework for spectrum allocation with interference constraint in cognitive radio networks. In *IEEE INFOCOM: Conference on Computer Communications*, San Diego, CA, USA, March 2010.

- (35) L. Chen and J. Leneutre. Efficient medium access control design for autonomous wireless networks - a game theoretic approach. In *IEEE LCN: Conference on Local Computer*, Zurich, Switzerland, October 2009.
- (36) I. Gawedzki and K. Al Agha. Resilience to dropping nodes in mobile ad hoc networks with link-state routing. In *IFIP Networking: International Conferences on Networking*, Singapore, May 2008.
- (37) S. Iellamo, L. Chen, and M. Coupechoux. Imitation-based spectrum access policy for CSMA/CA-based cognitive radio networks. In *WCNC: Wireless Communications and Networking Conference*, Paris, France, April 2012.
- (38) M. Iturralde, T. Ali-Yahiya, A. Wei, and A.-L. Beylot. Interference mitigation by dynamic self-power control in femtocell scenarios in LTE networks. In *IEEE GLOBECOM: Global Communications Conference*, Anaheim, California, USA, December 2012.
- (39) M. Iturralde, T. Ali-Yahiya, A. Wei, and A.-L. Beylot. A real-time services performance and interference mitigation for femtocell scenarios in LTE networks. In *IEEE LCN: Conference on Local Computer Networks*, Clearwater, Florida, USA, October 2012.
- (40) M. Iturralde, T. Ali-Yahiya, A. Wei, and A.-L. Beylot. Resource allocation using shapley value in LTE. In *IEEE PIMRC: International Conference on Personal, Indoor and Mobile Radio Communications*, Toronto, Canada, September 2011.
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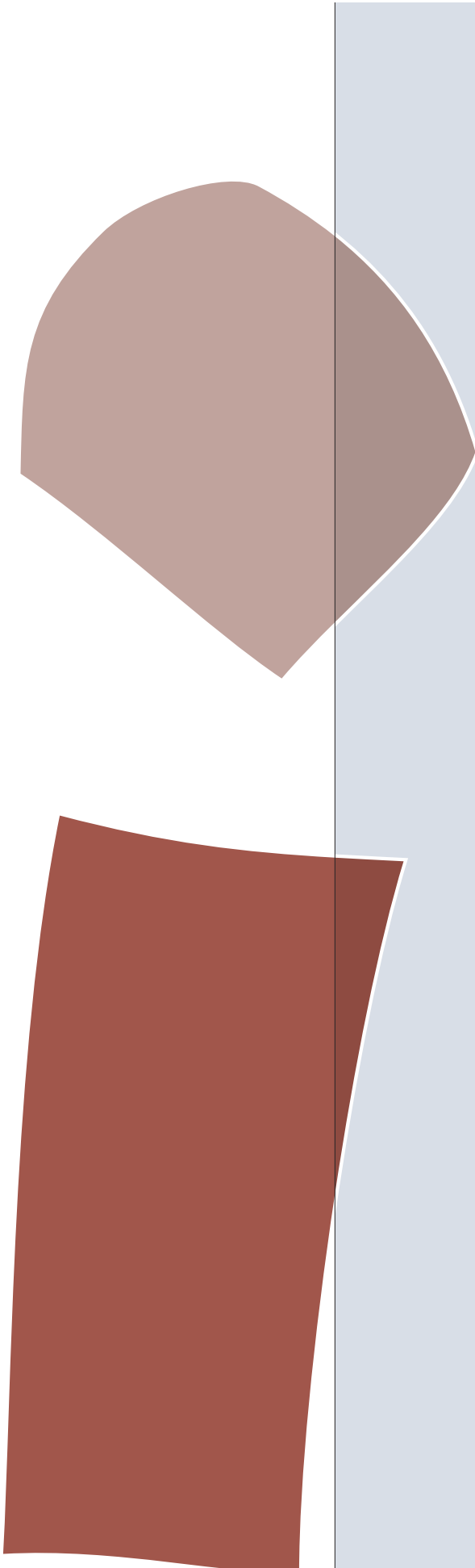
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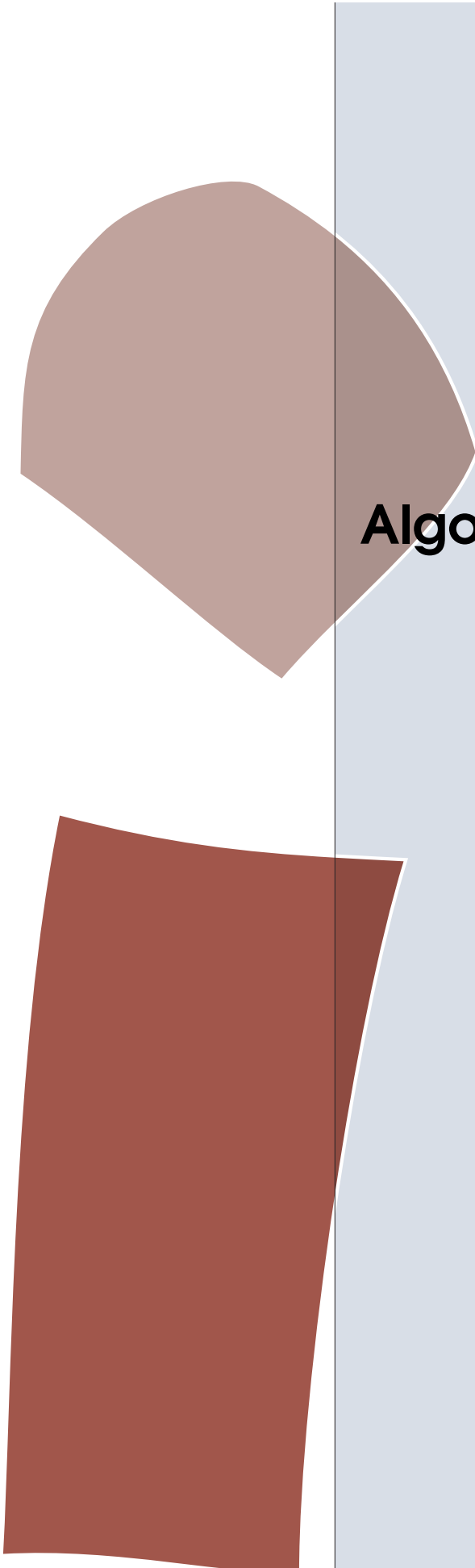
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9/ VALS

Verification of Algorithms, Languages and Systems



équipe VALS

Responsable: Burkhardt Wolff, Claude Marché

L'équipe VALS travaille dans le domaine scientifique des *Méthodes Formelles*. L'objectif général de l'équipe est de promouvoir les technologies de vérification formelle en les rendant plus facile à utiliser. Notre programme de recherche est structuré en six activités interagissant entre elles:

La démonstration automatique qui inclut des techniques de satisfiabilité modulo théories (SMT), la résolution de contraintes numériques, et des applications comme le *Model-Checking* à base de SMT.

L'arithmétique machine certifiée vise à la fois à formaliser l'arithmétique des ordinateurs, en particulier les calculs en virgule flottante, et les applications à la vérification de systèmes basés sur l'analyse numérique.

La formalisation de langages au sens large est une activité commune à une grande partie de l'équipe, en particulier à l'aide des assistants de preuve Coq et Isabelle, et permet la formalisation de la sémantique des langages de programmation, de la concurrence, des calculs numériques, etc.

Les langages et systèmes centrés-données visent à la conception et au développement de langages de programmation et de systèmes manipulant de grandes masses de données.

Le test formel à base de modèles promeut les approches formelles dans les processus de test en génie logiciel, en utilisant des représentations logiques et des techniques de preuve, ainsi que les méthodes d'exploration aléatoires, et les modèles de comportement.

La vérification déductive de programmes vise le développement de techniques pour prouver formellement qu'un programme respecte une spécification formelle. Elle s'appuie sur plusieurs des activités précédentes.



Verification of Algorithms, Languages and Systems

Head: Burkhardt Wolff, Claude Marché

The VALS team works in the scientific field called *Formal Methods*. The general objective of the team is to make formal verification an easier to use, more wide-spread technology. Our research programme is structured into six activities, interacting with each other:

Automated Deduction includes research around satisfiability modulo theories, numerical constraint solving, and applications like SMT-based model-checking.

Verified Computer Arithmetic aims at both the formalization of computer arithmetic, including floating-point computations, and applications to the verification of systems based on numerical analysis.

Formalization of Languages in a broad sense is an activity shared by many members of the team, in particular using proof assistants Coq and Isabelle, which serve at formalizing semantics of languages, concurrency, mathematical/numerical theories, etc.

Data-Centric Languages and Systems aim at designing and developing programming languages as well as systems that seriously take into account massive data. This includes improving existing languages and systems.

Formal Model-based Testing promotes formal approaches into the testing process in software engineering, using logical representations and proof techniques, random exploration methods, and behavioural models.

Deductive Program Verification aims at developing techniques to formally prove that a program respects a formal specification. It builds upon several of the activities above.

Research Group members

Permanent Members (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
BENZAKEN	Véronique	PREX	PARIS SUD
BOLDO*	Sylvie	CR1	Inria
CHARGUÉRAUD*	Arthur	CR2	Inria
CONCHON*	Sylvain	PR2	PARIS SUD
CONTEJEAN*	Évelyne	CR1	CNRS
FILLIÂTRE*	Jean-Christophe	CR1	CNRS
GAUDEL	Marie-Claude	PR émérite	PARIS SUD
LONGUET	Delphine	MCF	PARIS SUD
MANDEL**	Louis	MCF	PARIS SUD
MARCHÉ*	Claude	DR2	Inria
MELQUIOND*	Guillaume	CR1	Inria
NGUYEN	Kim	MCF	PARIS SUD
PASKEVICH*	Andrei	MCF	PARIS SUD
PAULIN-MOHRING*	Christine	PREX	PARIS SUD
VOISIN	Frédéric	MCFHC	PARIS SUD
WOLFF	Burkhardt	PR1	PARIS SUD
ZAÏDI	Fatiha	MCF	PARIS SUD

* member of the LRI-Inria joint team Toccata, directed by C. Marché.

** currently on leave ("détachement") at the Collège de France.

Temporary Personnel (October 1st, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
AÏSSAT	Romain	Doc.	PARIS SUD (AM)
CLOCHARD	Martin	Doc.	ENS Paris
DROSS	Claire	Doc.	AdaCore (CIFRE)
DUMBRAVA	Stefania	Doc.	PARIS SUD (AM)
FELIACHI	Abderrahmane	Post-doc	EURO-MILS
GONDELMAN	Léon	Doc.	PARIS SUD (ANR BWare grant)
IM	Hyeonseung	Post-doc	PARIS SUD (ANR Typex grant)
KHEFIFI	Rania	Doc.	PARIS SUD (CDD)
LELAY	Catherine	Doc.	Inria (Digiteo PhD grant)
MARTIN-DOREL	Erik	Post-doc.	Inria (ANR Verasco grant)
MEBSOUT	Alain	Doc.	PARIS SUD (AM)
NEMOUCHI	Yakoub	Doc.	PARIS SUD (CDD)
NGUYEN	Huu Nghia	Doc.	PARIS SUD (AM)
TAFAT-BOUZID	Asma	Post-doc	PARIS SUD (ATER)
TUONG	Frédéric	Doc.	IRT SystemX (CDD)
WENZEL	Markus	Post-doc	ANR Paral-ITP

The VALS team was created in July 2013 as the fusion of the former groups ForTesSe and Toccata. Toccata's life continues as an Inria project-team, associated to VALS.

ForTesSE: Synthetic presentation

Nom du responsable de l'équipe : **Burkhard WOLFF**

Effectifs de l'équipe

The group has now 5 university faculty members (1 PR, 3 MC, 1 PR émérite), 2 post-doctoral students, and 5 Ph.D. students. (compared to January, 2008 : 1 PR, 4 MC, 1 PR émérite, 2 Ph.D. students, and 1 post-doctoral student).

Personnels ayant quitté l'équipe pendant le contrat en cours

Johan Oudinet and Lina Bentakouk left the team on December 2011 after passing their Ph.D.; Matthias Krieger left on March 2012 after passing his Ph.D.; Pascal Poizat left the team on September 2012 and is now a professor at LIP6.

Nombre de recrutements réalisés au cours de la période considérée et origine des personnels

Delphine Longuet joined the team on September 2009 as a Maitre de Conférences after a Ph.D in Evry; Matthias Krieger and Abderrahmane Feliachi joined the team in September 2009 as Ph.D. students; Huu Nghia joined the team on January 2010 as a Ph.D. student; Markus Wenzel joined the team on April 2010 as a post-doc, coming from TUM, Munich; Rania Khefifi joined the team on November 2010 as a Ph.D. student; Romain Aissat and Yacoub Nemouchi joined the team on September 2012 as Ph.D. students; Frédéric Tuong joined the team on December 2012 as a Ph.D. student.

Production scientifique au cours de la période écoulée

We present four major results that are couples of high-level publications and available tool.

1 - HOL-TestGen: Achim D. Brucker, Burkhard Wolff: On Theorem Prover-based Testing. In Formal Aspects of Computing (FACJ), 25(5): 683-731, 2013.

HOL-TestGen is free software; you can redistribute it and/or modify it under the terms of a BSD-style licence. HOL-TestGen 1.5 has been deposited in APP: IDDN.FR.001.220032.000.S.A.2011.000.10000

2 - RUKIA: Alain Denise, Marie-Claude Gaudel, Sandrine-Dominique Gouraud, Richard Lassaigne, Johan Oudinet and Sylvain Peyronnet. Coverage-Biased Random Exploration of Large Models and Application to Testing. STTT, International Journal on Software Tools for Technology Transfer 14(1):73-93, 2012. Rukia is a free software under Lesser GNU Public license (LGPL). Rukia is also deposited in APP: IDDN.FR.001.350014.000.S.C.2009.000.00000.

3 - Isabelle/Circus: Abderrahmane Feliachi, Marie-Claude Gaudel, and Burkhard Wolff. Isabelle/Circus: A process specification and verification environment. In VSTTE proc., vol.7152 of LNCS, p.243-260, 2012. Isabelle/Circus specification and verification environment for Circus available at: <http://afp.sourceforge.net/entries/Circus.shtml>

4 - SBBC tool: Symbolic Branching Bisimulation for Conformance: A Symbolic Framework for the Conformance Checking of Value-Passing Choreographies. Huu Nghia Nguyen, Pascal Poizat and Fatiha Zaïdi. ICSSOC'2012, LNCS 7636:525-532, Springer, 2012. Available at: <https://www.lri.fr/~nhnghia/tools/sbbc>

Bilan quantitatif des publications de l'équipe

- Articles dans des revues internationales majeures: 11
- Articles dans les autres revues : 2
- Articles dans des conférences majeurs: 23
- Articles dans les autres conférences et workshops : 31
- Livres et chapitres de livres : 6

5 publications majeures

1. Achim D. Brucker, Burkhard Wolff: On theorem prover-based testing. Formal Asp. Comput. 25(5): 683-721 (2013).

2. Alain Denise, Marie-Claude Gaudel, Sandrine-Dominique Gouraud, Richard Lassaigne, Johan Oudinet, Sylvain Peyronnet: Coverage-biased random exploration of large models and application to testing. STTT 14(1): 73-93 (2012).
3. Radu Mateescu, Pascal Poizat, Gwen Salaun: Adaptation of Service Protocols Using Process Algebra and On-the-Fly Reduction Techniques. IEEE Trans. Software Eng. 38(4): 755-777 (2012).
4. Aline Carneiro Viana, Stephane Maag, Fatiha Zaïdi: One step forward: Linking wireless self-organizing network validation techniques with formal testing approaches. ACM Comput. Surv. 43(2): 7 (2011).
5. Delphine Longuet, Marc Aiguier, Pascale Le Gall: Proof-Guided Test Selection from First-Order Specifications with Equality. J. Autom. Reasoning 45(4): 437-473 (2010).

5 (max) documents majeurs (autres que publications) The four publicly available tools mentioned as major results, plus several major contributions to Isabelle/HOL as a modeling platform as well as implementation framework for Formal Methods Tools, including the novel Prover IDE (PIDE). Five official Isabelle releases were managed at LRI by M. Wenzel since June 2010.

5 (max) faits illustrant le rayonnement ou l'attractivité académique

1. Chairing and/or organisation of seven important international scientific events, with edition of the proceedings: **ICTAC 2010, ICST 2010, TAP 2011, ICTSS 2011, MKM 2012, UTP 2012, Dagstuhl Seminar on Symbolic Methods in Testing**, proceedings see <http://www.dagstuhl.de/13021>.
2. Foreign visitors (long stays): Ana Cavalcanti, Jim Woodcock, university of York, UK; Petra Malik, Victoria University of Wellington, NZ; Manuel Munez, Universidad Complutense de Madrid, SP; Eliane Martins, Universidade de Campinas, BR.
3. Co-directed PhD theses (co-tutelle): ETH Zürich, Lukas Brügger; Universidade São Paulo, Paulo Salem da Silva.
4. Numerous International Programme Committees and Steering Committees memberships, editorial boards of international scientific journals: Marie-Claude Gaudel, 5PC, 2SC, 2EB; Markus Wenzel, 6PC, 2SC; Burkhart Wolff, 20 PC, 2SC; Fatiha Zaïdi, 28 PC, 1SC.
5. Marie-Claude Gaudel was awarded Doctor Honoris Causa of the University of York, UK, and got several grants of the Royal Society and of the Royal Academy of Engineering.

5 (max) faits illustrant les interactions de l'équipe avec son environnement socio-économique ou culturel

1. Participation to the IRT System X: PhD thesis of Frédéric Tuong;
2. Participation to the European project Euro-Mills;
3. Participation to several ANR projects: Paral-ITP, PIMI, WebMov (ForTesSE leader), VERAP.
4. **Popular science:** contributions to "Fête de la Science"; Scientific Board of Centre d'Alembert d'Orsay; Scientific Board of the Club Science et Citoyens de Bobigny-Drancy; Scientific Board of S(cube), "Scientipole Savoirs et Société"; administrative board of the association "Femmes et Sciences"; contribution to the journal "Rayonnement du CNRS"

Principales contributions de l'équipe à des actions de formation Outside University Paris-Sud

- Summer, winter, and other seasons, schools: Summer SCHOOL TAROT (Training and Research on Testing), twice (Bath 2008, St Petersburg 2011); Digicosme Spring School (Orsay 2013)
- Tutorials on Isabelle (Cambridge, Orsay, Paris, Orsay, Orléans, Edinburgh) and on HOL/TestGen (NII Tokyo, Euro-Mills Paris)

Inside University Paris Sud

- Responsabilité de la Licence Informatique
- Co-responsabilité du Master pro ICI
- Coordonnation de l'Informatique pour le Cycle Préparatoire de Polytech Paris-Sud
- Coordination de la spécialité informatique en troisième année (bac+3) de filière ingénieur (formation initiale) à Polytech Paris-Sud
- Responsabilité de la formation continue, spécialité informatique, Polytech Paris Sud
- Responsabilité pour l'informatique des Missions Enseignements pour Paris-Sud et membre du Comité de Pilotage des Missions Enseignement
- Correspondance pour Paris Sud du Master Comasic

Research Group Members and evolution since 2008

Permanent Members (June 30th, 2013)			
<i>Name</i>	<i>First name</i>	<i>Position</i>	<i>Institution</i>
GAUDEL	Marie-Claude	PREM	PARIS SUD
LONGUET	Delphine	MCF	PARIS SUD
VOISIN	Frédéric	MCFHC	PARIS SUD
WOLFF	Burkhard	PR2	PARIS SUD
ZAIDI	Fatiha	MCF	PARIS SUD

Group evolution

- Delphine Longuet joined the team on September 2009 as a Maître de Conférences
- Abderrahmane Feliachi joined the team in September 2009 as a Ph. D. student
- Huu Nghia Nguyen joined the team on January 2010 as a Ph. D. student
- Markus Wenzel joined the team on April 2010 as a post-doc
- Rania Khefifi joined the team on November 2010 as a Ph. D. student
- Romain Aissat joined the team on September 2012 as a Ph. D. student
- Yacoub Nemouchi joined the team on September 2012 as a Ph. D. student
- Frédéric Tuong joined the team on December 2012 as a Ph. D. student
- Johan Oudinet left the team on December 2010 after passing his Ph.D.
- Matthias Krieger joined the team on September 2009 and left on March 2012 after passing his Ph.D.
- Lina Bentakouk left the team on December 2011 after passing her Ph.D.
- Pascal Poizat left the team on September 2012 and is now a professor at LIP6
- Abderrahmane Feliachi became post-doc after defending his thesis in December 2012.

Research Description

The research of the ForTesSE group is dedicated to formal methods and their applications to soft- and hardware systems. Particular emphasis is put on combinations of *Test* and *Proof* techniques.

There are three strongly related fundamental research activities underlying our approaches to system validation and verification. We categorize as follows:

1. testing using logical representations and proof techniques,
2. random exploration methods, and
3. behavioural models for testing, adaptation and composition.

The fundamental research of the group relies on theoretical activities around the formalisms used for specification and modelisation (logics (1, 51, 68), transition systems (30, 34) and process algebras (5, 32)) and their associated verification methods (theorem proving (4), symbolic evaluation (19, 36), model-checking (7, 38)) or exploration methods (random-based exploration of large models or programs (8)).

On the other end, the group engages to apply these activities in the development of tools, which is driven by specific *application domains* in software engineering. This is reflected by a number of international collaborations with industrial partners, be it directly(89) or within national (91, 88) or european projects (90).

Testing using logical representations and proof techniques

Participants: B. Wolff, A. Feliachi, M.-C. Gaudel, D. Longuet, M. Krieger, Y. Nemouchi, F. Tuong, M. Wenzel.

Techniques for automated test generation — be it from specifications in form of pre- and postconditions, from transition systems or from annotated programs — suffer from state-space explosion similarly to model-checking techniques. One possible answer to the challenge is to use symbolic representations of models, their normal forms, symbolic states and symbolic test cases (partitions of test data) were generated, processed, and finally input into constraint-solving techniques for test data selection. This way, the state-space explosion can be deferred at a later stage, allowing usually for a “deeper” exploration of the test space.

Theorem-prover based testing. Instead promising “push-button”-solutions to model-based testing, we developed an *interactive* test development approach based on the theorem proving environment Isabelle/HOL. The resulting HOL-TestGen system (4) is designed to explore and exploit the complementary assets of test and proof (an example is (19), where a proven correct symbolic transformation of problem-specific specifications allows drastically improved test generations).

Built on top of a widely-used interactive theorem prover excelling with a logical language of nearly unlimited expressive power, it provides automatic procedures for test case generation and test data selection as well as interactive means to perform logical massages of the intermediate results by derived rules. The purpose of this line of research is to investigate universal, i.e. not specification language oriented techniques for the representation of test specifications and their decomposition. This covers monadic representations of test sequences and infrastructures for automated test driver generation. We put particular emphasis on extending the Isabelle platform by pervasively parallel symbolic computing (43), which improves the exploitation of current multi-core hardware by an order of magnitude (37). Our developments inside the ANR Project Paral-ITP are meanwhile integrated in Isabelle’s standard distribution, together with an IDE-like user-interface (62).

Testing based on Process Algebra Specifications. Process algebras like CSP (Concurrent Sequential Processes), CCS/Lotos or Circus provide a framework to model abstract and concrete system processes, their reactive behavior and their architecture in form of sub-processes. We produced a logical embedding of the Circus language in Isabelle/HOL, geared towards efficient symbolic computing (51, 32), developed a testing theory (5) together with an efficient symbolic implementation called *Cirta* (92), which is currently integrated into HOL-TestGen in order to combine process-oriented with generic data-oriented test generation. *Cirta* generated automatically JUnit test suites for a critical component of a pacemaker monitoring system in collaboration with Biotronik GmbH (92).

Modeling Security Policies. The goal of this research area is to find unified framework to security policies, the “Unified Policy Framework” (UPF) enabling to model, combine, and test security enforcement points in system architectures and to test and prove abstract properties over them (see Brucker,Wolff: Formal firewall testing. Accepted in Aug.’13 in: Softw. Test. Verif. Reliab.). UPF has similar goals to Belnap-Logics for security modeling, but a more constructivist flavor. The main incentive of the approach is to view UPF-models as testable specifications. The UPF framework as well as concrete policies are specified in Higher-order logic. We mention two UPF-instance used in major case studies:

- automatic generation of test-cases for firewalls from policies ((19), and *Formal firewall testing* mentioned above), and
- together with our industrial partner BT, addressed the access-control policies for a large-scale patient data-management system for the NHS in Britain (20).

Operating and Embedded Systems. The goal of this research area is to develop modeling and testing techniques for low-level, machine oriented computer components. This includes memory and processor models (22) and their embedding in a “real OS”-environment (6) and related verification methods (1, 29). The models are typically oriented on bitvector representations; successful verification attempts require combinations of test and proofs in industrial certification processes (as undertaken in (90)).

Random exploration methods

Participants: M.-C. Gaudel, J. Oudinet, F. Voisin, R. Aissat

Methods based on randomness seem attractive for testing large programs or checking large models. However, designing efficient random methods is far from obvious since the underlying probability distributions must be carefully designed to get a good coverage of the program or model and to quantify it probabilistically. On the basis of classical results in the area of random generation of combinatorial structures, we have developed algorithms and tools for the randomised exploration of graphs with probabilistic guarantee of coverage. This work have led to applications to random program testing and model-checking. The main aspects have been published in STTT in 2011 (8). It has involved members of several LRI groups: Algo, BioInfo, ForTesSE and of the "Equipe de Logique Mathématique de Paris 7". Since 2008, our main results are the following.

The *dichopile* algorithm and the RUKIA library. Implementations of uniform random generation algorithms (namely recursive methods) need tables whose size grows with the length of the paths to be generated. Moreover, using floating numbers is essential for time and memory efficiencies. We have studied two different strategies: The first, most natural one, consisted in inverting the recurrences that are used in the classical recursive method; however, this method exhibits numerical instability when using floating point arithmetic (13). This led us to develop the second one called *dichopile*: based on a divide-and-conquer approach, it avoids numerical instability and offers an excellent compromise in terms of space and time requirements. The algorithm was published in Gascom'2010 (57) and then in TCS (10). Combined with our methods for uniform path exploration in very large composed models, it dramatically improves the scalability of our approach: in his thesis J. Oudinet was able to generate paths of length 4000 in an automaton with more than 12 million states (94). All these algorithms are implemented and available in the RUKIA library. Rukia is a free software under Lesser GNU Public license (LGPL).

Uniformly randomised LTL model-checking. We have generalised uniform drawing of paths to uniform drawing of so-called "lassos" that are interesting for model-checking of LTL formulas. This implies counting and drawing elementary circuits, which is known as a hard problem. However, efficient solutions exist for specific graphs, such as reducible data flow graphs, which correspond to well-structured programs and control-command systems. This work was published at ETAPS-FASE 2011 (58) and integrated in RUKIA. An interesting perspective would be to embed this method in an existing model-checker such as SPIN or CADP, with the aim of developing efficient randomised methods for LTL model-checking with as result a guaranteed probability of satisfaction of the checked formula.

Randomised coverage of states and transitions and Applications to structural testing of programs. This work revisits the thesis of Sandrine Gouraud, who left the team in 2008. Uniform drawing of paths has been adapted to address the coverage of other structural items like vertices (states), edges (transitions) or some structurally defined subset of all paths. The RUKIA library has been enriched accordingly by R. Aissat, a new PhD student. Our aim is showing that coverage-biased drawing of paths can be improved for not drawing too many unfeasible paths and can scale up reasonably well. Among other techniques we investigate the use of program slicing and of annotations on combinatorial aspects of a computation (like relations about the numbers of traversals of different loops or other parts of the program) in addition to the usual annotations about its functional behavior. We plan to implement a prototype within the Frama-C platform (<http://frama-c.com>) for a realistic subset of C, possibly using a memory model in the lines of (1) integrated in the ACSL annotation language provided by Frama-C.

Behavioural models for testing, adaptation and composition

Participants: D. Longuet, P. Poizat, F. Zaïdi, L. Bentakouk, H. N. Nguyen, R. Kefifi, M. Lallali

Behavioural models are very relevant for different domains of research. In our case, we need such models for testing, composition and adaptation techniques (7). We have conducted research based on formal models to verify, test, compose, and adapt Web services and communicating protocols. Our aim is to propose models that capture the genuine features of the applications in order to be closer to the real implementation which is very important especially when testing. The composition of Web services can be done from several perspectives, a centralised one, known as orchestration, or a distributed one, known as choreography. Such composition allows to create from existing services new added-value services.

Service Orchestration Modelling and Testing. Abstraction used in the requirement, composition, and adaptation processes, together with the important role played by composition execution engines, make

it important to test service compositions. In this direction, we have addressed conformance testing of service orchestrations with several methods that go from enumerative (28, 72) to symbolic approaches. The main contributions of this work are an end-to-end and fully automated online testing technique and a symbolic approach to avoid state space explosion in formal models due to the rich XML-based data used in Web service interfaces. This work has been published to Testcom/fates 2009 and TAP 2010 (35, 36). A tool is available as an eclipse plug-in at <http://swst.lri.fr>.

Model-checking and testing of Distributed and Concurrent Systems. In distributed environment, services can be developed independently and are composed to achieve common requirements through interactions between them. Several kinds of models like service choreographies, message sequence charts or Petri nets are used to define such requirements, specifying the interactions among a set of participants. As for choreography specifications, we have formalized the problems and developed a framework by which service choreographies can be developed correctly for top-down or bottom-up approaches. It consists in analyzing relation between a choreography specification and a choreography implementation at both model and real implementation level. Particularly, it concerns the composition/decomposition service design (40, 39), the testing of choreography implementation. In our framework, we support value-passing among service by using symbolic technique and SMT solver, which allows to overcome false negatives state space explosion issues due by abstracting or limiting data domain of value-passing in existing approaches. The second strength of our approach relies on the black-box passive testing of choreographies implementation. The framework is fully implemented and can be used online through a Web application (<http://Schora.lri.fr>). This work has been published in SAC 2012, ICSOC 2012 and in HASE 2012 (56, 55, 34). We also started to work on testing from Petri net specifications of concurrent systems, proposing a theoretical framework for this purpose. We defined several conformance relations allowing to handle concurrency explicitly. We proposed a test case generation algorithm and we defined a test selection criterion that allows to build a finite test set from an exhaustive infinite one, which covers every basic behaviour the specification describes. This work has been published in TAP 2012 (30).

Testing and model-checking of protocols. Based on the background of conformance and interoperability testing of communicating systems (53), we have addressed some of new issues raised by Wireless Self-Organizing Networks (WSO_N). We have proposed models that deal with such specific constraints and defined a testing generation approach to test properties of WSO_N protocols. We have also defined specific testing architecture that mainly relies on monitors to test the properties (11, 54, 48). In the network area, we have also proposed a flexible proactive data dissemination approach for data gathering in self-organized Wireless Sensor Networks (WSN). To address this issue, we gained experience from our background on random strategy and walks. This work has been published in MSWIM 2010 (26). We have also started an activity of model-checking in collaboration with Sylvain Cochon of the team Toccata. We have worked on an efficient model-checker, Cubicle, for parameterized systems that proved the safety of cache coherence protocols and mutual exclusion algorithms. This work has been published in CAV 2012 (38).

Context-Aware Personal Information Integration Users are faced with an increasing amount of personal information that are available under different formats (e.g., pdf, doc, mails, calendar). This leads to a real need to develop tools that can help them to manage efficiently this big amount of heterogeneous personal information. Personal Information Spaces (PIS) are at the core of Personal Information Management Systems (PIMS). They enable the structuring, storage, and retrieval of data on-demand. In (66), we have proposed a semantic context-aware PIS. The user may define his/her own ontology for personal information ontology directly or by reuse of existing domain ontologies. Furthermore, we have considered the fact that the usability of personal information depends on contexts.

Collaborations

Participation to national and international collaborative research projects

- VERAP, ANR, approximate verification of Probabilistic Systems, Michel de Rougemont (scientific coordinator), LRI, LIAFA, Equipe de Logique Mathématique, Université Paris 7 and CNRS

- RobustWeb, COFECUB, LRI, Telecom SudParis, Laas, Unicamp (Brésil), UFES(Brésil), INPE (Brésil), (2008-2012)
- Date, STICAmSud, LRI, FaMAF (Argentine), UACH (Chilie) (Janvier 2013-Janvier 2014)
- WebMov, ANR, F.Zaidi (scientific coordinator), LRI, Telecom SudParis, Labri, Softeam, Montimage, Unicamp (Brésil, associé)
- MoBaST, Model Based Software Testing, CNRS-Royal Society, Ana Cavalcanti and M.-C. Gaudel (scientific coordinators), Partners: LRI and CS Department University of York, (5), (14), (47)
- EURO-MILS, EU Integrated Project, Secure European virtualisation for trustworthy applications in critical domains, partners: Sysgo (France & Germany, scientific coordinator), Technikon(Austria), OpenSynergy(Germany), Jemm Research(France), EADS, Airbus(France), Thales (France), DFKI Saarbrücken (Germany), Universiteit Gent(Belgium), Open Universiteit(Netherlands), T-Systems (Germany). (Oct. 2012 - Sept. 2015).
- Paral-ITP, ANR, Pervasive Parallelism in Highly-Trustable Interactive Theorem Proving Systems, partners: LRI (scientific coordinator: B. Wolff), INRIA Saclay, INRIA Roquencourt. (Nov. 2011 - Apr. 2015).
- PIMI, ANR, Personnel Information Management through Internet, P. Poizat (scientific coordinator for LRI), Partners: Genigraph (leader), LRI, INRIA, IRIT, IT Sud Paris, Montimage

Collaborations with other laboratories

- MBT-SEC, (funded by British Telecom), Deriving test-cases from security policies seen as model-based specifications. (20, 19, 45) (Sept. 2007 - Aug. 2010).
- Aline Carneiro Viana, Equipe Hipercom, Inria-Saclay, Réseaux auto-organisables (26, 11).
- Stéphane Maag, Telecom SudParis, SAMOVAR UMR, Test de protocoles de communications (11, 54, 72).
- R. Lassaigne, Equipe de Logique Mathématique, Université Paris 7 and CNRS - UMR 7056: RAndom System Testing and Analysis, (8), (58), (17)
- Ana C. V. de Melo, co-tutelle PhD, Universidade de Sao Paulo, Paulo Salem da Silva, Multi-Agent Systems Verification by Means of Simulation Analysis, November 2011, (98).
- Radu Mateescu, Gwen Salaun, LIG and INRIA-Grenoble, Service adaptation and choreography verification, (7)
- Y. Yan, Concordia University (Canada), Service composition and repair (65, 67, 39)
- Stefan Haar, co-directed PhD, LSV ENS Cachan: Hernán Ponce de León: testing concurrent systems with event structures, (30)

Participation to national and international networks

Participation to “investissement d’avenir” program

- IDEX Paris-Saclay
- Labex DigiCosme (B. Wolff is co-director of the programme Scilex)
- IRT SystemX (B. Wolff and D. Longuet are part of the programme FSF (Projet Fiabilité et Sûreté de Fonctionnement), which funds the thesis of F. Tuong.)

9/ ForTesSE

Volunteer Professional Service

Management Positions in Scientific Organisations

- Digiteo: M.-C. Gaudel, présidente du Comité des Programmes (2006-2013)
- FNRS, Fonds National de la Recherche Scientifique, Belgique, M.-C. Gaudel (2005-2009)
- GDR-GPL, Conseil Scientifique, M.-C. Gaudel (2008-)
- GDR-GPL, co-direction of the group MTV2, F. Zaidi, 2008-2011
- GDR GPL, co-direction of the COSMAL WG, P. Poizat (since 2011)
- Research council of the faculty of Science d’Orsay, member, F. Zaïdi (since 2012)

Organisation of Conferences and Scientific Events

- ICST 2010 , *3rd International IEEE Conference on Software Testing, Verification and Validation*, **Paris**, 2010: M.-C. Gaudel, general chair, F. Zaidi, PhD symposium chair, B. Wolff, PC member, A. Feliachi, M. Krieger, J. Oudinet, F. Voisin, organisation committee
- ICTSS 2011, *23rd IFIP WG 6.1 International Conference on Testing Software and Systems* , **Paris**, 2011: B. Wolff, F. Zaidi, co-chair, A. Feliachi, D. Longuet, F. Voisin, organisation committee
- UTP 2012 , *4th International Symposium on Unifying Theories of Programming*, **Paris**, 2012: M.-C. Gaudel and B. Wolff, co-chair, A. Feliachi, organisation chair
- CSDM, Complex Systems Design and Management, F. Zaidi, **Paris**, 2013, 2012, Organizing Committee
- Service Cup at the Services joint conferences, , 2012: P. Poizat, co-chair
- *Dagstuhl Seminar on Symbolic Methods in Testing*, Dagstuhl, 2013: B. Wolff, co-chair

Steering Committee memberships:

- FME, *International Symposium on Formal Methods*, M.-C. Gaudel (2006-)
- ICTSS, *IFIP WG 6.1 Int. Conference on Testing Software and Systems*, F. Zaidi and B. Wolff (2011-)
- TAP, *International Conference on Tests and Proofs*, B. Wolff, (2011-)

Participation to editorial and programme committees

Journal editorial Committees

- Science of Computer Programming, Elsevier: Marie-Claude Gaudel, member of the editorial board, (1981-)
- Formal Aspects of Computing, Springer: Marie-Claude Gaudel, member of the editorial board, (1989-)
- 1024, *Bulletin de la société informatique de France*, SIF: M.-C. Gaudel (2013-)

Other Responsibilities

- F. Zaïdi, elected member of the CCSU-27ième section (Commission Consultative des Spécialistes de l'Université)
- B. Wolff, elected member of the CCSU-27ième section (Commission Consultative des Spécialistes de l'Université)
- D. Longuet, nominated member of the board ("conseil de laboratoire") of LRI, since 2011
- B. Wolff, elected member of the board ("conseil de laboratoire") of LRI, since 2011

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Honors

Prizes and Awards

- M.-C. Gaudel, *Doctor Honoris Causa*, University of York, 2013
- Best paper award at the OCL 2009 Workshop: A. D. Brucker, M. P. Krieger, and Burkhart Wolff. *Extending OCL with null-references*. In J. Cabot, J. Chimiak-Opoka, F. Jouault, M. Gogolla, and A. Knapp, editors, *The Pragmatics of OCL and Other Textual Specification Languages*, volume 6002 of *Lecture Notes in Computer Science*, pages 261-275. Springer, 2009.

Keynote Addresses

International

- M.-C. Gaudel, *ETAPS Workshop on Model Based Testing*, 2008, "Coverage-biased random exploration of large models", (17)

- F. Zaidi, *TAROT Summer School, Bath*, 2008: The WebMov Project
- B. Wolff, *Brainstorming Workshop For Creation of Center of Excellence in Information and Communication Technology, Indian Institute of Technology (IIT), Jodpur, Rajasthan*, 2010: Formal Methods and its Relevance for Industry and Emmergent Markets
- B. Wolff, *Workshop "Trusted Extensions of Interactive Theorem Provers", Cambridge University*, 2010: Plugins for the Isabelle Platform: A Perspective for Logically Safe, Extensible, Powerful and Interactive Formal Method Tools,
- F. Zaidi, *TAROT Summer School, University of St Petersburg*, 2011: Formal Testing of Web Services
- M.-C. Gaudel, *TAP 2011*, "Checking Models, Proving Programs, and Testing Systems", (15)
- M.-C. Gaudel, *ICTSS 2011*, "Counting for Random Testing", (16)

France

- B. Wolff, *Journees communes LTP - LAC - LAMHA), LIFO, Orleans*, 2012, Parallelizing Interactive Theorem Provers: Challenges, Foundations and First Results.
- B. Wolff, *Digicosme Spring School, Orsay*, 2013, Program Analysis and Verification

Other Honors

- M.-C. Gaudel, *Chevalier dans l'ordre de la Légion d'Honneur*, 2012

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Evaluation of Research

Editorial Boards

International

- Science of Computer Programming, Elsevier: M.-C. Gaudel, member of the editorial board, 1981-
- Formal Aspects of Computing, Springer: M.-C. Gaudel, member of the editorial board, 1989-

National

- 1024, *Bulletin de la société informatique de France, SIF*: M.-C. Gaudel (2013-)

Program Committees

Chair

- QSIC 2008, *IEEE Eighth International Conference on Quality Software*, M.-C. Gaudel, general chair, 2008
- ICST, *IEEE International Conference on Software Testing, Verification and Validation*, M.-C. Gaudel, general chair, 2010
- ICTAC, *International Colloquium on Theoretical Aspects of Computing*, M.-C. Gaudel, chair of the special track on software testing, 2010
- TAP 2011, *International Conference on Test and Proof*, B. Wolff, co-chair, 2011
- ICTSS-11, *IFIP International Conference of Testing Software and Systems*, B. Wolff and F. Zaidi, co-chairs, 2011
- OCL 2011, *International Workshop on OCL*, B. Wolff, 2011,
- UTP 2012, *International Conference on Unifying Theories of Programming*, M.-C. Gaudel and B. Wolff, co-chairs, Abderrahmane Feliachi organisation chair, 2012
- Dagstuhl 13021, *Symbolic Methods in Test Generation*, B. Wolff, co-chair, 2013

Member (international events)

Conferences and Symposia

- TPHOLs08, *International Conference on Theorem-Proving in Higher-order Logics*, B. Wolff, 2008
- TESTCOM/FATES, *The Joint Conference of the IFIP Int. Conference on Testing of Communicating Systems and the Int. Workshop on Formal Approaches to Testing of Software*, B. Wolff, 2009
- TAP, *International Conference on Tests and Proofs*, F. Zaidi, 2013, 2012, 2011
- ICSOFT, *International Conference on Software and Data Technologies*, F. Zaidi, 2011, 2010, 2009
- CUP, *IEEE Service Cup Contest*, F. Zaidi, 2012, 2011, 2010
- ICFEM, *International Conference on Formal Engineering Methods*, F. Zaidi, 2009
- TESTCOM/FATES, *The Joint Conference of the Int. Conference on Testing of Communicating Systems and the Int. Workshop on Formal Approaches to Testing of Software*, F. Zaidi, 2009
- FM 2009, *16th International Symposium on Formal Methods*, M.-C. Gaudel, 2009
- FoVeOOS, *International Conference on Formal Verification of Object-Oriented Software*, B. Wolff, 2010 and 2011
- ICST, *IEEE International Conference on Software Testing, Verification and Validation*, M.-C. Gaudel, 2008, 2009, F. Zaidi, 2010, 2011, 2012, B. Wolff, 2010 and 2011
- ICST, *IEEE International Conference on Software Testing, Verification and Validation (Industry Track)*, B. Wolff, 2010 and 2011
- ICTAC, *International Colloquium on Theoretical Aspects of Computing*, B. Wolff, 2010 and 2013
- ICTSS, *IFIP International Conference of Testing Software and Systems*, D. Longuet (2011), B. Wolff, 2010, 2012 and 2013, F. Zaidi, 2013, 2012, 2011.
- TAP, *International Conference on Test and Proofs*, B. Wolff, 2008, 2012 and 2013
- QSIC, *International Conference on Quality Software*, F. Zaidi, 2013, 2012, 2011.
- ICST Mentoring Program, *International Conference on Software Testing*, F. Zaidi, 2013
- ICWS, *International Conference on Web Services*, P. Poizat, 2011, 2012, 2013, F. Zaidi, 2011, 2012, 2013
- FACS, *International Symposium on Formal Aspects of Component Software*, P. Poizat, 2012
- ICEBE, *International Conference on e-Business Engineering*, P. Poizat, 2008, 2009, 2010, 2011, and 2012
- ICSOC, *International Conference on Service Oriented Computing*, P. Poizat, 2012
- ICSOFT, *International Joint Conference on Software Technologies*, P. Poizat, 2009, 2010, 2011, and 2012
- SAC-SVT, *Symposium on Applied Computing, Software Verification and Testing track* : Delphine Longuet (2013)
- ISSTA, *ACM International Symposium in Software Testing and Analysis*, M.-C. Gaudel, 2013
- Tools@, *International Conference on Software Testing (Tools Track)*, B. Wolff, 2013
- FM 2014, *19th International Symposium on Formal Methods*, M.-C. Gaudel, 2014

Workshops

- FACS, *International Workshop on Formal Aspects of Component Software*, P. Poizat, 2008
- MBT, *ETAPS Workshop on Model-Based Testing*, M.-C. Gaudel, 2008, 2009
- WASELF, *Workshop on Autonomic and SELF-Adaptive Systems*, P. Poizat, 2008, and 2009
- FOCLASA, *International Workshop on the Foundations of Coordination Languages and Software Architectures*, P. Poizat, 2008, 2009, 2010, and 2012
- MOCA, *International Workshop on Modelling of Objects, Components, and Agents*, P. Poizat, 2009
- ORGMOD, *International Workshop on Organization Modelling*, P. Poizat, 2009
- TAV-Web, *4th International Workshop on Testing, Analysis and Verification*, F. Zaidi, 2010
- WCSI, *International Workshop on Component and Service Interoperability*, P. Poizat, 2010
- CAMPUS, *Workshop on Context-Aware Adaptation Mechanisms for Pervasive and Ubiquitous Services*, P. Poizat, 2010, and 2011
- Service Cup at the Services joint conferences, P. Poizat, 2010, 2011, and 2012
- WS-FMDS, *Workshop on Formal Methods in the Development of Software*, P. Poizat, 2011, and 2012
- ICSOC PhD Symposium, P. Poizat, 2011
- UITP, *International Workshop on User-interfaces for Theorem Provers*, B. Wolff, 2011
- WS-FM, *International Workshop on Web Services and Formal Methods*, F. Zaidi, 2011
- SCENARIOS, *1st International Workshop on Scenario-based Testing*, F. Zaidi, 2011
- FormSERA, *Workshop on Formal Methods in Software Engineering: Rigorous and Agile Approaches*, F. Zaidi, 2012
- WS-FMDS, *International Workshop on Formal Methods in the Development of Software*, F. Zaidi, 2013, 2012, 2011
- Thedu, *International Workshop of Theorem Proving Components for Educational Software*, B. Wolff, 2011, 2012 and 2013
- OCL, *International Workshop on OCL*, B. Wolff, 2008, 2009, 2010, 2012 and 2013
- FORMALISE, *Workshop on Formal Methods in Software Engineering*, F. Zaidi, 2013

Member (national events)

- MSR, *Colloque Francophone sur la Modélisation des Systèmes Réactifs*, M.-C. Gaudel , 2009, 2011
- AFADL, Journées francophones internationales sur les approches formelles dans l'assistance du développement de logiciels, F. Zaidi, 2013, 2012, 2010
- CAL, Conférence Francophone sur les Architectures Logicielles, P. Poizat, 2008, 2009, 2010, 2011, 2012
- CIEL, Conférence en Ingénierie du Logiciel (CIEL is LMO+IDM), P. Poizat, 2012
- GPL2013, *Journées du GDR GPL*, M.-C. Gaudel , 2013

Evaluation Committees and Invited Expertise

International

- European Research Council (ERC Starting Grants), E. U. : M.-C. Gaudel member of Panel 6 (2008-2013)

National

- ANR, committee of programmes SIMI2, blanc et Jeunes Chercheurs et Chercheuses : M.-C. Gaudel (Mai 2011)
- CNRS, PEPS 2011, B. Wolff

Other evaluation activities

- Expertise for the ANR french agency - program INS and VERSO, F. Zaidi, 2012, 2011
- Expertise for the ANR french agency - B. Wolff
- Expertise for the ANR french agency - programs JCJC SIMI2 ARPEGE, P. Poizat, 2008, 2010, 2011
- Expertise for industrial PhD grant (CIFRE), F. Zaidi, 2009, 2010, P. Poizat, 2011
- Expertise for NWO (NL), P. Poizat, 2008, 2011
- Expertise for several ERC Advanced Grants, and for various projects submissions to EPSRC (UK), NSERC (Canada), FQRNT (Québec), Christian Doppler Forschungsgesellschaft (Austria), NWO (NL), Research Grant Council Hong Kong, NICTA (Australia), DFG (Germany), M.-C. Gaudel, (2008-2013)

Hiring Committees

- B. Wolff, hiring committees of professor positions at University Paris-Sud in 2013, 2012
- F. Zaïdi, hiring committees of assistant professor positions at University Paris-Sud in 2013 and 2010, at Grenoble and Lyon 1 in 2011, at Nancy in 2009
- D. Longuet, hiring committees of assistant professor positions at University of Poitiers and Ecole Centrale Paris in 2010

PhD and Habilitation Juries

- F. Zaïdi: reviewer (5 PhD), examiner (8 PhD)
- B. Wolff: president (2 PhD), reviewer (9 PhD), examiner (2 PhD)
- F. Voisin: examiner (1 PhD)
- M.-C. Gaudel: president, reviewer, and examiner, several times.

Reviews of journal submissions

- JSS, Journal of Systems and Software, F. Zaidi, 2011
- SOSYM, Journal of Software and Systems Modeling, F. Zaidi, 2011
- Journal Software: Practice and Experience (Wiley), F. Zaidi, 2010
- JISA, Journal of Internet Services and Application, F. Zaidi, 2010
- ETRI, Korean Journal, F. Zaidi, 2010
- STVR, Software Testing, Verification and Reliability, F. Zaidi, 2009
- TSI, Technique et Science Informatique, 2009

- STVR, Journal of Software Testing, Verification and Reliability (Wiley), B. Wolff, 2008,2009,2011(x 3), 2012(x 3), 2013(x 3)
- FAC, Formal Aspects of Computing (Springer), B. Wolff, 2010,2011, 2012 and 2013
- TOSEM, ACM Transactions On Software Engineering And Methodology (ACM), 2010
- STTT, Software Tools for Technology Transfer(Springer), B. Wolff, 2011
- SCP, Science of Computer Programming (Elsevier), B. Wolff, 2012
- Several journals, M.-C. Gaudel, (2008-2013)

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Interactions with the social, economic and cultural environment

Popularisation of Research Results

- Contributions to "Fête de la Science", 2012, general public, F. Voisin, secondary schools, B. Wolff
- Scientific board of Centre d'Alembert d'Orsay, M.-C. Gaudel, for many years ... <http://www.centre-dalembert.u-psud.fr/>
- Scientific board of the Club Science et Citoyens de Bobigny-Drancy: <http://www.scienceouverte.fr/> with organisation of a guided tour of LRI for pupils of secondary schools in November 2012, M.-C. Gaudel,
- Scientific board of S(cube), "Scientipole Savoirs et Société", http://www.scientipole-savoirs-societe.fr/scientipole_savoirs_societe/, M.-C. Gaudel, since 2011
- Board of the association "Femmes et Sciences": <http://www.femmesetsciences.fr/>; presentations in secondary schools and in professional orientation forums, M.-C. Gaudel, since 2011
- Rayonnement du CNRS, article titled "Le test de logiciel : pourquoi et comment" in March 2012, M.-C. Gaudel, (78)

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
Subvention CNRS	MoBasT	CNRS/Royal Society	01.2012 / 12 mo.	4.00 k€
Subvention DIGITEO	UTP'2012	Université Paris XI	01.2012 / 12 mo.	1.50 k€
Contrat ANR	PIMI	Université Paris XI	11.2010 / 36 mo.	180.57 k€
Contrat européen	EURO-MILS	Université Paris XI	10.2012 / 36 mo.	260.73 k€
Chaire U-PSud	HOL-TestGen XT	Université Paris XI	02.2009 / 36 mo.	170.00 k€
Chaire DIGITEO	HOL-TestGen XT (supp)	FCS Digiteo	02.2009 / 36 mo.	86.00 k€
Subvention DIGITEO	ICTSSv3	CNRS	07.2011 / 12 mo.	3.50 k€
Contrat ANR	Paral-ITP	Université Paris XI	11.2011 / 40 mo.	215.92 k€
Contrat ANR	WebMov	Université Paris XI	12.2007 / 30 mo.	163.46 k€
Contrat IRT SystemX	SysMLTests	Université Paris XI	1.1.2013 / 30 mo.	155.37 k€

MoBasT

Partners: Université York, LRI

See <http://fortesse.lri.fr/attachments/article/69/MoBasT-LRI-York.pdf>

Type: Subvention CNRS
Amount: 1.50 k€
Duration: 12 months
Scientific director for LRI:
M.C-Gaudel

This project aims at strengthening and consolidating an existing and fruitful collaboration in the area of software testing based on formal specifications. The considered specifications are in CIRCUS, a language

developed in York, which integrates the notions of states and complex data types (in a Z-like style) and communicating parallel processes inspired from CSP. Moreover, the language comes with a formal notion of refinement and allows to take into account abstract specifications and their transitions to models of programs. On the bases of the theory of formal software testing and the proof and test generation tools developed in LRI the project will address the following questions: What are the integrated testing strategies applicable to such languages, which combine aspects that have been studied separately, so far, with respect to testing? What are the integrated testing strategies applicable to such languages, which combine aspects that have been studied separately, so far, with respect to testing? How to justify these strategies and their coherence with the underlying test hypothesis? How to implement them in a well-founded way, starting from the existing proof and generation tools that exist in York and Orsay. We also want to address the problem of the selection of finite test sets. Since, in the exhaustive test sets, we have a symbolic version of the tests, with labels constraining communicated values, it is natural to consider strategies based on constraints decomposition and solving. We propose as well to go further and address the challenging problem of providing coverage of complex internal data operations, and justify the soundness of the techniques.

UTP'2012

Partners: LRI

See <http://utp12.lri.fr>

Subvention of the organization of the conference ICTSS, collocated with FM.

Type: Subvention DIGITEO
Amount: 1.50 k€
Duration: 12 months
Scientific director for LRI:
M.C-Gaudel

PIMI

Partners: GENIGRAPH Genigraph, INRIA, IT Institut Telecom - Sud Paris, Montimage Montimage, LRI Université de Paris-Sid, IRIT Université Toulouse III

See http://www.agence-nationale-recherche.fr/en/anr-funded-project/?tx_lwmsuivibilan_pi2\%5BCODE\%5D=ANR-10-VERS-0014

Type: Contrat ANR
Amount: 180.57 k€
Duration: 36 months
Scientific director for LRI: P. Poizat

The future Internet will bring a growing number of networked applications (services), devices and individual data (including private ones) to end-users (citizens, consumers, employees). The important challenges are the organization of their access, and the guarantee of trust and privacy. The objectives of the PIMI project (Personal Information Management through Internet) are the definition of a model-based design environment and a deployment platform for Personal Information Management System (PIMS). The future PIMS must provide the end-user personal data access with services that are relevant to his needs. In order to take mobility into account, the PIMS will be accessed both by mobile devices (smartphone) and Internet-connected Personal Computers. With the increasing number of e-services and associated data being accessible through Internet, the number and complexity of PIMS will augment dramatically in the near future. This will require strong research investment in a number of topics, all contributing to the expected usability and accessibility of Individual Information Spaces for the end-user: Electronic trust and reputation of the services, Secured private data transfer between PIMS and between services, Ergonomic Human Computer Interface including mobile ones, Service composition and re-composition based on end-users requirements (life events), on e-service trust and runtime feedback, Quality of Service / Quality of Experience self adaptation, and Advanced algorithms to monitor the PIMS, the private data and service accesses

EURO-MILS

Partners: Sysgo (France & Germany, coord.), Technikon(Austria), Open-Synergy(Germany), Jemm Research(France), EADS, Airbus(France), Thales (France), DFKI Saarbrücken (Germany), Universiteit Gent(Belgium), Open Universiteit(Netherlands), T-Systems (Germany)

See <https://www.euromils.eu>

Type: Contrat européen
Amount: 260.73 k€
Duration: 36 months
Scientific director for LRI:
B.Wolff

Secure European virtualisation for trustworthy applications in critical domains. The mission of the EURO-MILS project is to develop a solution for virtualisation of heterogeneous resources and provide strong guarantees for isolation of resources by means of Common Criteria certification with usage of formal methods.

ForTesSE is involved in particular as part of the activity to use model-based testing techniques to establish conformance of the real code to the projects system models. Part of the research is oriented to the question, how can tests be organized in a format such that it is useable in an Common Criteria EAL5+ certification process.

HOL-TestGen XT

Partners: LRI

See ---

Type: Chaire d'Exc.
U-PSud
Amount: 170.00 k€
Duration: 36 months
Scientific director for LRI:
B.Wolff

The ultimate goal of this research proposal is to extend the realm of feasible state-spaces for HOL-TestGen by 4 orders of magnitude - thus offering even more potential for industrial applications in realistic model-based test-scenarios. We suggest a combination of 3 techniques to achieve this goal: - We will combine HOL-TestGen with reasonably integrated and configured automated provers from the SAT solver system family, in particular Z3. - With increasing complexity, there will always remain unresolvable constraints. We will use new Isabelle code-generators to convert constraint-systems of unknown logical status into optimized random test code. - In our experience, the success depends substantially on derived rules from the test domain that help to detect unsatisfiable test-cases early. We will explore ways to derive such forms of domain-specific simplification rules can be automated.

HOL-TestGen XT (supplement)

Partners: LRI

See ---

Type: Chaire DIGITEO
Amount: 86000 k€
Duration: 36 months
Scientific director for LRI:
B.Wolff

Financing supplement of the Chaire d'Excellence HOL-TestGen XT

ICTSSv3

Partners: LRI

See <http://ictss2011.lri.fr>

Type: Subvention DIGITEO
Amount: 3.50 k€
Duration: 12 months
Scientific director for LRI:
F.Zaidi

Subvention of the organization of the conference ICTSS, collocated with FM.

Paral-ITP

Partners: LRI (coord.), INRIA Saclay, INRIA Roquencourt

See <https://www.lri.fr/~wolff/projects/ANR-Paral-ITP/>

Type: Contrat ANR
Amount: 215.92 k€
Duration: 40 months
Scientific director for LRI: B.
Wolff

The proposed project intends to overcome the sequential execution model for the interactive theorem proving systems Coq and Isabelle, to make the resources of multi-core hardware available for even larger proof developments. Beyond traditional processing of proof scripts as sequence of proof commands, and batchloading of theory modules, there is a large space of possibilities and challenges for pervasive parallelism. This affects many layers of each prover system: basic computational structures, inference kernel, tactical programming, proof command language, and interactive front-ends. Some of these aspects need to be addressed for Coq and Isabelle in slightly different ways, to accommodate different approaches in either system tradition. These substantial extensions of the operational aspects of interactive theorem proving shall retain the trustability of LCF-style proving at the very core. The parallelization mechanisms are of foundational importance for HOL-TestGen, a modeling and test data generation environment based on Isabelle.

WebMov

Partners: LRI - Université de Paris-Sud, TSP(coord.), LaBRI - Université de Bordeaux I, Unicamp (Brésil), SOFTEAM (PME), Montimage (PME), LIMOS - Université de Clermont Ferrand 1, L3I - Université de la Rochelle

Type: Contrat ANR
Amount: 163.46 k€
Duration: 36 months
Scientific director for LRI: F. Zaidi

See <http://webmov.lri.fr>

The main objective of WebMoV is to contribute to the design, composition and validation of Web Services through a high level of abstraction view and a SOA based logical architecture vision. In this domain, industry usually constructs new services by composition of modules which describe existing Web Services. These composition mechanisms are called orchestration. In this proposal, we are interested in the design and composition mechanisms for Web Services as well as their validation using different types of testing techniques.

SysMLTests

Partners: Partenaires

See [#contract_system_X](http://fortesse.lri.fr/index.php?option=com_content&view=article&id=69&Itemid=85)

Type: TypeContrat
Amount: 155.37 k€
Duration: 36 months
Scientific director for LRI: B. Wolff

The contract finances the thesis "Automated Generation of Timed Tests with Isabelle and HOL-TestGen" attempts to apply "proof-based testing techniques" on concrete embedded real-time systems to be concretized by project partners. The Isabelle/HOL-TestGen-system (a plugin in Isabelle/HOL) will be used to formalize wide-spread specification languages (UML, OCL, SysML, Scade) as logical embeddings and to extend them by techniques to generate tests from models involving real-time constraints, currently used in distributed and massively parallel processors. Particular emphasis will be put on integration of visualization techniques to be integrated into the platform Isabelle/PIDE underlying HOL-TestGen.

Private contracts and grants (jan 2008 - jun 2013)

Type	Name	Managing Institution	Start / Duration	Amount
Industriel	CIFRE ALL4TEC	CEPHYTEN	11.2011 / 36 mo.	21.99 k€
Industriel	Usine Logicielle	Université Paris XI	04.2006 / 24 mo.	107.00 k€

CIFRE ALL4TEC

Partners: All4Tec

See ---

Type: Industriel
Amount: 4.0 k€
Duration: 12 months
Scientific director for LRI: M.-C. Gaudel

Convention CIFRE: the subject of the thesis was the definition of quality criteria for models, in the context of Matelo, a test generation tool based on stochastic models. The contract was canceled in november 2013, after one year, due to the departure of the student

Usine Logicielle/Software Factory

Partners: Thales, Dassault, MBDA, Hispano-Suiza, IFP, CEA-LIST, Supelec, LIP6

See <http://www.systematic-paris-region.org/fr/projets/usine-logicielle>

Type: Industriel
Amount: 107.0 k€
Duration: 36 months
Scientific director for LRI: M.-C. Gaudel

Within this big project of the Systematic "Pole de compétitivité" the LRI contributors developed with CEA-LIST a tool for statistical testing of reactive systems described in Lustre. The project lasted from 02/2006 to 02/2009

Software Licensing and Distribution

RUKIA - Random Uniform walk In Automata

<http://rukia.lri.fr/>

Contact: GAUDEL

Isabelle/HOL - Isabelle/HOL

<http://www.cl.cam.ac.uk/research/hvg/isabelle/>

Contact: WENZEL

Le Système HOL-Z - The HOL-Z System

<http://www.brucker.ch/projects/hol-z/>

Contact: WOLFF

HOL-TestGen - A generator of test-data from HOL specifications

<http://www.brucker.ch/projects/hol-testgen/index.en.html>

Contact: WOLFF

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Training and Education

Graduate Courses

- Master informatique, Université Paris Sud,
 - *Test des Systèmes Informatique* Burkhard Wolff
 - *Sûreté et Sécurité de Fonctionnement*, Fatih Zaidi,
- Master of Science Computer and Communication Network, Télécom sudParis, *Symbolic Model Checking*, Fatih Zaidi.

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Thesis

Habilitation à Diriger des Recherches

Name	Defense
Fatih ZAIDI	12.2010
Pascal POIZAT	12.2011

Defended thesis

Name	Start	Defense	Funding	Advisor
Lina BENTAKOUK	01.12.2007	16.12.2011	CDD sur contrat UPS	GAUDEL
Abderrahmane FELIACHI	01.10.2009	12.12.2012	Alloc. Ministère	GAUDEL
Matthias KRIEGER	01.01.2009	09.12.2011	CDD sur contrat UPS	WOLFF
Johan OUDINET	01.10.2007	19.11.2010	Alloc. Ministère	GAUDEL
Paulo SALEM DA SILVA	10.01.2009	28.11.2011	autre	GAUDEL

Thesis in progress			
<i>Name</i>	<i>Start</i>	<i>Funding</i>	<i>Advisor</i>
Romain AISSAT	01.10.2012	Alloc. Ministère	WOLFF
Rania KHEFIFI	15.11.2011	CDD sur contrat UPS	POIZAT
Yakoub NEMOUCHI	01.10.2012	CDD sur contrat UPS	WOLFF
Huu Nghia NGUYEN	01.01.2010	Alloc. Ministère	DAGUE
Frederic TUONG	01.02.2013	autre	WOLFF

Toccata: Synthetic presentation

Nom du responsable de l'équipe : **Claude MARCHÉ**, depuis janvier 2012 (Christine PAULIN jusqu'à décembre 2011)

Effectifs de l'équipe au 1er janvier 2008

5 enseignants-chercheurs ; 4 chercheurs ; 2 techniciens, ingénieurs et autres personnels ; 10 post-docs et doctorants.

Personnels ayant quitté l'équipe pendant le contrat en cours

- Marc Pouzet, Professeur Paris-Sud, mutation à l'UPMC mis à disposition de l'É.N.S. Paris en mars 2010.
- Laurence Puel, Professeur Paris-Sud, à la retraite depuis septembre 2012.
- total: 2 statutaires (71 mois) ; 13 doctorants, qui ont soutenu leur thèse durant cette période (326 mois) ; 7 post-docs (111 mois).

Nombre de recrutements réalisés au cours de la période considérée et origine des personnels

- Guillaume Melquiond, CR Inria 2008, était Post-doc lab. commun Inria-Microsoft-Research. Thèse É.N.S. Lyon 2006
- Andrei Paskevich, MCF Paris-Sud 2009, était Post-doc au CNAM. Thèse Univ. Paris 12 2007
- Véronique Benzaken, Professeur Paris-Sud, venue de l'équipe BD du LRI en 2010
- Kim Nguyen, MCF Paris-Sud 2010, était Post-doc au NICTA Sydney, Australie. Thèse Univ. Paris-Sud en 2008
- Arthur Charguéraud, CR Inria 2012, était Post-doc au Max Planck Institute for Software Systems, Kaiserslautern, Allemagne. Thèse Univ. Paris 7 en 2010

Production scientifique au cours de la période écoulée

1. Le développement de Why3, nouvelle génération de Why, a commencé en 2010. Il a rapidement atteint un état mature (articles Boogie 2011, ESOP 2013 et CADE 2013). Il est utilisé comme outil intermédiaire dans l'environnement Frama-C pour l'analyse statique de code C critiques (projet ANR U3CAT), et dans le futur environnement Spark2014 (projet FUI Hi-Lite) pour la vérification de codes Ada. Ces outils sont de plus en plus utilisés dans l'enseignement.
2. Le prouveur Alt-Ergo a atteint une maturité et un impact très significatif. Il a été qualifié par Airbus France pour utilisation dans le développement de code critiques. Il est utilisé depuis 2011 dans l'environnement SparkPro, et le sera dans Spark2014.
3. Étude d'un programme, écrit en langage C, résolvant numériquement (par discrétisation) une équation différentielle de propagation d'une onde acoustique le long d'une corde (projet ANR FOST). Preuve formelle complète de l'erreur de méthode introduite par le schéma de différences finies (article ITP 2010), et de l'erreur introduite par les arrondis dans les calculs (article ICALP 2009). Étude complète publiée dans le Journal of Automated Reasoning (2013).
4. La bibliothèque Coq ALEA (projet ANR SCALP) pour la formalisation des algorithmes randomisés a un impact important. Elle est utilisée dans d'autres développements certifiés, notamment pour l'environnement CertiCrypt pour la preuve de code cryptographiques, qui s'appuie sur un langage de programmation probabiliste au lieu du modèle algébrique de protocoles plus généralement adopté dans ce contexte.
5. Le model-checker Cubicle est le seul au monde à prouver automatiquement un protocole industriel de cohérence de cache (FLASH). Il a permis de recevoir un Academic Grant d'Intel pour l'année 2013, et continue à susciter de nombreux travaux de recherche (certification en Why3, nouveaux algorithmes d'inférence d'invariants, etc.). Collaboration fructueuse avec le Strategic Cad Lab d'Intel.

Bilan quantitatif des publications de l'équipe

- Articles de revue : internationales majeures 17 ; autres revues 5
- Articles dans des conférences et workshops : internationaux majeurs 48 ; autres conférences et workshops 51
- Livres et chapitres de livres : 8 ; éditions d'ouvrages : 3

5 publications majeures

- S. Conchon, É. Contejean, M. Iguernelala. "Canonized Rewriting and Ground AC Completion Modulo Shostak Theories". Tools and Algorithms for the Construction and Analysis of Systems (TACAS), volume 6605 of LNCS, pages 45-59, Saarbrücken, Germany, April 2011. Best EATCS paper award 2011.
- F. Bobot, S. Conchon, É. Contejean, M. Iguernelala, A. Mahboubi, A. Mebsout, G. Melquiond. "A Simplex-based extension of Fourier-Motzkin for solving linear integer arithmetic". 6th International Joint Conference on Automated Reasoning (IJCAR), volume 7364 of LNCS, pages 67-81, Manchester, UK, June 2012.

- S. Conchon, A. Goel, S. Krstic, A. Mebsout, F. Zaidi. "Cubicle: A parallel SMT-based model checker for parameterized systems". 24th International Conference on Computer Aided Verification (CAV), volume 7358 of LNCS, Berkeley, CA, USA, July 2012.
- A. Charguéraud. "Pretty-big-step semantics". 22nd European Symposium on Programming (ESOP), volume 7792 of LNCS, pages 41-60, March 2013.
- V. Benzaken, G. Castagna, K. Nguyen, J. Siméon. "Static and dynamic semantics of NoSQL languages". 40th ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages (POPL), Roma, Italy, January 2013.

5 (max) documents majeurs (autres que publications) En dehors des publications, notre production scientifique est surtout représentée par les nombreux logiciels que nous développons, tous distribués en Open Source (<http://toccata.lri.fr/tools.en.html>)

- Chaîne de vérification de code C : Frama-C (développé avec le CEA-List), Jessie/Why (déposé à l'APP) et Why3.
- Prouveurs automatiques : Alt-Ergo (déposé à l'APP) et Gappa
- Bibliothèques Coq : Flocq, Alea, Coccinelle, Coquelicot
- CDuce, un langage fonctionnel orienté XML (<http://www.cduce.org/>)
- Cubicle, un model-checker basé sur l'approche SMT (<http://cubicle.lri.fr/>)

5 (max) faits illustrant le rayonnement ou l'attractivité académique

- S. Conchon, É. Contejean et M. Iguernelala ont obtenu le prix 2011 de l'EATCS (European Association for Theoretical Computer Science), <http://www.eatcs.org/index.php/best-etaps-paper> pour le meilleur article théorique de l'ensemble des conférences ETAPS
- C. Paulin docteur honoris causa Université de Goteborg, Suède, octobre 2011
- Organisation de la conférence Internationale "Formal Verification of Object-Oriented Software", Paris, du 28 au 30 juin 2010, <http://foveoos2010.cost-ic0701.org/>
- Organisation de la compétition de vérification associée à la conférence VSTTE 2012, <https://sites.google.com/site/vstte2012/compet>
- J.-C. Filliâtre, membre de l'IFIP Working Group 1.9/2.15 (Verified Software) depuis 2011, <http://www.ifip.org/bulletin/bulltcs/memtc01.htm#wg19>

5 (max) faits illustrant les interactions de l'équipe avec son environnement socio-économique ou culturel

- Contrat industriel avec Airbus France : support pour maintenance et qualification d'Alt-Ergo pour son utilisation dans la certification de code critique avionique.
- Projet FUI Hi-Lite du pôle de compétitivité System@tic, <http://www.adacore.com/press/completion-of-project-hi-lite/>, débouchant sur le futur Spark2014.
- Plusieurs thèses CIFRE : avec Dassault Aviation, Gemalto, France Telecom, AdaCore.
- Concours Castor Informatique en lycées et collèges (<http://castor-informatique.fr/>). 92 000 participants en 2012.
- Articles de vulgarisation (<https://www.lri.fr/~sboldo/mediation.html>) et animations des fêtes de la science.

Principales contributions de l'équipe à des actions de formation

- Organisation de l'école de printemps DigiCosme 2013, "Program Analysis and Verification" du 22 au 26 avril 2013, <http://digicosme.lri.fr/Spring+School+2013>
- Cours au Master Parisien de Recherche en Informatique (<https://wikimpri.dptinfo.ens-cachan.fr/doku.php?id=cours:cours2>) : "Démonstration automatique", "Assistants de preuve", "Preuve de programme".
- Cours donnés à des écoles de jeunes chercheurs : EJCP 2012 et 2013 (<http://why3.lri.fr/ejcp-2013/>), Laser 2011 (<http://laser.inf.ethz.ch/2011/>), FoVeOOS Winter School 2011 (<http://krakatoa.lri.fr/ws/>), EJCIM 2012 (<http://ejcim2012.irisa.fr/>), APSSFM 2009 et 2013 (http://sts.thss.tsinghua.edu.cn/APSSFM_2013)
- Articles sur le site Interstices https://interstices.info/jcms/c_36152/boldo

Research Group Members and evolution since 2008

Permanent Members (June 30th, 2013)			
Name	First name	Position	Institution
BENZAKEN	Véronique	PREX	PARIS SUD
BOLDO	Sylvie	CR1	Inria
CHARGUÉRAUD	Arthur	CR2	Inria
CONCHON	Sylvain	MCF	PARIS SUD
CONTEJEAN	Évelyne	CR1	CNRS
FILLIÂTRE	Jean-Christophe	CR1	CNRS
MANDEL	Louis	MCF	PARIS SUD
MARCHÉ	Claude	DR2	Inria
MELQUIOND	Guillaume	CR1	Inria
NGUYEN	Kim	MCF	PARIS SUD
PASKEVICH	Andrei	MCF	PARIS SUD
PAULIN-MOHRING	Christine	PR1	PARIS SUD

Doctoral Students (June 30th, 2013)			
Name	First name	Funding	Institution
DROSS	Claire	CIFRE	AdaCore
DUMBRAVA	Stefania	AM	PARIS SUD
IGUERNELALA	Mohamed	ATER	PARIS SUD
LELAY	Catherine	Digiteo grant	Inria
MEBSOUT	Alain	AM	PARIS SUD
TAFAT-BOUZID	Asma	ATER	PARIS SUD

Temporary Personnel** (2008-2013)					
Name	First name	Position	Institution	Arrival	Departure
AYAD	Ali	Post-doc	Inria	09.2008	01.2009
BAELDE	David	Post-doc	CNRS	09.2010	12.2011
COUSINEAU	Denis	Post-doc	Inria	10.2011	09.2012
IM	Hyeonseung	Post-doc	PARIS SUD	11.2012	2014
KRISHNAMANI	Kalyan	Post-doc	Inria	09.2009	08.2011
MAKAROV	Evgeny	Post-doc	Inria	05.2011	10.2011
ODOT	Aurélien	Engineer	Inria	09.2006	08.2008
ROUX	Cody	Post-doc	Inria	05.2011	06.2012
RÉGIS-GIANAS	Yann	Post-doc	Inria	10.2007	09.2008
STOULS	Nicolas	Engineer	Inria	10.2007	09.2008

Visitors for 3 months or more (2008-2013)					
Name	First name	Position	Institution	Arrival	Departure
COURTIEU	Pierre	CRCT	CNAM, CEDRIC laboratory	10.2012	03.2013
ISHII	Daisuke	invited re-searcher	National Institute of Informatics, Japan	05.2011	12.2011
VIEIRA	Bárbara	PhD student	Universidade do Minho, Portugal	03.2009	05.2009

** past and current PhD students are listed in Section Thesis

Group evolution

In Nov. 2008, G. Melquiond was hired as CR Inria, strengthening our axis on floating-point program analysis. In Sep. 2009, A. Paskevich was hired as Maitre de Conférences, bringing new competences both on

automated deduction and program verification. In Mar. 2010, M. Pouzet left the team and went to É.N.S. Paris, consequently the axis on synchronous programming from our research programme got thinner. V. Benzaken joined the team in Sep. 2010, moving from the LRI “BD” team, bringing a new competence on programming languages and advanced type systems for databases. K. Nguyen was hired as Maître de Conférences at the same time, to support this new axis. L. Puel left the team in Sep. 2012, when she retired. A. Charguéraud was hired as CR Inria in Sep. 2012, bringing new competences on several aspects: verification of higher-order imperative programs, formalization of programming languages and verification of concurrent programs.

9/ Toccata

Research Description

Safety-critical software applications appear in various domains like transportation, telecommunication, banking, health services. In such contexts, a high assurance in the reliability of software is required. The general objective of the team is to promote the use of formal methods to provide such a level of assurance.

Deductive methods, that are based on computer-assisted theorem proving are central in the approaches we propose. We characterize ourselves by the will to consider both theory and practice. We develop a significant amount of software, that are distributed as open source, and used in external applications.

Below we describe our research programme, structured into six activities. For each of them, we present an overview and then detail a few important results obtained since 2008.

Activity 1: Formally Verified Programs

The use of automated theorem proving to statically check that a program respects a formal specification is an old idea originating from Floyd and Hoare in the early 1970s. Yet, it is only quite recently that some concrete achievements were obtained using deduction-based verification. One of the first example, around 1998, is the development of critical software embedded on driver-free trains like Paris metro line 14, using the *Atelier B* system. Other success stories of that kind happened since 2000, such as the *L4-verified* project developing a formally verified micro-kernel with high security guarantees, using analysis tools on top of the Isabelle/HOL proof assistant.

The first activity of our team is centered on deductive program verification. We develop several tools which interact with each other and with other external tools, as illustrated on Figure 9.1. The tools in pink boxes are designed by us, while those in blue boxes are designed by partners. The central tool is Why3 (206, 124), which includes both a Verification Condition generator and a set of encoders and printers. The VC generator reads source programs in a dedicated input language that includes both specifications and code. It produces verification conditions that are encoded and printed into various formats and syntax so that a large set of interactive or automatic provers can be used to discharge the verification conditions. As front-ends, our tool Krakatoa (239) reads annotated Java source code and produces Why3 code. The tool Jessie (252, 114) is a plug-in for the Frama-C environment (which we designed in collaboration with CEA-List); it does the same for annotated C code. The GnatProve tool is a prototype developed by AdaCore company; it reads annotated Ada code and also produces Why3 code. Last but not least, the modeling of programs semantics and the specification of their expected behaviors is based on some libraries of mathematical theories that we develop, either in the logic language of Why3 or in Coq. These are the yellow boxes of the diagram.

Environments for Deductive Verification The development of our tools and environments leads to publications, typically tool descriptions. We published the original concepts behind the Why3 logic language, where logic theories are structured and reused (206), our proof sessions system for maintaining proofs when specifications evolve (151), and the description of the WhyML intermediate language for both

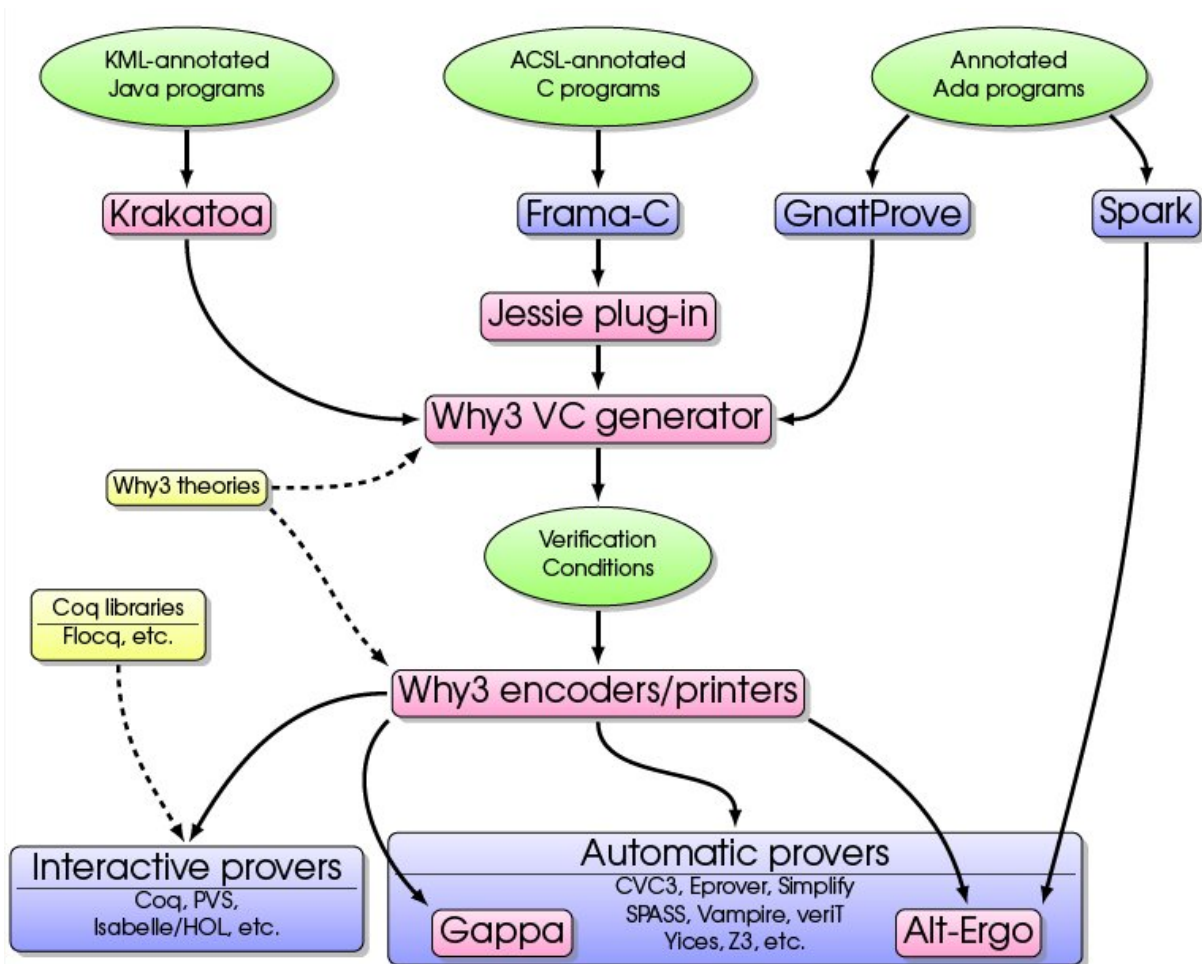


Figure 9.1: Interactions between our tools and with others

programming and proving (154). Why3 is used as an intermediate language by several other tools in the world. An evidence of its impact is the number of invited conferences that we gave to present it (123, 124, 125, 126, 127).

Memory models, Modularity, Reusability An important part of this activity is the design of suitable formal models of the semantics of programs. Regarding models for pointer programs underlying the front-ends for C and Java, we proposed models based on fine-grained representations of the heap memory, based on regions and permissions (218). We proposed an approach for specifying pointer programs inspired from Separation Logic but still making use of classical first order logic (150). On top of a representation using regions, we proposed a new approach for refinement of pointer programs (202), allowing for a more modular reasoning and the reusability of components, which is a key requirement. Still regarding reusability, we proposed new constructs for specifying generic components (199).

We also investigated the issues related to the combination of higher-order programs and side-effects (210, 293).

Inference of contracts A general drawback of deductive verification is the need to provide formal specifications to each functions of the code, under the form of a contract, and each loop, under the form of loop invariants. We investigated the possibility of generating parts of such contract automatically, either by abstract interpretation techniques (175, 114, 303) or by predicate abstraction (274).

Case studies and Applications To emphasize the usability of our tools, one first method is to publish representative case studies. For example, we published some solutions to the VACID-0 challenges (<http://vacid.codeplex.com/>): sparse arrays (187), binary heaps (263). Others published case studies a C code for computing solutions to the n -queens problem (153), and containers of Ada (142). All our case studies are available on a so-called “gallery of verified programs” on our web page (<http://toccata.lri.fr/gallery/index.en.html>).

Another mean to publicize our tools is to participate to the verification competitions, which have been organized since 2010 (193). We even organized the competition affiliated to VSTTE'2012 (208).

Concerning applications, apart from the use of Why3 as intermediate language in Frama-C and in Spark2013, we can mention applications to cryptography, either by directly using Why3 (191, 99), or again using why3 as intermediate language by the EasyCrypt project (<http://www.easycrypt.info/>). We have also investigated the verification of assembly code, such as ARM programs (198).

Hybrid systems The deductive approach is not limited to programs. We have also extended it to verifying the safety of hybrid automata, that is, systems comprised of discrete states and continuous transitions. The idea is to handle such systems as if they were programs, to infer loop invariants, and to prove the resulting verification conditions (138).

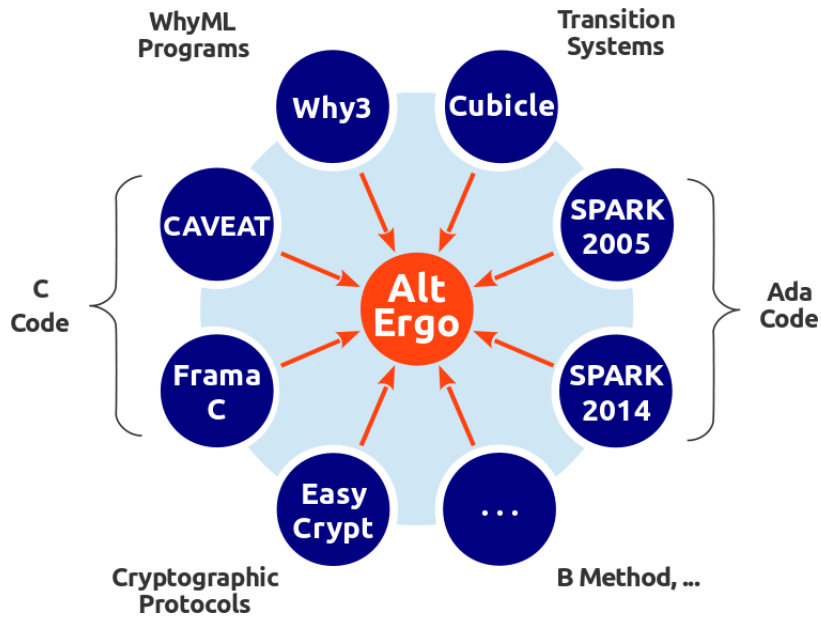
Activity 2: Automated Deduction

Automated theorem provers play a central role in the verification field. As shown in the previous section (Activity 1), provers like Alt-Ergo or Gappa are used in the Why3 plate-form to discharge verification conditions automatically. Theorem provers are also used as back-ends in other tools like testing tools, model-checkers etc. As a consequence, improving the efficiency and expressiveness of automatic provers has a strong impact in the all field of computer-aided verification.

The Toccata team has a long historical background on automated deduction. Starting from rewriting techniques in the 90's, it has evolved towards the Satisfiability Modulo Theory (SMT) paradigm in the mid-2000s in order to prove logical formulas generated by program verification toolboxes (see Activity 1). Along all these years, Toccata (formerly Démons and ProVal) has always associated theory to practice by implementing state-of-the-art automated deduction tools: the CiME rewriting toolbox, the SMT solver Alt-Ergo, etc. This list has been completed during the report period with the Gappa prover, developed by G. Melquiond who joined our team in 2008.

Proving Termination Since the last decade, a great deal of attention has been given to termination in the rewriting community, and since some termination tools were found faulty during termination tools' competitions, producing *certificates* of termination became a challenging domain. Coccinelle (194) is a formal Coq library which models universal algebras, term rewriting, various term orderings, and termination criteria. Formally proving paper and pencil known theorems allows to remove irrelevant hypothesis, and to propose some new, more general, termination criteria (148). Coccinelle has been used in combination with the CiME rewriting tool box in order to produce concrete termination certificates for a large set of rewriting systems coming from the termination problem database (147).

SMT Solvers. Among automated provers, our tool Alt-Ergo (282) is an SMT solver that is able to deal with quantifiers, arithmetic in integers or real numbers, and a few other theories. Its main originality is to handle, without encoding, polymorphic first-order formulas (207). As shown by the following picture, Alt-Ergo is used as a back-end of numerous verification plate-forms.



Decision procedures for specific theories. We worked on several theories in order to improve the efficiency and expressiveness of Alt-Ergo. For instance, we have developed an efficient algorithm for combining the free theory of equality with Shostak theories (219). We designed a new decision procedure to natively handle associative and commutative symbols found, for instance, in models of finite sets (163, 164, 107). We proposed an original extension of the simplex algorithm for linear integer formulas (152). We started to work on the treatment of floating-point numbers in Alt-Ergo. For that purpose, we designed a decision procedure based on the approach of the Gappa tool (220). Finally, we also proposed a framework to reason about triggers, the main mechanism used by SMT solvers to handle quantifiers (203).

Encoding schemes for polymorphic logics. The ML-like polymorphism of Why3's logic requires a subtle translation scheme to external prover logics. In (149) we have proposed a new approach for encoding polymorphic theories into monomorphic ones. In order to further the TPTP community to polymorphism, we have proposed an extension of the TFF0 syntax with rank-1 polymorphism (131).

Model-checking. In collaboration with the Strategic Cad Lab at Intel, we develop Cubicle (162), a model checker for verifying safety properties of parameterized systems. Cubicle implements the Model Checking Modulo Theory (MCMT) framework and it is written on top of Alt-Ergo.

Benchmarks and applications. We are concern by the effectiveness of our automatic deduction tools. In order to measure their efficiency, we conduct experiments on a large number of benchmarks, including industrial case studies (197).

Activity 3: Certified Tools and Libraries

An emerging trend in formal verification methods is the verification of the analysis tools themselves, as exemplified by the CompCert verified compiler. We have conducted several studies in this direction in the past, that we detail below. We are not interested in verifying standalone tools, but also in the design of verified reusable libraries, in particular on top of the Coq proof assistant.

Certified Mathematical Libraries A first category of libraries that we design on top of Coq aims at formalizing mathematical concepts. First, we developed several formalizations of floating-point arithmetic. This started with the PFF library (<http://lipforge.ens-lyon.fr/www/pff/>). An alternative independent library is the one used by the Gappa prover to produce Coq certificates (101). Both are now subsumed by our Flocq library (170).

We also designed the Coquelicot library (<http://coquelicot.saclay.inria.fr/>), an extension of the Coq standard library for reals. It is a user-friendly library for real analysis with an easier way of writing formulas and theorem statements, a comprehensive set of theorems and some automations (176, 223).

We also formalized in Coq mathematical concept around probability theory, this is provided by the Alea library (100). This formalization is the basis for reasoning on randomized algorithms. Alea is notably used by the CertiCrypt environment (<http://certicrypt.gforge.inria.fr/>) for the certification of cryptographic codes. Unlike the majority of approaches of verification of cryptographic protocols, CertiCrypt relies on a concrete randomized programming language, which permits to model attacks at the code level and not only at the protocol level.

Formalized Semantics Formalization of the semantics of languages is also typically done using Coq. We designed the Coccinelle library (194) to formalize term rewriting systems. It is used for the construction of Coq certificates by automated termination tools (148). It can be used to build proof certificates for other properties of term rewriting systems (147). An application is the formalization of high-level properties of distributed algorithms, as studied in the Pactole project.

Concerning semantics in general, we proposed the new concept of “Pretty-big-step” semantics (141), intermediate between small-steps and big-steps ones. We have shown that it is not mandatory to use an assistant as expressive as Coq to formalize semantics: the Why3 language is expressive enough, and allows a much higher degree of automation in the proofs (177).

Functional Programming We have worked on the design of several functional programming libraries, mainly using the OCaml language. Although a bit aside from the main research topics of the team, this topic is very important for us in term of impact. We present a general view of *Semi-persistent data-structures* (165) which permit to program efficient data structures while keeping a purely functional interface for them. Such an efficient data structures is the structure of ropes (179).

We designed OCaml libraries for graphs (221), for map-reduce style distributed programming (178, 209), for solving combinatoric problems (180). We also developed and distribute programming tools like OcamlViz (189) for monitoring OCaml programs, MLPOST (186) to produce graphical figures from OCaml code. We also maintain our bibtex2html for producing HTML documents from BibTeX files, used to produce hundreds of thousands of pages in the world.

Tools Verification A quite recent research topic in our team is the verification of tools. The first project we conducted in this direction is the design of certified kernel of the Alt-Ergo prover, on top of Coq (299). Although not covering all aspects of Alt-Ergo, it demonstrated it was possible for a fairly large kernel that includes a SAT solver, a decision procedure for equality and linear integer arithmetic.

A second project is the design of a certified VC generator for C programs annotated in ACSL. A first step was the design of the certified VC generator analogous to Why (160), and then a certified compiler from C/ACSL to Why (297). That second part is based upon the operational semantics of C provided by CompCert, upon which we formalized the semantics of ACSL.

Our objective is to go further into such a direction, and to scale-up on larger tools we aim at automatizing the proof as much as possible. This is why we proposed another formalization of a VC generator (177), done using Why3 instead of Coq, for which we showed that the degree of automation is high.

Activity 4: Verified Computer Arithmetic

In industrial applications, numerical computations are very common (e.g. control software in transportation) and they typically involve floating-point numbers. In order to analyze numerical programs, we have developed several tools. There are some Coq libraries (see above), namely PFF and Flocq. There is also the Gappa solver for automatically proving numerical properties (101). In recent years, we have demonstrated our capability toward specifying and proving properties of floating-point programs, properties which are both complex and precise about the behavior of these programs.

Floating-point arithmetic For the purpose of verifying numerical programs, the first step is the modeling of floating-point numbers. The Flocq library (170) provides a multi-radix and multi-precision Coq formalization for various floating- and fixed-point formats, coming with a comprehensive set of theorems and

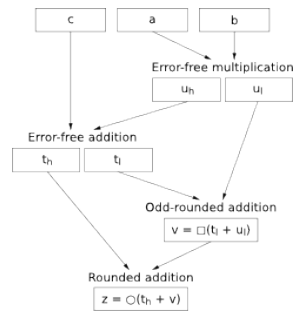


Figure 9.2: Emulating the FMA.

automations based on Gappa (224). This model interacts with our tool chain thanks to a Jessie model of floats (140), so that exceptional behavior may either be allowed or prevented by proof obligations.

We have also an expertise on floating-point arithmetic, exercised independently from programs. This includes several algorithms: emulation of the FMA (112) described in Figure 9.2, error of the FMA (110), argument reduction (109), predecessor and successor (104). We also contributed to the Handbook of Floating-Point Arithmetic in 2009 (227).

Verified numerical computations We of course applied our methodology to numerous numerical programs. See for instance the web galleries of certified programs of our team¹, Hisseo², S. Boldo³, and industrial case studies in the U3CAT ANR project. Several of these examples are presented in (111). An implementation of an elementary function is studied in (102). A program for accurately computing the area of a triangle is presented in (167) and for the discriminant in (115). Investigations about finite field arithmetic are in (222). Interval arithmetic was used to correctly approximate the Masser-Gramain mathematical constant (117).

A challenging case study was the analysis and the proof of both the method error and the rounding error of a numerical analysis program solving the one-dimension acoustic wave equation, using the second-order centered finite difference explicit scheme. It was presented in part for the method error (168) and in another part for the rounding error (166) and fully in a paper in the JAR journal (108).

Compiler- and architecture-related problems Unfortunately, even C programs that were carefully proved may end up failing, as floating-point operations will be subjected to several transformations, e.g. compilation, before being actually executed. There are several ways to circumvent this. We may take into account all the possible compilation features and issues (171, 120). We may also prove programs directly on the assembly code (225). Lastly, we may design a verified compiler that correctly supports floating-point arithmetic (169).

Activity 5: Data-Centric Programming Languages and Systems

Internet explosion and the ever growing importance of data in applications has given birth to a whirlwind of new data models (XML, JSON, RDF), languages (XPath, XQuery, Pig, Jaql, Sparql, JavaScript, ...) and data engines. Data, in all forms, is increasingly large in volume. The availability and reliability of such large data volumes is a gold mine for companies, scientists and simply citizens.

On one hand, it is clear that languages manipulating such data can greatly benefit from formal uniform foundations, and we argue that such foundations should account for novel features critical to various application domains. Also, most of those languages provide limited type checking, or ignore it altogether. We believe type checking is essential for many applications, with usage ranging from error detection to optimization.

On the other hand, and surprisingly, while the amount of data stored and managed by data engines

¹<http://toccata.lri.fr/gallery/index.en.html>

²<http://hisseo.saclay.inria.fr/>

³<http://www.lri.fr/~sboldo/research.html>

has drastically increased, little attention has been devoted to ensure that such (complex) systems are indeed reliable. Obtaining strong guarantees relies on the use of formal tools.

The data-centric languages and systems thematic aims at (i) designing and developing programming languages as well as systems that seriously take into account massive data (ii) improving existing languages and/or systems and (iii) provide certified implementations of data intensive management systems and/or languages. The final purpose is to build robust and efficient platforms on well founded theoretical grounds.

Data-centric Languages Based on the approach of semantic subtyping (103) we began working on NoSQL languages very popular in the context of big data and/or cloud computing. We defined a general framework that can both express and type such languages via an encoding into a core calculus. Each such language can in this way preserve its execution model but obtain for free a formal semantics, a type inference system and, as it happens, a prototype implementation. This contribution has been published at the ACM International Symposium on Programming Language (POPL 2013) (173).

The design and implementation of CDuce started in the early 2000 and is still going on. We are extending CDuce (and the semantic subtyping approach (103)) with polymorphism in collaboration with G. Castagna from PPS - CNRS - Université Paris Diderot. To this end a first highly challenging step consisted in defining an explicitly typed polymorphic calculus (with recursive types, arrows, unions, intersection and negation), such a definition required the definition of a calculus explicitly typed for intersection types: a problem left open for twenty years. This work will appear in POPL 2014. Another part of this extension of CDuce to polymorphism was the study of the calculus in order to be able to generate typing constraints in order to provide local type inference for polymorphic function application (Castagna Nguyen Xu). Based on this, we obtained an implementation technique, relying on a smart extension of the closure technique, that allows to execute polymorphic function application with the same efficiency than in the monomorphic case. This is quite standard in the case of languages such as ML but absolutely astonishing for a language such as CDuce which allows for dynamic dispatch on types thus preventing type erasure.

Data-centric Systems: automata based XML query engines A first line of research consisted, based on previous work, to provide type-based optimizations for XPath/XQuery engines. The approach proposed various static analysis in order to prune the documents to be queried, only loading the relevant part that the query need to compute its result. This led to the ACM TODS publication (113).

Complementarily to the previously mentioned static analyses aspects, we also focus on *efficient* implementations of XML standards (XPath in particular) based on tree automata. A first result is the SXSL query engine (on which we report in (139)) which uses a novel dynamic analyses of tree automata that makes SXSL on par with state of the art query engines. Building on SXSL, the TAToo library (Tree Automata TOOLkit) aims at providing both an efficient runtime and powerful static analyses (query containment/emptiness checking) in the same framework (<http://typex.lri.fr/software.html>).

Data-centric Systems: toward mechanized and verified implementations In this line of research, we are highly interested in the certification of data intensive systems such as relational database systems, XPath/XQuery and semi structured data engines using formal tools such as Solvers (The WAM-Solver), SMT provers (e.g., Alt-ergo) embedded in the Why(3) platform as well as interactive theorem provers (e.g., Coq).

In the context of a PhD that began in October 2012, we designed and implemented a Coq library for the relational data model. Based on this library, we are currently verifying an SQL compiler. This includes proving the correction of the translation of queries into their relational algebra counterpart but also prove that the algorithms used to implement relational operators conform to their (Coq formalized) specification and finally prove the correction of the query optimizer. We are also addressing the problem of formally verifying database updates.

Activity 6: Synchronous Programming

Synchronous languages have demonstrated in the past their pertinence for the development of the most critical embedded systems, both from the theoretical point of view and from the industrial point of view (Airbus airplanes, EDF nuclear plants, railway signaling, etc.). They belong to a wide range of programming and modeling tools allowing to describe in a unique formalism both an embedded controller

and its environment, to simulate/verify the whole and to generate target code. Among those tools, the most representative ones are SCADE based on a synchronous language and Simulink which offers a wider expressiveness as it combines both discrete and continuous time.

Our research group worked on the design, semantics, and compilation of synchronous languages considering their relationship with typed functional languages. In the past years, we addressed the following topics: (1) providing new abstraction mechanisms, compilation techniques, and dedicated type systems to increase the expressiveness and safety of synchronous languages; (2) the theory of n -synchronous systems, a relaxed model of synchrony allowing to deal with the communication with bounded buffers; (3) the semantics and compilation of hybrid modelers where programs mix continuous and discrete time. Our results are experimented in several programming languages developed in the group: Lucid Synchrone, ReactiveML (118), Lucy-n (215); used both to validate them and to communicate with industrial partners. We have a solid experience of collaboration with production team from industry, in particular with Esterel-Technologies, Dassault-Systèmes and NXP. Several research results have been developed jointly or come directly from problems they encountered. As an example, various features from Lucid Synchrone are integrated to the compiler of SCADE 6 developed at Esterel-Technologies and distributed since 2008 (among others, type and clock calculus, initialization analysis, hierarchical automata). A compiler of Lucid Synchrone has also been developed at Dassault-Systèmes (Grenoble) and is now integrated inside the CATIA environment. The work on n -synchrony is the result of a close collaboration with the group of Marc Duranton at NXP (Eindhoven).

n -Synchronous Kahn Networks In collaboration with Albert Cohen, Christine Eisenbeis (INRIA Alchemy), and Marc Duranton (NXP, Eindhoven), we introduced the theory of n -synchronous Kahn networks as a relaxed model of synchrony. The n -synchronous model allows to compose streams that have *almost the same clock* and can be synchronized through the use of a finite buffer. This relaxed model is achieved by introducing a sub-typing rule in the clock calculus to localize places where synchronization code must be inserted. Sub-typing can be checked for ultimately periodic clocks (184, 211). Nevertheless, this check can be costly when clock patterns are long, and is restricted to periodic behaviors only. An abstraction mechanism, allowing to deal with sets of (non necessarily periodic) clocks has been proposed in (135, 183).

Based on those ideas, we have designed and implemented the language Lucy-n (185, 215). This language provides a dedicated type system, the clock calculus, which is able to verify properties like the absence of buffer overflows and deadlocks. Moreover, it computes static schedules of the programs and sufficient buffer sizes. It has been applied to the static scheduling of latency insensitive designs (157). The theory has been formalized in the proof assistant Coq (183, 200, 215, 290).

We also worked on other extensions of the synchronous model, for example an object oriented features (132) or distributed applications (136).

Semantics and Compilation of Hybrid System Modelers Hybrid systems modelers such as Simulink have become the corner stone of embedded system development. They allow both *discrete* controllers and their *continuous* environments to be expressed *in a single language*. Despite the availability of such tools, there remain a number of issues related to the lack of reproducibility of simulations and of a clear semantics or the whole.

In collaboration with Albert Benveniste, Benoit Caillaud, and Timothy Bourke (INRIA Rennes), we proposed using nonstandard analysis as a semantic domain for hybrid modelers (130). Then, we considered a minimal, yet full-featured synchronous language, where data-flow equations can be mixed with ordinary differential equations (ODEs) with possible reset. A type system is proposed to statically distinguish discrete computations from continuous ones and to ensure that signals are used in their proper domains. The extended data-flow language is realized through a source-to-source transformation into a synchronous subset, which can then be compiled using existing tools into routines that are both efficient and bounded in their use of memory. These routines are orchestrated with a single off-the-shelf numerical solver (SUNDIALS) using a simple but precise algorithm which treats causally-related cascades of zero-crossings.

Modular and formally defined Code Generation Our research activity has also concerned the development of compilation methods.

In collaboration with P. Raymond (VERIMAG, Grenoble), we have worked on the modular generation of sequential imperative code from synchronous data-flow networks. Though this question has been identified almost twenty years ago, it has almost been left aside until the recent work of Lubliner, Szegedy, and Tripakis presented at POPL'09. The problem is proven to be intractable and the authors derive an iter-

ative algorithm where each step is encoded as a SAT problem. Despite the apparent intractability of the problem, it appears that real problems rarely fall in this category. Based on an analysis of input/output dependences, we have proposed a polynomial algorithm that (1) either gives an optimal solution or (2) gives a non trivial lower bound on the number of classes to start an iterative combinatorial search (158, 119). In all the examples we have considered (the whole SCADE library and two industrial examples from Airbus), the polynomial algorithm finds an optimal scheduling.

We also worked on the formal description of a reference compiler for a Lustre-like language extended with automata. The formal description of a compiler is given in (143). An implementation in Coq, together with a formalization of the semantics of all intermediate languages has been done (289). This work is under revision for a journal publication.

Synchrony for interactive applications The synchronous model is used to program safety critical embedded systems because it has good properties such as a simple semantics and a deterministic model of concurrency. These properties can also be useful in a more general context like the programming of discrete simulations. Therefore, we develop the ReactiveML language which embeds the synchronous model inside a subset of OCaml.

The possibility to define complex data structures and the expressiveness of the language has allowed to write an interpreter of Antescofo (129). Antescofo⁴ is a language dedicated to mixed music, that is musical pieces where human musicians interact with electronic parts. The electronic part have to handle in particular, tempo variations, synchronizations and errors. The read-eval-print loop of ReactiveML (212) has permitted to extends the Antescofo system with live coding (192).

Besides, for the programming of systems that exhibits multiple time scales, we proposed an extension of the synchronous model of concurrency, called reactive domains (156). Reactive domains allow the creation of local time scales and enable refinement, that is, the replacement of an approximation of a system with a more detailed version without changing its behavior as observed by the rest of the program. This is the kind of patterns that are really common in discrete simulations.

9/ Toccata

Collaborations

Our collaborations that are materialized by contracts are listed in Section 9.19.3.

Visits to and from International Teams

- J. Siméon from IBM research Watson - USA visited our team in October 2011 working on type systems for NoSQL languages (173).
- K. Nguyễn visited J. Siméon and K. Rose IBM research Watson - USA in April 2011
- V. Benzaken visited J. Siméon and K. Rose at IBM research Watson - USA in April 2011 and gave a seminar on CDuce.
- J.-C. Filliâtre visited Alwyn Goodloe at the National Institute of Aerospace (Hampton, USA) in September 2009 and gave a tutorial on the Why tool. J.-C. Filliâtre also presented the ACSL specification language (248) and the Frama-C platform.
- M. Pouzet visited Arvind (MIT, Boston, USA) and Grégoire Hamon (TheMathworks, USA) in July 2009. He presented the N-synchronous model.
- S. Conchon visited Intel Strategic Cad Labs during summer 2012.
- J.C. Filliâtre visited SRI (Menlo Park, California, USA) during summer 2012.
- M. Pouzet visited TheMathworks (Natick, USA) in July 2010 and gave a talk on VeLus, a formally certified Lustre compiler.
- Dr César Muñoz from the National Institute of Aerospace (NIA, Hampton, Virginia, USA) visited the Proval team for one month, in July 2008, with Digiteo funding support. The cooperation will continue in particular in relation with the Hisseo project, on the subject on analysing avionics code involving floating-point computations.

⁴<http://repmus.ircam.fr/antescofo>

- We had two visits associated with the Orchid project in collaboration with National Taiwan University: Pr. Yih-Kuen Tsay together with his student Ming-Hsien Tsai for one week in July 2008 and Tyng-Ruey Chuang from Academia Sinica for one week in August 2008.
- Barbará Vieira, Ph.D. student at Universidade do Minho (Braga, Portugal), visited ProVal from March to May 2009. She worked with J.-C. Filliâtre on a verification tool for CAO, a domain-specific language for cryptographic protocols (<http://www.cs.bris.ac.uk/~page/research/cao.html>).
- D. Ishii (National Institute of Informatics, Japan) visited the team for 8 months to work on applying program verification methods to hybrid systems.
- Thierry Coquand (University of Gothenburg, Sweden) visited our team in January as part of the Digiteo invitation program. He worked with C. Paulin and other researchers from Typical and MSR-INRIA research center on the use of the Coq proof assistant for the development of formal mathematics.
- Simão Melo de Sousa (Universidade da Beira Interior, Portugal) visited ProVal from September to November 2010. He worked with J.-C. Filliâtre on the deductive verification of ARM7 assembly programs, with application to the WCET problem.
- L. Mandel visited IBM Watson for 6 weeks (254).

Other Collaborations

- V. Benzaken, and K. Nguyễn, PPS-CNRS: Data Centric Languages work on NoSQL and XQuery 3.0 types systems (173)
- S. Conchon has continued his collaboration with S. Krstic and A. Goel (Intel Strategic Cad Labs in Hillsboro, OR, USA) on the development of the Cubicle SMT-based model checker (162).
- J.-C. Filliâtre has collaboration with University do Minho (Braga, Portugal) on the use of Why as intermediate for verification of cryptographic programs (99).
- J.-C. Filliâtre has collaboration with Universidade da Beira Interior (Covilhã, Portugal) on the use of Why as intermediate language for verification of ARM programs (198).
- Our on-going development of a verified JavaScript interpreter, described above, is an active collaboration with people from Imperial College, London, UK.

Participation to National and International Networks

FoVeOOS project: Formal Verification of Object-Oriented Software

- European Program COST (European Cooperation in the field of Scientific and Technical Research, <http://www.cost.esf.org/>)
- project IC-0701, <http://www.cost-ic0701.org/>
- Duration: May 2008 - April 2012
- Coordinator: B. Beckert, University Karlsruhe, Germany
- Other partners: 40 academic groups among 18 countries in Belgium, Denmark, Estonia, France, Germany, Ireland, Israel, Italy, The Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland and United Kingdom.
- C. Marché, coordinator for France, and coordinator of working group 2: Modularisation and Components

The aim of this action is to develop verification technology with the reach and power to assure dependability of object-oriented programs on industrial scale.

Coordination Action TYPES TYPES was a working group in the EU's 6th framework programme. It started in September 2004 lasted until april 2008. It was a continuation of a number of successful European projects starting in 1997. <http://www.cs.chalmers.se/Cs/Research/Logic/Types/>

The project involved not less than 33 academic groups in Sweden, Finland, Italy, Portugal, Estonia, Serbia, Germany, France, United Kingdom, Poland ; and industrial research groups at France Telecom and Dassault Aviation.

The aim of the research was to develop the technology of formal reasoning and computer programming based on Type Theory. This is done by improving the languages and computerised tools for reasoning, and by applying the technology in several domains such as analysis of programming languages, certified software, formalisation of mathematics and mathematics education.

Participation to “Investissements d’avenir” Programme

Labex “DigiCosme” C. Paulin is the director of the Labex “DigiCosme” (<http://www.labex-digicosme.fr/>).

DigiCosme is an excellence laboratory center (labex) in the area of Information and Communication Science and Technology. It is funded for 9M euros for the 2012-2019 period as part of the program “Investissements d’Avenir” launched by the French ministry of research. It is operated by the *fondation de coopération scientifique Paris-Saclay* as part of the “initiative d’excellence” Paris-Saclay.

DigiCosme is both concerned with Research and Education. Regarding research topics, it emphasizes three main action lines: Software Reliability and Security, Intelligent network structures and Data intelligence.

9/ Toccata

Volunteer Professional Service

Management Positions in Scientific Organisations

- V. Benzaken, elected member of the CNU 27th section (“Conseil National des Universités”) since 2011
- V. Benzaken, elected member of the CNESER (“Conseil National de l’Enseignement Supérieur et de la Recherche”) since 2011
- V. Benzaken, member of the council of the faculty of science d’Orsay (“Conseil d’UFR”) since 2011
- V. Benzaken, vice head (in charge of research) of the computer science department since Jan. 2012
- S. Boldo, elected representative of the researchers at the “comité de centre” of the INRIA Saclay - Île-de-France, 2008-2010.
- S. Conchon, elected member of the “Conseil scientifique de l’Université Paris-Sud” since June 2012.
- É. Contejean, elected member of the “Comité National de la Recherche Scientifique” (CoNRS), 6th section, since september 2012.
- C. Paulin, elected member of the board (“conseil d’administration”) of University Paris-Sud 11 until july 2008.
- C. Paulin, déléguée scientifique of the Inria Saclay Île-de-France center, and member of the national evaluation board of Inria (2008-2010).
- C. Paulin, director of the Graduate school in Computer Science at University Paris Sud <http://dep-info.u-psud.fr/ed/> (2008-2012).
- C. Paulin, deputy director of the LRI in 2011.
- C. Paulin, head of the new *Digicosme* laboratory of excellence (<http://labex-digicosme.fr/>) since 2012.
- C. Paulin, in charge of the assembly of directors of graduate schools at Université Paris-Sud, since 2012.
- C. Paulin, member of the board of the “Commission Académique Consultative” of the Initiative d’Excellence Paris-Saclay, since 2012.
- C. Paulin, president of the Computer Science Department of the University Paris-Sud <https://www.dep-informatique.u-psud.fr/>, since February 2012.
- C. Paulin is the representative of Univ. Paris-Sud for the education part of the EIT KIC ICT Labs. She contributed to the proposition of two master programs as well as the action on weaving Innovation and Entrepreneurship in Doctoral programs and the preparation of the Summer School “Imagine the future in ICT”.

Organisation of Conferences and Scientific Events

- J.-C. Filliâtre co-organized (with Leo Freitas, University of York, UK) the VSTTE’09 workshop (November 2009, Eindhoven, the Netherlands). <http://vstte09.lri.fr/>.
- J.-C. Filliâtre co-organized (with Cormac Flanagan, University of California, Santa Cruz, CA, USA) the PLPV’10 workshop (January 2010, Madrid, Spain). <http://slang.soe.ucsc.edu/plpv10/>.
- C. Paulin co-organized the *Digiteo Annual Forum 2009* (http://www.digiteo.fr/Digiteo_Annual_Forum_2009) which happened on Oct 21, 2009 at École Polytechnique. 335 participants. C. Marché was responsible for a session on critical software at this Forum.
- C. Marché co-organized (with B. Beckert, Karlsruhe Institute of Technology, Germany) the International Conference on Formal Verification of Object-Oriented Software (Paris, France, June 28-30, 2010). <http://foveoos2010.cost-ic0701.org/> (237).

- On behalf of the VSTTE 2012 conference (Philadelphia, USA, January 2012), A. Paskevich and J.-C. Filliâtre organized the first formal VSTTE program verification competition (<https://sites.google.com/site/vstte2012/compet>). It lasted for 48 hours, from November 8 to November 10. A set of five verification problems was proposed to the participants. Each problem consisted of an algorithm given in pseudocode, together with a set of properties to be mechanically proved. A total of 29 teams (79 participants) sent solutions, which is considered an excellent success.
- C. Paulin organizer of the first DigiCosme Colloquium (<http://labex-digicosme.fr/Colloque2012>), Sept. 12-13, École Polytechnique, France.
- C. Paulin organizer of the 4th Conference on Interactive Theorem Proving (<http://itp2013.inria.fr/>, July 2013).
- C. Marché organizer of the first DigiCosme Spring School (<http://labex-digicosme.fr/Spring+School+2013>, <https://www.lri.fr/~marche/DigiCosmeSchool/index.html>) whose theme was *Program Analysis and Verification*, April 2013.

Working Groups

- V. Benzaken, member of BDA steering committee (since 2005).
- M. Pouzet, member of IFIP Working Group 2.11 (Program Generation) <http://www.cs.rice.edu/~taha/wg2.11/>.
- J.-C. Filliâtre, member of IFIP Working Group 1.9/2.15 (Verified Software) <http://www.ifip.org/bulletin/bullfcs/memfcs01.htm#wg19>
- C. Paulin, member of the steering committee of the european TYPES working group, until 2008.

Other Responsibilities

- V. Benzaken, elected member of the CCSU-27ième section (Commission Consultative des Spécialistes de l'Université)
- M. Pouzet, member of the "*commission de spécialistes*", section 27, INPL Nancy, 2008.
- C. Marché, member of the "*commission de spécialistes*", Section 27, University Paris-Sud 11, 2008.
- C. Marché, French National Coordinator for the COST action "Formal Verification of Object-Oriented Programs", 2008-2012.
- G. Melquiond is an elected officer of the IEEE-1788 standardization committee on interval arithmetic (2008-?).
- S. Conchon, member of the "*commission de spécialistes*", Section 27, University Paris-Sud 11, 2008-2009.
- S. Conchon is an elected member of the board ("*conseil du laboratoire*") of Laboratoire de Recherche en Informatique (LRI), 2008-2009.
- M. Pouzet is an elected member of the "*conseil du laboratoire*" of LRI, 2008-2009.
- S. Boldo, member of the CLHS, *comité local hygiène et sécurité* and member of the CLFP, *comité local de formation permanente* of Inria, 2010-2011.
- E. Contejean and C. Marché, nominated members of the "*conseil du laboratoire*" of LRI since April 2010.
- G. Melquiond, C. Paulin, members of the "*commission consultative de spécialistes de l'université*", Section 27, University Paris-Sud 11 since April 2010.
- S. Boldo, elected member of the Inria Evaluation Committee, since 2011.
- S. Boldo, member of the committee for the monitoring of PhD students (*commission de suivi des doctorants*), 2011-2013
- S. Boldo, member of the MECSI group for networking about computer science popularization inside INRIA, since 2011. Scientific head for Saclay since 2012.
- C. Marché is member of the program committee of Digiteo (<http://www.digiteo.fr/>), 2008-2013.
- C. Paulin, member of the program committee of Digiteo, <http://www.digiteo.fr/>, since 2010.
- C. Marché, member of the selection committee of the "DIM Logiciels et Systèmes Complexes", providing grants to research projects, funded by *Île-de-France* regional council and Digiteo cluster, <http://www.dimisc.fr/>.
- S. Boldo, scientific head for Saclay for the MECSI group for networking about computer science popularization inside Inria.
- A. Charguéraud is vice-president of "France-IOI", the organization in charge of the selection and the training of the French team to the International Olympiads in Informatics, since 2004.
- C. Lelay, elected member of the "*conseil du laboratoire*" of LRI since November 2011.
- C. Lelay, elected representative of the students at the Doctoral School in Computer Science at University Paris-Sud since November 2011.
- A. Paskevich is in charge (together with C. Bastoul) of Licence professionnelle PER (L3) at IUT d'Orsay, Paris-Sud University since September 2012.

Honors

Prizes and Awards

- S. Conchon, E. Contejean, M. Iguernelala, award 2011 of the European Association for Theoretical Computer Science <http://www.eatcs.org/index.php/best-etaps-paper> for the best theoretical paper of all ETAPS Conferences (164), 2011.
- C. Paulin, Doctor Honoris Causa, University of Gothenburg, Sweden, October 21, 2011.
- Marc Pouzet, junior member of the IUF (*"Institut Universitaire de France"*), that distinguishes each year a few French university professors for the high quality of their research activities, 2008-2010.
- Project Pactole won the best Digiteo poster award at the annual Digiteo forum on the 21st of October http://www.digiteo.fr/Digiteo_Annual_Forum_2009.

Keynote Addresses

International

- J.-C. Filliâtre was invited speaker at SMT 2008 (Princeton, USA) (122): *Using SMT solvers for deductive verification of C and Java programs*.
- M. Pouzet was invited speaker at ISOR 2008 (Alger, Algeria, 2-6/2008): *Synchrony and Clocks in Khan Process Networks*.
- J.-C. Filliâtre was invited speaker at AFM'09 (Grenoble, France): *Invited tutorial: Why — an intermediate language for deductive program verification* (123).
- M. Pouzet was invited to the annual meeting of IFIP WG2.8 on Functional Programming (Frauenchiemsee, Germany, June 7-12, 2009).
- C. Paulin was invited to the conference *"Philosophy and Foundations of Mathematics : Epistemological and Ontological Aspects"* dedicated to Per Martin-Löf on the occasion of his retirement in Uppsala, May 5-8, 2009.
- G. Melquiond was invited to present the IEEE-1788 standardization process (137) at the Arith 19 symposium in Portland, OR, June 8-10, 2009.
- S. Boldo, invited speaker at the Third International Workshop on Numerical Software Verification (NVS-3) on July 15th 2010: *Formal verification of numerical programs: from C annotated programs to Coq proofs*.
- L. Mandel, invited lecture at Journées Francophones des Langages Applicatifs: *Cours de ReactiveML*
- J.-C. Filliâtre, "Memo Tables", invited at the IFIP Working Group 2.8 *Functional Programming* (Marble Falls, Texas, USA, March 7-11, 2011).
- P. Herms, "Certification of a Verification Condition Generator in Coq", seminar of the Gallium-Moscova teams, Rocquencourt, June 20th.
- C. Marché, "Verifying Behavioral Specifications of Programs: the Why Approach", seminar of the ELP team, Departamento de Sistemas Informáticos y Computación, Universidad Politécnica de Valencia, Spain, March 25th.
- C. Paulin, "About Inductive-Recursive Definitions in Coq", invited speaker at the workshop on Proofs and Programs, Gothenburg, Sweden, Oct. 22th.
- G. Melquiond, "Wave Equation Numerical Resolution: a Comprehensive Mechanized Proof of a C Program", CaCoS Workshop, Grenoble, July 26th.
- J.-C. Filliâtre, "Combining Interactive and Automated Theorem Proving in Why3", Automation in Proof Assistants 2012, Tallinn, Estonia, April 2012.
- J.-C. Filliâtre, "Combining Interactive and Automated Theorem Proving using Why3 (invited tutorial)", Second International Workshop on Intermediate Verification Languages (BOOGIE 2012), Berkeley, California, USA, July 2012.
- J.-C. Filliâtre, "One Logic To Use Them All", 24th International Conference on Automated Deduction, Lake Placid, USA, June 2013.

France

- T. Nguyen, "Hardware-independent proofs of numerical programs", seminar of the Arenal team, Lyon, January 20th.
- G. Melquiond was invited speaker at the arithmetic workshop of GDR IM (RAIM'09) in Lyon, October 26-28, 2009.
- S. Boldo was invited to the main INRIA Paris-Rocquencourt seminar, "*Le modèle et l'algorithme*" (<http://www.inria.fr/rocquencourt/rendez-vous/modele-et-algo/>), on October 1st.
- M. Pouzet was invited speaker at "journées de l'AFSEC, Toulouse, 27 janvier 2009: *Abstraction d'horloges dans les systèmes synchrones*."
- S. Boldo, "Contours de la communauté", invited talk at the *4es Rencontres Arithmétique de l'Informatique Mathématique* (RAIM'11) in Perpignan. (Collected data about the outline of the computer arithmetic community in France: sites, themes, fundings. . .).
- S. Boldo, "Preuve de programmes d'analyse numérique", seminar of the AriC team, Lyon, January 5th.
- K. Nguyen, "Programmation XML, de la théorie aux outils", invited lecture at "24^e Journées Franco-phones des Langages Applicatifs", Aussois, February 3-6, 2013.
- C. Lelay, "Improving Real Analysis in Coq: a User-Friendly Approach to Integrals and Derivatives", Co-approx seminar (for the Tamadi ANR), Lyon, July 11th.
- C. Lelay, "Improving Real Analysis in Coq: a User-Friendly Approach to Integrals and Derivatives", LAC/LaMHA/LTP Days, Orléans, October 25th.

9/ Toccata

Evaluation of Research

Editorial Boards

International

- C. Paulin co-edited with Ph. Audebaud the proceedings of the conference MPC'08 as a Springer volume in the serie Lectures Notes in Computer Science, she also co-edited a special issue of Science of Computer Programming devoted to selected papers of this conference.
- Marc Pouzet is associate editor of the EURASIP Journal on Embedded systems (<http://www.hindawi.com/journals/es/>). He is "directeur de collection" for Hermes publisher.
- J.-C. Filliâtre is member of the editorial board of the *Journal of Functional Programming*.
- C. Paulin is member of the editorial board of the *Journal of Formalized Reasoning*.
- C. Marché co-edited with B. Beckert a special issue of Elsevier Lectures Notes in Computer Science devoted to selected papers of the conference FoVeOOS'10 (237).
- J.-C. Filliâtre edited a special issue of Software Tools for Technology Transfer devoted to selected papers of the workshop VSTTE 2009. This includes an introduction paper on deductive software verification (106).

National

- S. Boldo is member of the editorial committee of the popular science web site *interstices*, <http://interstices.info/>.

Program Committees

Chair

- C. Paulin, program co-chair of the 9th International Conference on Mathematics of Program Construction, MPC 2008.
- C. Paulin, program co-chair of the 4th International Conference on Interactive Theorem Proving, ITP 2013.

- C. Marché, program co-chair of the 1st International Conference on Formal Verification of Object-Oriented Software, FoVeOOS 2010.
- C. Marché, *Tool Chair* of the program committee of the 19th International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS 2013, Rome, Italy, <http://www.etaps.org/2013/tacas13>), part of the ETAPS joint Conference. The tool chair is responsible for the evaluation and selection of tool papers and tool demonstrations, following precise guidelines given in the call for papers. This initiative of TACAS aims at making the selection of such submissions more accurate (<http://www.etaps.org/2013/tacas13/tacas13-tool-papers-menu>).
- S. Conchon, program co-chair of the Journées Francophones des Langages Applicatifs, JFLA 2010.
- S. Conchon, program chair of the Journées Francophones des Langages Applicatifs, JFLA 2011, La Bresse, France, January 2011.
- M. Pouzet, member of the steering committee of the workshop on synchronous programming (SLAP) since 2006.

Member (international events)

- V. Benzaken, European Symposium on Programming- ETAPS ESOP, 2013.
- V. Benzaken, International Conference on Data Engineering ICDE, 2011.
- V. Benzaken International XML Symposium (XSYM 2010)
- V. Benzaken International Conference on Very Large Databases VLDB, 2009.
- V. Benzaken ACM International workshop on Programming Languages for XML (PLAN-X 2008).
- S. Boldo, 4th International Workshop on Numerical Software Verification, NSV 2011, affiliated to CAV.
- S. Conchon, ACM Sigplan Workshop on ML, 2008.
- S. Conchon, 10th International SMT workshop 2012, Manchester, UK.
- É. Contejean, ACM SIGPLAN 2011 Workshop on Partial Evaluation and Program Manipulation, PEPM 2011, co-located with POPL, Austin, Texas.
- É. Contejean, the International Workshop on Proof Search in Axiomatic Theories and Type Theories (PSATT 2011, affiliated to CADE, Wrocław, Poland).
- É. Contejean, 23rd International Conference on Rewriting Techniques and Applications, RTA 2012, <http://rta2012.frs.cm.is.nagoya-u.ac.jp/>.
- É. Contejean, 24th International Conference on Automated Deduction, CADE-24, 2013, <http://www.cade-24.info/>.
- J.-C. Filliâtre, 21st International Conference on Theorem Proving in Higher Order Logics, TPHOLs 2008, Montréal, Québec, Canada.
- J.-C. Filliâtre, 3rd Automated Formal Methods workshop, AFM 2008, Princeton, USA.
- J.-C. Filliâtre, AFM 2009
- J.-C. Filliâtre, PLMMS 2009
- J.-C. Filliâtre, TPHOLs 2009
- J.-C. Filliâtre, VSTTE 2009
- J.-C. Filliâtre, PLPV 2010.
- J.-C. Filliâtre, AFM 2010.
- J.-C. Filliâtre, IWS 2010
- J.-C. Filliâtre, PLPV 2010.
- J.-C. Filliâtre, 2nd conference on Interactive Theorem Proving (ITP 2011).
- J.-C. Filliâtre, workshop Analyze to Compile, Compile to Analyze, ACCA 2011.
- J.-C. Filliâtre, conference Verified Software: Theories, Tools and Experiments, VSTTE 2012.
- J.-C. Filliâtre, conference NASA Formal Methods, NFM 2012.
- J.-C. Filliâtre, 10th Asian Symposium on Programming Languages and Systems, APLAS 2012.
- C. Marché, 7th International Workshop on Rewriting Logic and its Applications, WRLA 2008.
- C. Marché, 22th International Conference on Automated Deduction, CADE 2009.
- C. Marché, 2nd International Conference on Formal Verification of Object-Oriented Software, FoVeOOS 2011, Turin, Italy.
- C. Marché, 23rd International Conference on Automated Deduction, CADE 2011, Wrocław, Poland.
- C. Marché, 1st International Workshop on Intermediate Verification Languages, BOOGIE 2011, affiliated to CADE.
- K. Nguyen, DBPL 2011, 13th International Symposium on Database Programming Languages August 29th, 2011, Seattle, Washington, USA, co-located with VLDB 2011
- K. Nguyen, PADL 2013, 15th International Symposium on Practical Aspects of Declarative Languages, January 21-22, 2013, co-located with POPL 2013
- K. Nguyen, WebDB 2013, 16th International Workshop on the Web and Databases, New York, NY, USA, June 23, 2013, co-located with ACM Sigmod 2013
- C. Paulin, 21st International Conference on Theorem Proving in Higher Order Logics, TPHOLs 2008, Montreal, Quebec, Canada.
- C. Paulin, 10th International Conference on Mathematics of Program Construction, MPC 2010.
- C. Paulin, 2nd conference on Interactive Theorem Proving (ITP 2011).
- C. Paulin, 5th ACM SIGPLAN Workshop on Programming Languages meets Program Verification, PLPV 2011, affiliated

to POPL.

- C. Paulin, 3rd conference on Interactive Theorem Proving, ITP 2012.
- M. Pouzet, Real-Time and Network Systems Conference, 2008.
- M. Pouzet, Real-Time and Network Systems Conference 2009.
- M. Pouzet, MSR 2009.
- M. Pouzet, workshop on Hardware Functional Languages, 2009.
- M. Pouzet, 31st IEEE Real-Time Systems Symposium conference, RTSS 2010.
- M. Pouzet, Formal Methods in Computer Aided Design, FMCAD 2010.
- M. Pouzet, Design, Automation & Test in Europe, DATE 2010.
- M. Pouzet, Conference on Real-Time and Network Systems, RTNS 2010.
- M. Pouzet, workshop of Design Correct Circuits, DCC 2010, affiliated to ETAPS.

Member (national events)

- D. Baelde, Journées Francophones des Langages Applicatifs, JFLA 2012.
- V. Benzaken, Bases de Données Avancées (BDA) 2013.
- V. Benzaken, Bases de Données Avancées (BDA) 2011.
- S. Boldo, Journées Francophones des Langages Applicatifs, JFLA 2011
- S. Conchon, Journées Francophones des Langages Applicatifs, JFLA 2009.
- J.-C. Filliâtre, Inforum 2010.
- L. Mandel, Journées Francophones des Langages Applicatifs, JFLA 2012.
- G. Melquiond, Journées Francophones des Langages Applicatifs, JFLA 2012.
- M. Pouzet, Journées Francophones des Langages Applicatifs, JFLA 2008.
- M. Pouzet, Approches Formelles dans l'Assistance au Développement de Logiciels, AFADL 2008.
- M. Pouzet, Approches Formelles dans l'Assistance au Développement de Logiciels, AFADL 2010.

Evaluation Committees and Invited Expertise

International

- C. Paulin participated to the hiring committee for a senior lecturer position at in Logic of Programs at University of Göteborg in Sweden, 2012.
- C. Paulin participated to the review panels for the German Excellence Initiative proposals for Graduate Schools in informatics, 2011.

National

- V. Benzaken, 2011, member of the AERES evaluation commission for LIF and LSIS CNRS labs.
- V. Benzaken, 2009, member of the commission for "*prime d'excellence scientifique (PES) 27ème section*".
- É. Contejean, member of the "*jury de l'agrégation externe de mathématiques*" as an expert in computer science for the hiring session, 2008-2011.
- C. Marché and S. Boldo, members of the "*jury de l'agrégation externe de mathématiques*" as experts in computer science, since 2012.
- G. Melquiond is an examiner for the computer science entrance exam to École Normale Supérieure since 2010.
- C. Paulin is a member of the "Commission Scientifique", in charge of selecting PhD students, post-doc, invited researchers funded by Inria Saclay - Île-de-France, 2011-2012.
- J.-C. Filliâtre is *correcteur au concours d'entrée à l'École Polytechnique* (computer science examiner for the entrance exam at École Polytechnique) since 2008.
- S. Conchon is *correcteur au concours d'entrée à l'École Polytechnique* (computer science examiner for the entrance exam at École Polytechnique), 2009-2011.

Other evaluation activities

Hiring Committees

- V. Benzaken, Professor position at Paris Sud (2013).

- V. Benzaken, Professor position at Paris Sud (2012).
- V. Benzaken, President of the recruiting commission Assistant Professor position at Paris Sud (2011).
- V. Benzaken, Inria Rocquencourt CR1 hiring committee (2010).
- V. Benzaken, Inria Rocquencourt CR2 hiring committee (2010).
- V. Benzaken, Inria Lille, CR1 hiring committee (2010).
- V. Benzaken, Inria Lille, CR2 hiring committee (2010).
- V. Benzaken, Assistant Professor Paris Sud IUT (2009).
- V. Benzaken, Professor position at INPG (2009).
- V. Benzaken, Inria Saclay, CR2 hiring committee (2008).
- V. Benzaken, Inria de Rennes, CR2 hiring committee (2008).
- S. Boldo, national CR1 and CR2 hiring committee in 2012.
- S. Boldo, Saclay and Sophia-Antipolis CR2 hiring committees in 2013.
- É. Contejean, hiring committee for an assistant professor position at IRCAM & University Paris 6 (Spring 2013).
- S. Boldo, member of hiring committee of a communication engineer (IR-COM1) for the INRIA, 2010.
- C. Marché, M. Pouzet and X. Urbain: hiring committee for one assistant professor position at ENSIE, in Evry (spring 2010).
- M. Pouzet, hiring committee for a full professor position at Ecole Supérieure d'Informatique et Applications de Lorraine (ESIAL) in Nancy (spring 2010).
- L. Mandel, hiring committee for one assistant professor position at ENSIMAG, in Grenoble (spring 2010).
- C. Paulin, Saclay CR2 hiring committee (2008), national DR2 hiring committee (2008, 2009, 2010), Sophia-Antipolis CR2 committee (2009), Nancy-Lorraine CR2 committee (2010).
- C. Paulin, hiring committees of assistant professor positions at ENS Cachan (2009) Ecole des Mines de Nantes (2009) University Paris 7 (2010, 2011, 2013), professor positions at ENS Lyon (2009), ENSEEHT Toulouse (2011) CNAM (2012) ENS Cachan (2013).
- C. Paulin, hiring committees of assistant professor and positions at University Paris-Sud (MCF chaire INRIA 2010, Professor 2012 & 2013), president of an hiring committee for a professor position at University Paris-Sud in 2011.
- X. Urbain, hiring committee for two assistant professor positions at UPB/ENSEIRB-MATMECA, Bordeaux (Spring 2010).
- X. Urbain, hiring committee for an assistant professor position at École Centrale, Paris (Spring 2011).
- S. Boldo was in the committee in charge of selecting an Inria support staff (TR, *technicien de recherche*) for the Saclay finance and accounting service (SAF), 2012.

PhD and Habilitation Juries

- V. Benzaken: president (2) reviewer (6 PhD) examiner (8 PhD -3 HdR)
- S. Boldo: examiner (1)
- J.-C. Filliâtre: reviewer (3 times), examiner (2)
- C. Marché: president (5), reviewer (4), examiner (3)
- C. Paulin: president (2), reviewer (5), examiner (3)
- M. Pouzet: president (2), reviewer (3)

9/ Toccata

Interactions with the social, economic and cultural environment

Industrial Collaborations, Transfer

Industrial contracts are listed in Section 9.19.3.

Direct transfer

- Airbus France expressed in 2009 the wish to integrate our tool Alt-Ergo in its process of certification of the critical softwares in their next generation planes. We thus started the procedure of *qualifying* Alt-Ergo in the sense of the DO-178B norm, which fixes the constraints on software development to achieve certification of an avionics software. This was done as part of the *ADT Alt-Ergo* and also funded by a bilateral contract. The technical documents (functional specifications and benchmark suite) have been accepted by Airbus in 2011. These documents are submitted by Airbus to the certification authorities in 2012.

- Since 2010, Alt-Ergo is used in the Spark Pro toolset, developed by Altran-Praxis, for the engineering of high-assurance software. Alt-Ergo can be used by customers as an alternate prover for automatically proving verification conditions. Its usage is described in the new edition of the Spark book (<http://www.altran-praxis.com/book/>, Chapter "Advanced proof tools")
- since 2010, in the context of the Hi-Lite project, the AdaCore company (Paris) implements a new tool GnatProve which aims at formal verification of Ada programs. They translate annotated Ada code into the Why3 intermediate language and then use the Why3 system to generate proof obligations and discharge them with Alt-Ergo, or other available back-end provers. GnatProve is a prototype that aims at becoming the successor "Spark2014" of Spark (<http://www.open-do.org/2012/11/30/future-version-of-spark-will-be-based-on-ada-2012/>).

Industrial collaborations

- S. Conchon has started a collaboration with S. Krstic and A. Goel (Intel Strategic Cad Labs in Hillsboro, OR, USA) that aims in the development of an SMT-based model checker. With A. Mebsout and F. Zaidi (ForTesSe, LRI), they implement the Cubicle model checker which uses the Alt-Ergo theorem prover to discharge its proof obligations.
- J.-C. Filliâtre and C. Marché started in 2011 a collaboration with D. Mentré at Mitsubishi Electric R&D Centre Europe (Rennes), about the use of the Why3 environment and its back-end provers as an alternative to the built-in prover of Atelier B. This collaboration led first to a publication (197) and then became part of the new ANR project BWare.
- S. Conchon, A. Mebsout and F. Zaidi (ForTesSe team, LRI) continued their collaboration with S. Krstic and A. Goel (Intel Strategic Cad Labs in Hillsboro, OR, USA) that aims in the development of the SMT-based model checker Cubicle (<http://cubicle.lri.fr>).

Standardization efforts

- S. Boldo and G. Melquiond have participated in the revision of the IEEE-754 (1985) standard on floating-point arithmetic. The new 2008 standard has been approved in June and it is the official standard since August 2008. Both names appear in the author list; An article by S. Boldo appears in the bibliography.
- G. Melquiond also participates in the meetings of the IEEE-1788 standardization committee on interval arithmetic. The "Technology Transfer and Innovation" INRIA department is funding his travel expenses till late 2011.

Invited presentations at various Transfer forums

- C. Marché presented the techniques of deductive verification for checking safety properties at the "séminaire de réflexion-programmes du CEA-LIST", Dreux, France, March 25th, 2008.
- C. Marché presented our deductive verification approach for C programs at the "Workshop Airbus/partners on formal verification tools strategy", Toulouse, France, December 4-5, 2008.
- The tools Frama-C, Why and Alt-Ergo were presented at the Imatch day on 23 november 2010, on the themes of security and proof of programs (C. Marché, S. Conchon, C. Paulin) <http://www.inria.fr/centres-de-recherche-inria/saclay-ile-de-france/agenda/imatch-securite-preuve-de-programmes>
- Journées INRIA-Industrie in Toulouse, 2010: Sylvain Conchon presented a demo of the Alt-Ergo theorem prover.

Popularisation of Research Results

Fête de la science and other such events

- F. Plateau and Y. Moy prepared an activity related to logics for the "Fête de la science" 2008. Six team members animated this activity that one hundred children attended to.
- S. Boldo prepared an activity related to programs and astronomy for the event "10e Salon de la culture et des jeux mathématiques" (2009). It is based on an OCaml program that gives an accurate graphical representation of the night sky, from any location on Earth, at any date and time. Three team members animated this activity that was reused for the event "Fête de la science" 2009. Four team members animated this activity.
- C. Auger and S. Conchon gave a talk at "Fête de la science" 2009 about the order of magnitude of problems computer science has to deal with. The goal of this talk was to show that naive brute force algorithms can not solve many problems occurring in practice, even with the help of billions of supercomputers. This talk has also been given by S. Conchon during the award ceremony of "Olympiades de mathématiques" on May 2009.
- Three team members created and animated the event "Salon de la Culture et des Jeux Mathématiques", Paris, May 2010 jointly with Y. Régis-Gianas, pi.r2 team, INRIA Paris-Rocquencourt. This activity was reused for the event "Fête de la science" 2010. Four team members animated this activity for children and the general public.
- S. Boldo, head for the Fête de la science for the LRI laboratory in 2012. The laboratory welcomed both industrials, pupils and general public: 6 different stands, 6 classes, a total of more than 250 visiting persons. Two other team members welcomed the public.

- S. Boldo and A. Charguéraud belong to the organization committee of the *Castor informatique* <http://castor-informatique.fr/>, an international competition to present computer science to pupils (from 6ème to terminale). More than 91,000 teenagers played on the 40 proposed exercises in November 2012.

Talks and documents

- S. Boldo was interviewed in March 2008 by J. Jongwane for a podcast on the interstices web site: <http://interstices.info/a-propos-calcul-ordinateurs>.
- S. Boldo gave a talk at "Unithé ou café" on January 2008 to popularize issues related to floating-point arithmetic flaws to all the INRIA Saclay - Île-de-France staff.
- S. Boldo was invited to write a popular science article about programming in DocSciences, a magazine edited by the "Académie de Versailles". This special issue of November 2008 is co-edited with the INRIA and is about the basics of computer science (241). This article was then put on the popular science web site interstices.
- S. Boldo gave a talk for mathematic and technology secondary school teachers. On June 10th and 16th 2009, the teachers attended several talks in a seminar called "Formation Informatique et Objets Numériques" in order to prepare a computer science option in the secondary schools of the academy of Versailles. A CD was edited by the INRIA with all participants' talks, and the talks are also available on <http://www.inria.fr/rocquencourt/ressources/multimedia/formation-informatique-et-objets-numerique/>.
- S. Boldo gave several talks for mathematic teachers: at the assembly of secondary school teachers on October 14th, 2009, at Interstice on May 10th 2010 (a meeting for teachers about teaching and TICE), at the IUFM on June 3rd 2010.
- G. Melquiond animated the INRIA stand at the European Research Career Fair in Berlin, May 28, 2009.
- S. Boldo is invited speaker on December 8th 2009 at a special day for a hundred secondary school girls (15-16 years old) to promote women in mathematics and computer science.
- S. Boldo wrote an article in 2010 for the popular science web site interstices about the fact that it is always the computer's fault: <http://interstices.info/idee-recue-informatique-18> (242).
- S. Boldo was invited to participate to the web-TV of the Cité des Sciences et de l'Industrie for the show *Qui veut gagner des neurones?* about computer science in 2010: <http://www.universcience.tv/media/1340/l-informatique.html> (243).
- S. Boldo, in collaboration with T. Viéville (INRIA Nancy Grand-Est) wrote two chapters of the book "Introduction à la science informatique", edited by G. Dowek (232, 233). This 2011 book aims at helping the secondary school teachers for the incoming computer science teaching.
- S. Boldo, brief news on "Mathématiques de la planète Terre" <http://mpt2013.fr/meme-les-ordinateurs-ont-des-erreurs/>
- C. Paulin gave a talk at "Unithé ou café" on February 2012 to popularize issues related to proof theory to all the INRIA Saclay - Île-de-France staff.
- C. Paulin was interviewed by 01 Business & Technologies about education in Computer Science in the context of the labex DigiCosme, the paper was published in May 2012.

Management

- Since April 2008, S. Boldo is member of the editorial committee of the popular science web site interstices <http://interstices.info/>.
- From July 2009 to 2011, S. Boldo is elected member of the board of the Animath association that promotes mathematics among young people.
- S. Boldo, scientific head for Saclay for the MECSI group for networking about computer science popularization inside Inria.
- S. Boldo, member of the popularization committee, *comité de médiation scientifique*, of Inria.
- S. Boldo is responsible for a *mission doctorale* for popularization. She is in charge of Li Gong of the LIMSI laboratory.

Contracts and grants

Public contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
ANR	Typex	Université Paris XI	01.2012 / 36 mo.	128.14 k€
ANR	FOST	INRIA	01.2009 / 36 mo.	56.64 k€
DIGITEO	HISSEO	INRIA	09.2008 / 36 mo.	106.32 k€
ANR	Bware	Université Paris XI	09.2012 / 48 mo.	166.99 k€
ANR	DECERT	Université Paris XI	01.2009 / 45 mo.	111.28 k€
ANR	A3PAT	CNRS	12.2005 / 42 mo.	93.50 k€
DIGITEO	PACTOLE	Université Paris XI	10.2009 / 36 mo.	7.00 k€
ANR	CAT	INRIA	12.2005 / 44 mo.	161.41 k€
ANR	CerPAN	CNRS	12.2005 / 42 mo.	56.00 k€
ANR	PARTOUT	Université Paris XI	01.2009 / 48 mo.	71.24 k€
ANR	VERASCO	INRIA	01.2012 / 48 mo.	164.37 k€
Subvention	CeProMi	INRIA	03.2008 / 21 mo.	25.00 k€
Subvention	CONVENTION D'ENSEIGNEMENT CATHER	INRIA	10.2011 / 12 mo.	6.17 k€
DIGITEO	DIM COQUELICOT	INRIA	09.2011 / 36 mo.	102.20 k€
Contrat européen	FVOOS	INRIA	05.2008 / 36 mo.	0.00 k€
Region IDF	HI-LITE	INRIA	05.2010 / 36 mo.	51.59 k€
ANR	U3CAT	INRIA	12.2008 / 36 mo.	123.54 k€
Contrat européen	EIT ICT LABS-KIC 2011	Université Paris XI	01.2011 / 12 mo.	23.81 k€
Contrat européen	EIT ICT LABS-KIC 2012	Université Paris XI	01.2012 / 12 mo.	54.81 k€
ANR	SCALP	CNRS	01.2008 / 48 mo.	18.32 k€
Contrat européen	TYPES	Université Paris XI	09.2004 / 44 mo.	43.00 k€
Subvention	IUF	Université Paris XI	01.2007 / 36 mo.	19.00 k€
ANR	SIESTA	Université Paris XI	12.2007 / 36 mo.	26.35 k€
Subvention	Synchronics	INRIA	01.2008 / 48 mo.	32.00 k€
Private contracts and grants (jan 2008 - jun 2013)				
Type	Name	Managing Institution	Start / Duration	Amount
Industriel	AIRBUS - SPECIFICATION ALT-ERGO	INRIA	08.2010 / 5 mo.	35.00 k€
CIFRE	ADACORE	INRIA	01.2011 / 36 mo.	45.00 k€
CIFRE	DASSAULT-AVIATION	Université Paris XI	02.2005 / 36 mo.	20.00 k€
CIFRE	GEMALTO	Université Paris XI	05.2005 / 80 mo.	3.00 k€
CIFRE	FRANCE-TELECOM	Université Paris XI	01.2006 / 36 mo.	20.00 k€
Industriel	PFC	INRIA	01.2007 / 30 mo.	100.00 k€
CIFRE	ATHIS	Université Paris XI	02.2005 / 36 mo.	25.08 k€
Industriel	GENCOD	Université Paris XI	09.2007 / 24 mo.	79.36 k€

Deductive Program Verification

CAT

Partners: CEA List (Saclay, project leader), INRIA Rennes (Team Lande), Dassault Aviation (Saint-Cloud), Airbus France (Toulouse), Siemens.

See <http://frama-c.cea.fr>

Type: ANR
Amount: 161.41 k€
Duration: 44 months
Scientific director for LRI:
C. Marché

The goal of the project was to develop an open-source toolkit for analysing industrial-size C programs during development, verification, maintenance and evolution. The resulting environment is Frama-C.

CeProMi

Partners: Gallium team (INRIA Rocquencourt), Cassis team (INRIA Nancy), TFC team (LIFC, Besançon), DCS team (VERIMAG, Grenoble)

See <http://www.lri.fr/cepromi/>

Type: ARC Inria
Amount: 25.00 k€
Duration: 21 months
Scientific director for LRI:
C. Marché

The goal was to propose new theoretical bases for proving programs involving memory sharing and side effects (typically, pointer programs in C, objects in OO languages, records with mutable fields in ML).

There were three different levels of studies: extensions of specification languages with appropriate notions of invariants and description of side effects; design of advanced type systems and static analyses for detecting either alias or separation of pointers; design of verification conditions calculi incorporating notions of modules, pointer separation and refinement.

U3CAT

Partners: CEA-List (Saclay, project leader), Lande team (INRIA Rennes), Gallium team (INRIA Rocquencourt), Dassault Aviation (Saint-Cloud), Airbus France (Toulouse), ATOS Origin (Toulouse), CNAM Cedric laboratory (Evry), CS Communication & Systems (Toulouse), Hispano-Suiza/Safran (Moissy-Cramayel).

See <http://frama-c.cea.fr>

Type: ANR
Amount: 123.54 k€
Duration: 36 months
Scientific director for LRI:
Marché

U3CAT (Unification of Critical C Code Analysis Techniques) aims at verification techniques of C programs, and is partly a follow-up of the former CAT project. The main goal of the project is to integrate various analysis techniques in a single framework, and make them cooperate in a sound way. We address the following general issues:

- Verification techniques for floating-point programs;
- Specification and verification of dynamic or temporal properties;
- Combination of static analysis techniques;
- Management of verification sessions and activities;
- Certification of the tools chains for compilation and for verification.

Hi-Lite

Partners: AdaCore (project leader), Altran, Astrium Space Transportation, CEA-LIST, Thales Communications

See <http://www.open-do.org/projects/hi-lite/>

Type: FUI
Amount: 51.59 k€
Duration: 36 months
Scientific director for LRI:
C. Marché

Hi-Lite is a project in the SYSTEMATIC Paris Region French cluster in complex systems design and management. Hi-Lite is a project aiming at popularizing formal methods for the development of high-integrity software. It targets ease of adoption through a loose integration of formal proofs with testing and static analysis, that allows combining techniques around a common expression of specifications. Its technical focus is on modularity, that allows a divide-and-conquer approach to large software systems, as well as an early adoption by all programmers in the software life cycle.

Our involvements in that project include the use of the Alt-Ergo prover as back-end to already existing tools for SPARK/ADA, and the design of a verification chain for an extended SPARK/ADA language to verification conditions, via the Why VC generator.

PFC

Partners: Gemalto, CEA-LIST, Trusted Logic

The PFC project (Plateforme de Confiance, trusted platforms) is a project in the SYSTEM@TIC Paris Region French cluster in complex systems design and management <http://www.systematic-paris-region.org>. This cluster involves industrial groups, SMEs and academic partners in the Paris-Region and is supported by the french government and the regional council.

The goal of the project is the conception and validation of secure and safe embedded applications.

Type: System@tic
Amount: 20.00 k€
Duration: 36 months
Scientific director for LRI:
C. Paulin-Mohring

Automated Deduction

BWare

Partners: Cedric laboratory at CNAM (CPR Team, project leader) ; Inria teams Gallium, Deducteam and Asap ; Mitsubishi Electric R&D Centre Europe, the ClearSy company that develops and maintains Atelier B and the OCamlPro start-up.

See <http://bware.lri.fr>

It is an industrial research project that aims to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the B method and requiring high guarantees of confidence. The methodology used in this project consists in building a generic platform of verification relying on different theorem provers, such as first-order provers and SMT solvers. The variety of these theorem provers aims at allowing a wide panel of proof obligations to be automatically verified by the platform. The major part of the verification tools used in BWare have already been involved in some experiments, which have consisted in verifying proof obligations or proof rules coming from industrial applications. This therefore should be a driving factor to reduce the risks of the project, which can then focus on the design of several extensions of the verification tools to deal with a larger amount of proof obligations.

Type: ANR
Amount: 166.99 k€
Duration: 48 months
Scientific director for LRI:
S. Conchon

DECERT

Partners: IRISA/INRIA Rennes - Bretagne Atlantique (project leader), CEA List, LORIA/INRIA Nancy - Grand Est, , INRIA Sophia Antipolis - Méditerranée, Systeme

See <http://decert.gforge.inria.fr/>

The goal of the project DECERT (DEduction and CERTification) is to design and implement new efficient cooperating decision procedures (in particular for fragments of arithmetics), to standardize output interfaces based on certificates proof objects and to integrate SMT provers with skeptical proof assistants and larger verification contexts such as the Rodin tool for B and the Frama-C/Jessie tool chain for verifying C programs.

Type: ANR
Amount: 111.28 k€
Duration: 45 months
Scientific director for LRI:
S. Conchon

A3PAT

Partners: ENSIIE (project leader), Inria Sophia, Labri, LRI

See <http://a3pat.ensiie.fr/>

Aimed at helping proof assistants with trustworthy decision procedures, in particular by generating proof traces in order to build proof terms.

Type: ANR
Amount: 93.50 k€
Duration: 42 months
Scientific director for LRI:
É. Contejean

Alt-Ergo

Partners: External Collaborators: Airbus France (Toulouse), Dassault Aviation (Saint-Cloud), team Typical (INRIA, École Polytechnique).

See <http://alt-ergo.lri.fr/>

Type: ADT Inria
Amount: Montant k€
Duration: Duree months
Scientific director for LRI:
S. Conchon

The goal is the maturation of the Alt-Ergo prover towards its use in an industrial context in particular for avionics. The expected outcomes of this ADT are the following:

- improving the efficiency of Alt-Ergo;
- fine tuning of Alt-Ergo for the SMT competition;
- generation of counter-examples;
- the qualification of Alt-Ergo for the norm DO-178B.

Verified Libraries and Tools

SCALP

Partners: Verimag (leader), INRIA Sophia-Antipolis (Everest then Marelle team), ENS Lyon, LRI, CNAM.

See <http://scalp.gforge.inria.fr/>

Type: ANR
Amount: 18.32 k€
Duration: 48 months
Scientific director for LRI:
C. Paulin-Mohring

The SCALP project (Security of Cryptographic Algorithms with Probabilities) aims at developing automated tools for the verification of cryptographic systems.

Verasco

Partners: teams Gallium (leader) and Abstraction (Inria Paris-Rocquencourt), Airbus avionics and simulation (Toulouse), IRISA (Rennes), Verimag (Grenoble).

See <http://verasco.imag.fr>

Type: ANR
Amount: 164.37 k€
Duration: 48 months
Scientific director for LRI:
G. Melquiond

The main goal of the project is to investigate the formal verification of static analyzers and of compilers, two families of tools that play a crucial role in the development and validation of critical embedded software. More precisely, the project aims at developing a generic static analyzer based on abstract interpretation for the C language, along with a number of advanced abstract domains and domain combination operators, and prove the soundness of this analyzer using the Coq proof assistant. Likewise, it will keep working on the CompCert C formally-verified compiler, the first realistic C compiler that has been mechanically proved to be free of miscompilation, and carry it to the point where it could be used in the critical software industry.

Coquelicot

Partners: LIX (Palaiseau), University Paris 13

See <http://coquelicot.saclay.inria.fr>

Type: Digiteo
Amount: 102.20 k€
Duration: 36 months
Scientific director for LRI:
S. Boldo

The Coquelicot project aims at creating a modern formalization of the real numbers in Coq, with a focus on practicality (176, 223). This is sorely needed to ease the verification of numerical applications, especially those involving advanced mathematics.

Pactole

Partners: CÉDRIC (CNAM/ENSIIE), LIP6 (UPMC).

See <http://pactole.lri.fr/>

Type: Digiteo
Amount: 7.00 k€
Duration: 36 months
Scientific director for LRI:
E. Contejean

The Pactole project focuses on automation and formal verification for ubiquitous, large scale environments. Tasks include proof automation techniques for distributed systems, verification conditions for fault tolerant distributed systems, specification and design of fundamental services for mobile sensor networks. The principal investigator of Pactole is Xavier Urbain.

Computer Arithmetic

CerPAN

Partners: University Paris 13, INRIA and CNAM

See <http://www-lipn.univ-paris13.fr/CerPAN/>

Type: ANR
Amount: 56.00 k€
Duration: 42 months
Scientific director for LRI:
J.-C. Filliâtre

This project aimed at developing and applying methods which allow to formally prove the soundness of programs coming from numerical analysis techniques. We were more precisely working on problems related to the verification of floating point algorithms.

FOST

Partners: University Paris 13, INRIA Paris - Rocquencourt (team Estime).

See <http://fost.saclay.inria.fr>

Type: ANR
Amount: 56.64 k€
Duration: 36 months
Scientific director for LRI:
S. Boldo

The FOST (Formal prOofs of Scientific compuTation programs) project follows CerPAN's footprints as it aims at developing new methods to bound the global error of a numerical program. These methods will be very generic in order to prove a large range of numerical analysis programs. Moreover, FOST aims at providing reusable methods that are understandable by non-specialists of formal methods.

Hiseo

Partners: CEA List (Saclay, project leader), INRIA Paris-Rocquencourt (Team Gallium).

See <http://hiseo.saclay.inria.fr>

Type: Digiteo
Amount: 106.32 k€
Duration: 36 months
Scientific director for LRI:
S. Boldo

Hiseo project focuses on the problems related to the treatment of floating-point computations in the compilation process, especially in the case of the compilation of critical C code (301, 140).

Data-Centric Languages

Typex

Partners: PPS (CNRS & University Paris Denis Diderot), INRIA Rhône-Alpes (team Tyrex).

See <http://typex.lri.fr/>

Type: ANR
Amount: 128.14 k€
Duration: 36 months
Scientific director for LRI:
V. Benzaken

The goal of this project is to produce a new generation of XML programming languages stemming from the synergy of integrating three approaches into a unique framework: a logical approach, a data-oriented approach and a programming language approach. Languages whose constructions are inspired by the latest results in the PL research; with precise and polymorphic type systems that merge PL

typing techniques with logical-solver-based type inference; with efficient implementations issued by latest researches on tree automata and formally certified by latest theorem prover technologies; with optimizations directly issued from their types systems and the logical formalizations and whose efficiency will be formally guaranteed; with the capacity to specify and formally verify invariants, business rules, and data integrity. Languages with a direct and immediate impact on standardization processes.

Synchronous Programming

PARTOUT

Partners: INRIA Mimosa (project leader), CNAM, LRI.

See <http://www-sop.inria.fr/mimosa/PARTOUT>

Type: ANR
Amount: 71.24 k€
Duration: 48 months
Scientific director for LRI:
L. Mandel

The goal of the project PARTOUT is, from a programming language point of view, to study the impact on programming of the globalization of parallelism which now covers all the spectrum of informatics, ranging from multicore architectures and distributed systems, up to applications deployed on the Web.

SIESTA

Partners: AIRBUS, Turbomeca, Hispano-Suiza, Onera, CEA List, Esterel-Technologies, EADS, LRI, LIG.

See <http://www.siesta-project.com>

Type: ANR
Amount: 26.35 k€
Duration: 36 months
Scientific director for LRI:
M. Pouzet

This project addresses the automated testing of embedded systems implemented in SCADE or Simulink. M. Pouzet is involved on the architecture of the SCADE 6 compiler to integrate verification techniques. The challenge is to take new programming constructs (e.g., hierarchical automata, reset and general forms of clocks) into account to improve verification techniques and modularity.

Synchronics

Partners: INRIA Rhône Alpes (co-leader), IRISA, VERIMAG

See <http://synchronics.inria.fr/>

Type: Action d'Envergure
Inria
Amount: 32.00 k€
Duration: 48 months
Scientific director for LRI:
M. Pouzet

The goal of the project is to propose new languages for the development of embedded systems allowing *from a unique source* to both simulate the system with its environment and generate code. It capitalizes on recent extensions of data-flow synchronous languages (Lucid Synchrone, ReactiveML), a relaxed form of synchrony, and means to mix discrete and continuous systems inside the synchronous model of time.

The project focuses on language extensions to increase modularity, dedicated type systems to ensure safety properties, efficient compilation and the mix of discrete and continuous time.

GENCOD

Partners: Dassault-Aviation, Thales, Esterel-Technologies, TNI, Airbus

The GENCOD project aims at defining methods to certify the Esterel compiler for hardware (Norm. DO 254, the hardware version of DO 178 B used for critical software)

Type: Industriel
Amount: 79.36 k€
Duration: 24 months
Scientific director for LRI:
M. Pouzet

Software Licensing and Distribution

Each software we produce is freely distributed under some open-source licence.

Program Verification

Why3 - The Why3 platform

<http://why3.lri.fr/>

Contact: J.-C. FILLIÂTRE

Why3 is a platform for deductive program verification. It provides a rich language for specification and programming, called WhyML, and relies on external theorem provers, both automated and interactive, to discharge verification conditions. Why3 comes with a standard library of logical theories (integer and real arithmetic, Boolean operations, sets and maps, etc.) and basic programming data structures (arrays, queues, hash tables, etc.). A user can write WhyML programs directly and get correct-by-construction OCaml programs through an automated extraction mechanism. WhyML is also used as an intermediate language for the verification of C, Java, or Ada programs.

Why3 is a complete reimplement of the former Why platform. Among the new features are: numerous extensions to the input language, a new architecture for calling external provers, and a well-designed API, allowing to use Why3 as a software library. An important emphasis is put on modularity and genericity, giving the end user a possibility to easily reuse Why3 formalizations or to add support for a new external prover if wanted.

Krakatoa and Jessie - Tools for Java and C Program Verification

<http://krakatoa.lri.fr>

Contact: C. MARCHÉ

Krakatoa and Jessie are two front-ends of the Why platform for deductive program verification. Krakatoa deals with Java programs annotated in a variant of the The Java Modeling Language. Jessie is a Frama-C plug-in that deals with C programs annotated in the ANSI/ISO C Specification Language (ACSL).

Frama-C - Framework for Modular Analysis of C codes

<http://frama-c.cea.fr/>

Contact: C. MARCHÉ

Frama-C is a tool suite dedicated to the analysis of source code of software written in C. Frama-C gathers several static analysis techniques in a single collaborative framework. The collaborative approach of Frama-C allows static analyzers to build upon the results already computed by other analyzers in the framework. Thanks to this approach, Frama-C provides sophisticated tools, such as a slicer and dependency analysis. The development of Frama-C is led by CEA-List.

CFML - a Characteristic Formula generator for ML

<http://arthur.chargueraud.org/softs/cfml/>

Contact: A. CHARGUÉRAUD

CFML can be used to verify Caml programs using the Coq proof assistant. It is based on the concept of characteristic formulae. CFML consists of two parts: (1) a generator that parses Caml code and produces characteristic formulae expressed as Coq axioms (the generator itself is implemented in Caml) and (2) a Coq library that provides tactics for manipulating characteristic formulae interactively.

Automated Deduction

Alt-Ergo - The Alt-Ergo theorem prover

<http://alt-ergo.lri.fr/>

Contact: S. CONCHON

Alt-Ergo is an open source automatic theorem prover dedicated to program verification. It is an SMT solver based on CC(X): a congruence closure algorithm parameterized by an equational theory X. Alt-Ergo is based on a home-made SAT-solver and implements an instantiation mechanism for quantified formulas. It is used internally in several major verification platforms: Caveat, Frama-C, SparkAda 2005, Spark2014, EasyCrypt.

CiME - CiME, a tool box for automated deduction.

<http://cime.lri.fr>

Contact: E. CONTEJEAN

CiME is a rewriting toolbox. CiME3 is the last generation of it, its main new feature being the production of traces for Coq. The development of CiME3 is now leaded by the CPR team at CNAM/ENSIIE. <http://www.ensiie.fr/~a3pat/online/cime3.php>

CUBICLE - A parallel SMT-based model checker for parameterized systems

<http://cubicle.lri.fr/>

Contact: S. CONCHON

Cubicle is an open source model checker for verifying safety properties of array-based systems. This is a syntactically restricted class of parametrized transition systems with states represented as arrays indexed by an arbitrary number of processes. Cache coherence protocols and mutual exclusion algorithms are typical examples of such systems.

Cubicle model-checks by a symbolic backward reachability analysis on infinite sets of states represented by specific simple formulas, called cubes. Cubicle is based on ideas introduced by MCMT from which, in addition to revealing the implementation details, it differs in a more friendly input language and a concurrent architecture. Cubicle is written in OCaml. Its SMT solver is a tightly integrated, lightweight and enhanced version of Alt-Ergo; and its parallel implementation relies on the Functory library.

Gappa - A tool for certifying numerical applications

<http://gappa.gforge.inria.fr/>

Contact: G. MELQUIOND

Gappa is a tool intended to help verifying and formally proving properties on numerical programs dealing with floating-point or fixed-point arithmetic. It has been used to write robust floating-point filters for CGAL and it is used to certify elementary functions in CRLibm. While Gappa is intended to be used directly, it can also act as a backend prover for the Why software verification platform or as an automatic tactic for the Coq proof assistant.

Synchronous Programming

ReactiveML - The ReactiveML language

<http://rml.inria.fr>

Contact: L. MANDEL

A programming language for implementing interactive systems. ReactiveML combines the temporal expressiveness of synchronous languages with the power of functional programming.

Lucid Synchrone - An experimental language for the implementation of reactive systems.

<http://www.di.ens.fr/~pouzet/lucid-synchrone/>

Contact: M. POUZET

Lucid Synchrone serves as an experimental language and environment for the implementation of reactive systems. It is based on the synchronous model of time as provided by Lustre combined with some features from ML languages. It is a strongly typed, higher-order functional language managing infinite sequences or streams as primitive values. These streams are used for representing input and output signals of reactive systems and are combined through the use of synchronous data-flow primitives à la Lustre. The language is founded on several type systems (e.g., type and clock inference, causality and initialization analysis) which statically guaranty safety properties on the generated code. Programs are compiled into sequential imperative OCaml code.

Data Centric Languages

CDuce - An XML centric Programming Language

<http://www.cduce.org>

Contact: V. BENZAKEN

CDuce is a modern XML-oriented functional language with innovative features. A compiler is available under the terms of an open-source license. CDuce is type-safe, efficient, and offers powerful constructions to work with XML documents. It is included in major Linux distributions. CDuce has a very wide range of applications such as those listed at URL <http://www.cduce.org/appli.html>.

Objective Caml libraries and tools

Bibtex2html - Generator of HTML files from BibTeX bibliographic databases

<http://www.lri.fr/~filliatr/bibtex2html/>

Contact: J.-C. FILLIÂTRE

bibtex2html is a collection of tools for translating from BibTeX to HTML. They allow to produce, from a set of bibliography files in BibTeX format, a bibliography in HTML format. Bibtex2html is distributed as a package in most Linux distributions. Package popularity contests show that it is among the 20% most often installed packages. We estimate that between 10000 and 100000 web pages have been generated using Bibtex2html.

ocamlgraph - Ocaml graph library

<http://ocamlgraph.lri.fr/>

Contact: J.-C. FILLIÂTRE

OCamlgraph is a graph library for Objective Caml. Its contribution is three-fold: (1) an easy-to-use graph data structure together with several operations and algorithms over graphs, (2) several other graph implementations for those not satisfied with the one above and (3) several classic operations and algorithms over graphs. Ocamlgraph is used internally by Frama-C, Why3, Alt-Ergo, etc.

Mlpost - Mlpost, an Objective Caml interface to Metapost

<http://mlpost.lri.fr/>

Contact: J.-C. FILLIÂTRE

Mlpost is an Objective Caml interface to Metapost. It permits the generation of pictures directly from an OCaml program.

Functory - A functor is a place where functional workers are manufacturing programs

<http://functory.lri.fr>

Contact: J.-C. FILLIÂTRE

Functory is a distributed computing library for Objective Caml which facilitates distributed execution of parallelizable computations in a seamless fashion. Further, it is polymorphic, incorporates a robust fault-tolerant mechanism and is already being deployed in real-world applications.

Coq Libraries

Coccinelle - Coccinelle

<http://www.lri.fr/~contejea/Coccinelle/coccinelle.html>

Contact: E. CONTEJEAN

A Coq library for term rewriting. Besides the usual definitions and theorems of term algebras, term rewriting and term orderings, it also models some of the algorithms implemented in the CIME toolbox, such a matching, matching modulo associativity-commutativity, computation of the one-step reducts of a term, RPO comparison between two terms, etc. The RPO algorithm can effectively be run inside Coq,

and is used in the Color library (<http://color.inria.fr/>) as well as for certifying Spike implicit induction theorems in Coq.

ALEA - A library for reasoning on randomized algorithms in Coq

<http://www.lri.fr/~paulin/ALEA/>

Contact: C. PAULIN-MOHRING

This library forms a basis for reasoning on randomized algorithms in the Coq proof assistant. It is developed in the framework of the SCALP project on Security of Cryptographic ALgorithms with Probabilities. It is notably used within the CertiCrypt environment.

Flocq Library - A formalization of floating-point arithmetic in Coq

<http://flocq.gforge.inria.fr/>

Contact: S. BOLDO

Flocq (Floats for Coq) is a floating-point formalization for the Coq system. It provides a comprehensive library of theorems on a multi-radix multi-precision arithmetic. It also supports efficient numerical computations inside Coq. Notably it is used in the CompCert verified compiler project, for proving that compilation of floating-point expression preserves their semantics.

Coq.Interval - The Coq.Interval library for automatically proving bounds of real-valued expressions

<http://www.lri.fr/~melquion/soft/coq-interval/>

Contact: G. MELQUIOND

This library provides tactics for simplifying the proofs of inequalities on expressions of real numbers for the Coq proof assistant.

The Coquelicot library - A user-friendly Coq library for real analysis

<http://coquelicot.saclay.inria.fr/>

Contact: S. BOLDO

An easier way of writing formulas and theorem statements is achieved by relying on total functions in place of dependent types for limits, derivatives, integrals, power series, and so on. To help with the proof process, the library comes with a comprehensive set of theorems that cover not only these notions, but also some extensions such as parametric integrals, two-dimensional differentiability, asymptotic behaviors. It also offers some automations for performing differentiability proofs. Moreover, Coquelicot is a conservative extension of Coq's standard library and we provide correspondence theorems between the two libraries. We have exercised the library on several use cases: in an exam at university entry level, for the definitions and properties of Bessel functions, and for the solution of the one-dimensional wave equation.

9/ Toccata

Training and Education

Schools for Junior Researchers

- Winter School on Verification of Object-Oriented Programs (Viinistu, Estonia, 25-29 January 2009), C. Marché, lecture on the Krakatoa tool (4h course + 1h practical lab, <http://krakatoa.lri.fr/ws/>).
- 1st Asian-Pacific Summer School on Formal Methods (Beijing, China, August 24-31, 2009, <http://formes.asia/cms/coqschool/2009/>), G. Melquiond, lecture on the Ssreflect Coq tactic, and lecture on the Why tool.
- 8th LASER Summer School on Software Engineering <http://laser.inf.ethz.ch/2011/>: "Tools for Practical Software Verification", C. Paulin (4h).
- GDR Informatique-Mathématique school for young researchers: "Arithmétique des ordinateurs et preuves formelles", S. Boldo (2h), G. Melquiond (2h).

- École Jeunes Chercheurs en Programmation (EJCP 2012): J.-C. Filliâtre, "Vérification Dédutive de Programmes avec Why3" (4h, <http://why3.lri.fr/ejcp-2012/>).
- Organization of DigiCosme Spring School 2013, April 22-26, 2013, C. Marché, <http://digicosme.lri.fr/Spring+School+2013>
- DigiCosme Spring School 2013, J.-C. Filliâtre, "Deductive Program Verification with Why3" (3h, <https://www.lri.fr/~marche/DigiCosmeSchool/filliatre.html>)

Graduate Courses

- Master Parisien de Recherche en Informatique (MPRI) <http://mpri.master.univ-paris7.fr/>
 - *Automated Deduction* (<https://wikimpri.dptinfo.ens-cachan.fr/doku.php?id=cours:c-2-5>): É. Contejean, 2008-2009 (12h), 2009-2010 (12h), 2010-2011 (12h), 2011-2012 (12h) 2012-2013 (10h30); X. Urbain, 2009-2010 (12h), 2010-2011 (12h), 2011-2012 (12h) ; S. Conchon 2011-2012 (9h)
 - *Proof assistants*: C. Paulin, 2008-2009 (12h), 2009-2010 (6h), 2010-2011 (6h), 2011-2012 (6h) ; G. Melquiond, 2010-2011 (9h), 2011-2012 (9h)
 - *Synchronous Systems*: M. Pouzet, 2008-2009 (12h), 2009-2010 (12h)
 - *Foundations of proof assistants*: S. Boldo, 2009-2010 (10h), 2010-2011 (2h)
 - *Proofs of Programs* (<http://www.lri.fr/~marche/MPRI-2-36-1/>): C. Marché, 2011-2012 (12h), 2012-2013 (12h) ; G. Melquiond, 2011-2012 (12h), 2012-2013 (12h).
- Professional Master ISIC *Ingenieurie des Systèmes Industriels Complexes* (École Polytechnique, University Paris-Sud 11 and INSTN, <http://www.dix.polytechnique.fr/chaire-systemes-complexes/>)
 - *Synchronous Programming*: Marc Pouzet, 2008-2009 (24h), 2009-2010 (24h)
- Master Informatique (Université Paris-Sud)
 - *Compilation* (M1): C. Paulin, 2010-2011 (50h), D. Baelde 2010-2011 (28h) , S. Conchon, 2011-2012.
 - *Compilation* (Polytech): C. Dross, 2011-2012
 - *Projet de compilation* (M1): R. Bardou, 2010-2011 (64h) A. Tafat, 2011-2012 (33h), M. Iguernelala 2011-2012 (33h)

9/ Toccata

Thesis

Habilitation à Diriger des Recherches	
Name	Defense
Sylvain CONCHON	12.2012
Jean-Christophe FILLIÂTRE	12.2011
Xavier URBAIN	11.2010

Defended thesis				
Name	Start	Defense	Funding	Advisor
Cédric AUGER	01.09.2008	07.02.2013	Alloc. Ministère	POUZET
Romain BARDOU	01.09.2007	14.10.2011	Alloc. Ministère	MARCHÉ
François BOBOT	01.10.2008	12.12.2011	Alloc. Ministère	FILLIÂTRE
Paolo HERMS	01.10.2009	14.01.2013	CEA-List	MARCHÉ
Thierry HUBERT	01.10.2004	20.06.2008	CIFRE Dassault-Aviation	MARCHÉ
Mohamed IGUERNELALA	01.10.2009	10.06.2013	Alloc. Ministère	CONCHON, CONTEJEAN
Johannes KANIG	01.09.2007	26.11.2010	CDD sur contrat INRIA	PAULIN-MOHRING, FILLIÂTRE
Stéphane LESCUYER	16.07.2007	04.01.2011	CDD sur contrat INRIA	CONTEJEAN, CONCHON
Yannick MOY	01.12.2005	15.01.2009	CIFRE France Telecom	MARCHÉ
Thi Minh Tuyen NGUYEN	01.02.2009	11.06.2012	Contrat Digeo-Inria	MARCHÉ, BOLDO
Florence PLATEAU	01.10.2005	06.01.2010	Alloc. Ministère	POUZET, MANDEL
Nicolas ROUSSET	01.10.2004	30.06.2008	CIFRE Gemalto	MARCHÉ
Matthieu SOZEAU	01.10.2005	08.12.2008	Alloc. Ministère	PAULIN-MOHRING
Asma TAFAT-BOUZID	01.10.2009	06.09.2013	Alloc. Ministère	MARCHÉ

Thesis in progress			
<i>Name</i>	<i>Start</i>	<i>Funding</i>	<i>Advisor</i>
Martin CLOCHARD	14.09.2013	E.N.S. Paris	MARCHÉ
Claire DROSS	01.01.2011	CIFRE AdaCore	MARCHÉ, PASKEVICH
Stefania DUMBRAVA	01.10.2012	Alloc. Ministère	BENZAKEN, CONTEJEAN
Léon GONDELMAN	01.10.2013	Contrat ANR BWare	FILLIÂTRE, PASKEVICH
Catherine LELAY	03.10.2011	contrat Digiteo-Inria	BOLDO, MELQUIOND
Alain MEBSOUT	01.10.2011	Alloc. Ministère	CONCHON

9/ VALS

Strategy and five-year project

Following the general policy of the LRI that suggests to group similar activities in larger teams, we decided to join the former teams ForTesSE and Toccata. The name of this new team is VALS, standing for "Verification/Validation of Algorithms, Languages and Systems". We detail below why this fusion makes sense in a scientific point of view.

Self Assessment

Strengths: One of the particular strengths of both former teams ForTesSE and Toccata are their tradition of combining theory and practice, fundamental and applied research. Their research ranges from semantic models for specification- and programming languages, over concrete know-how in automated and interactive theorem-prover technology, down to the design and implementation of recognized tools and tool-chains for a variety of verification techniques. Successful applications, partly in collaboration with industrial partners, demonstrate that VALS will belong to the global players in the field of applied formal methods.

Both former parts of the VALS team have a strong national and international network with academic and industrial partners. We engage in various ANR and European projects. We also have intense local cooperation with major scientific players on the plateau de Saclay such as the CEA; here lies the key for its success in the development of recognized formal methods tools in an academic environment, together with the fact that it attracted a high number of permanent researchers.

Both former parts of VALS have a strong publication record and a high academic recognition in their respective fields, which is reflected in the participation of numerous program committees and conference organizations.

We'd like to add that we enjoy our collaborative style of research and the vividness of our group.

Weaknesses: While VALS has a clear focus on the foundational research axes, it can be asserted that its efforts in the various application domains is quite scattered driven by a perhaps too large variety of partnerships and collaborations. It would be desirable if the number of collaborations could be reduced to a smaller number of larger/more intensive partnerships.

With respect to the former Toccata part of the VALS team, it was criticized in the past that its collaborations are too French-centric. It was also recommended to address fundamental computing trends like concurrency more actively.

With respect to the former ForTesSE part of the VALS team, it can be criticized that its permanent staff is slightly over-aged, and needs a more active recruiting strategy to attract strong personal and to achieve a size which is more sane. It is particularly desirable that full-time researchers join the team on testing issues.

In order to maintain the quality of tools and documentation, the team should be reinforced by engineers.

Opportunities: The world of computing is changing: becoming ubiquitous, there are larger, more complex and more safety- and security-critical software systems whose quality must be assured by appropriate verification technologies. This is reflected by the growing demand for formal certification processes, e.g. Common Criteria ISO/IEC 15408 require the use of formal methods, both in Test and Proof, as developed in VALS.

Finally, it can be observed that there is for all tools (Frama-C, SparkAda, Isabelle, HOL-TestGen) an increasing number of users — reflected both by downloads and mailing list traffic.

New computing architectures — parallel / grid / cloud — represent new ways to master the inherent complexity of symbolic computing as is fundamental for the technologies developed in VALS. Such changes of basic technologies will have a profound effect both on verification methods, their demand by industrial partners, as well as their implementation.

Last but not least, we view the changes of the academic environment (catchword: Université Paris-Saclay) as a means to integrate verification engineering into traditional software engineering, which can be anchored more intensively into the bachelor and master programme of this institution — a way, to instruct and attract new scientific staff.

Threats: Advancing both fundamental research *and* tool development in an academic environment puts a team inevitably under a certain stress: Development of research tools is time-consuming and not always rewarding in terms of publications. While both former parts of VALS managed this balancing act quite well in the past, it can be safely stated that the complexity of underlying technology (e.g. multi-core architectures) and the demands of wider user groups (user interfaces, documentation) is growing. There is a perceivable threat that in the competition with industrial research institutions such as Microsoft Research, VALS might be outperformed simply by their investments both in terms of time and money. Just an example for the kind of concurrency we face: the white-box fuzz-testgeneration tool SAGE uses a ca. 100 man year effort involving a massive parallel server farm to solve billions of constraints by Z3; the approach is used to systematically detect errors in Win7, Windows and Office.

As mentioned earlier, it is particularly difficult to attract PhD students and scientific staff that fits into our profile: the necessary combination of mathematics, logic and software engineering is difficult to find on the national and international market of applicants.

In principle, the underlying technologies of our research are remarkably computing intensive, which is a problem when scaling-up to industrial size systems. An obvious answer to this threat are new computing paradigms (massive parallel computing, multi-core and grid computing); in order to cope with these trends, additional training and personnel will be necessary.

Strategy

Why does the fusion make sense? Test and proof, originally perceived as adversaries, have a lot in common in leading edge approaches: as “formal methods” (FM), they have both their roots in logic and discrete mathematics, and they share an interest in formal semantics for programming and specification languages, in modeling-approaches for programs and systems, as well as constraint-solving technologies and theorem provers. This mutual interest is reflected by recent collaborations between Toccata and ForTesSE (the Cubicle project). Last but not least, we identified a set of challenges that both former parts of the team would like to address together, listed below.

General objectives. We identified the following general trends in the scientific community that corresponds to our potential in the new VALS team:

1. making verification an easier to use, more wide-spread technology ;
2. gaining experience in non-standard application domains, for example hybrid and concurrent systems ;
3. advancing the prover technology: e.g. by non-linear arithmetic and parallel prover design ;
4. combining test and proof, e.g. by invariant-generation, verified optimized test-generations, etc. ;
5. combining proofs and probability.

We believe that the fused VALS team is an adequate structure, joining complementary skills and expertise of its members, to address these objectives. The detailed scientific programme below corresponds to

the way we plan to implement solutions to these objectives.

Scientific Programme

The scientific programme of VALS is structured into six activities. We detail each of these activities below, together with the list of participants. We then provide a list of a few challenges that we want to address in the future. The interest in those challenges is shared between the former parts of the team. We then discuss the application domains we target, and finally give a few elements of positioning.

Activities

Automated Deduction. Participants: S. Conchon (contact), F. Zaïdi, E. Contejean, G. Melquiond, A. Paskevich.

Automated Theorem Proving and its applications will remain an important activity of the team. This includes research around satisfiability modulo theories (Alt-Ergo prover), numerical constraint solving (Gappa solver), and applications like SMT-based model-checking (Cubicle).

Verified Computer Arithmetic. Participants: S. Boldo (contact), G. Melquiond, C. Marché, B. Wolff.

The research around numerical programs took a lot of importance in the past 5 five years in particular in Toccata. We want to pursue these efforts, towards several directions such as the verification of numerical analysis systems, hybrid systems.

Formalisation of Languages. Participants: B. Wolff (contact), E. Contejean (contact), A. Charguéraud, D. Longuet, V. Benzaken, Ch. Paulin, C. Marché, S. Boldo.

Formalizing in a broad sense is indeed an activity of all members of former teams, in particular using assistants like Coq and Isabelle. It will continue in the future, for formalizing semantics of languages, concurrency, mathematical/numerical theories, etc.

Data-Centric Languages and Systems. Participants: V. Benzaken (contact), K. Nguyen, E. Contejean. This activity aims at designing and developing programming languages as well as systems that seriously take into account massive data. This includes improving existing languages and systems. Ultimately it aims at providing formally verified implementations of data intensive management systems.

Formal Model-based Testing. Participants: F. Zaïdi (contact), B. Wolff, D. Longuet, F. Voisin, M.-C. Gaudel. Testing will remain a strong research activity of the team. Important directions will be to scale up testing techniques by handling efficiently the concurrency aspects of distributed systems (for instance Web services, wireless self-organised networks, etc.) as well as by advancing symbolic and probabilistic approaches. Moreover, we will investigate how to overcome the infeasible paths issues for the test of C programs by finding suitable combinations with static analysis methods.

Deductive Program Verification. Participants: J.-C. Filliâtre (contact), A. Charguéraud, A. Paskevich, C. Marché, G. Melquiond, Ch. Paulin, B. Wolff.

Our approach of deductive program verification is in need for improved techniques for modular reasoning, support for genericity, for higher-order programs, for refinement-based approaches. This is a key towards scaling-up, in particular via the development of reusable verified libraries.

Transverse challenges we want to address, shared by both former teams

Non-linear arithmetic. Critical software often involves numerical computations on physical quantities. *Hybrid systems* are those which mix continuous quantities and discrete ones. Such a system can be modeled typically by transitions systems guarded by numerical constraints. In all cases, the constraints involved are usually non-linear ones, hence both in the contexts of testing and proving, it is desirable to rely on automated decision procedures able to check the satisfiability of such kind of constraints.

Parallelism and verification. The challenge raised by parallelism in the context of verification is two-fold: a challenge as a target as well as an implementation means of verification tools. Testing of concurrent programs requires the definition of efficient architectures for distributed testing. Besides the challenge of modeling concurrence, already addressed in the activity *Formalisation of Languages*, there is the necessity to profit from advances in recent hardware: since 2005, there are no further increases of CPU clock-rates; increasing computing power can only be gained by addressing multi-core and grid computing platforms. This represents a sensible paradigm shift both in algorithmic design as well as system architecture.

Combination of dynamic and static analysis. Combining the respective power of dynamic methods (test, run-time checking) and static analysis is an interesting research direction per se, and is certainly a way to leverage adoption of formal methods in industry. It is indeed required in certification processes in industry. We already have short-term plans to go in such a direction, in the context of platforms like Spark2014 for Ada, Frama-C for C code (and its executable-ACSL specification language), but also in our own platform Why3 for which we plan to provide an environment for directly executing annotated programs.

Verified languages, systems and tools An emerging trend is the verification of the analysis tools themselves, as exemplified by the CompCert verified compiler. The assurance level provided by a system is directly related to the size of its *Trusted Code Base*, i.e. the core of the system that is not verified, the remaining being verified on top of that core. Libraries (e.g. Flocq, ALEA) and tools (e.g. HOL-TestGen) built on top of assistants (e.g. Coq, Isabelle/HOL) have a small TCB, whereas standalone tools (e.g. automated theorem provers) have a large one. This challenge aims at reducing the TCB of such tools to small cores, thus producing “verified” tools. We target the development of verified theorem provers, verification condition generators, interpreters, compilers including compilers for data-centric languages, etc.

Probabilities and Verification Scaling-up to large size systems is always a challenge for formal methods. The use of randomized methods is a very promising approach to solve scaling-up issues, ensuring a probabilistic guarantee of the results. Randomized methods have a great potential to apply on many domains including formal testing and proving. Besides, studying verification of randomized programs and systems, which have important application in security, must be continued.

Application areas

VALS will continue to seek for academic and industrial partners to advance and apply its technologies; this covers in particular projects concerning code-verification (in particular numeric algorithms involving floats), security infrastructures, web services, embedded and operating systems, etc. We will try to find more strategic partnerships with companies and larger shares in research projects.

Positioning in the local, national and international context

The domain of formal methods for software engineering is historically a major axis of research in the LRI. This domain of research is important in the context of the institutional evolutions of the “Plateau de Saclay”, in the recent past, the present and for the future. In the past years, the RTRA Digeo played an important role for the development of collaborative research on the Plateau, and Software Engineering was one of its seven themes of its research programme. In the present, software was also important in the “investissements d’avenir”: SciLex is one of the three action lines of the Labex DigiCosme, centered on the reliability of software ; the IRT SystemX, which is more focused on industrial applications, has one theme around embedded systems, where the same problematic appears. We are strongly involved in all these actions.

The near future is the creation of the Université Paris-Saclay, and the creation of a large computer science department. The interest in formal software engineering methods will be shared by several institutions: Inria Saclay, CEA, LSV, ENSTA ParisTech, etc. The new VALS team aims at playing a central role in this future join of forces on the Plateau. Also, we are strongly involved in the new Master programme of the future STIC department. This would be a new mean to attract students, e.g. from engineering schools, to do a PhD thesis.

Our strategy also fits in the national context. We are members of both GDR of CNRS “Génie de la Programmation et du Logiciel” and “Informatique Mathématique”. We will continue collaborations with

many teams in France. At the international level, we want to develop our contacts with major institutions and sites of our domain, such as Microsoft Research, ETH Zürich, Imperial College London, etc. Our involvement in the IFIP WG 1.9/2.5 is also representative of our involvement in world-wide trends.

We plan to continue and improve our collaborations with industrial partners, in particular the companies that promote formal methods. These collaborations are not only a precious source of concrete challenges and real case studies: they are a key for the spreading and the transfer of our methods and tools in the industry.



FORTESSE team publications

Journal articles

Major international journals

- (1) S. Böhme, M. Moskal, W. Schulte, and Burkhart Wolff. HOL-Boogie — an interactive prover-backend for the verified C compiler. *Journal of Automated Reasoning (JAR)*, 44(1–2):111–144, 2009.
- (2) A. D. Brucker and Burkhart Wolff. An extensible encoding of object-oriented data models in HOL with an application to IMP++. *Journal of Automated Reasoning (JAR)*, 41(3–4):219–249, 2008. Serge Autexier, Heiko Mantel, Stephan Merz, and Tobias Nipkow (eds).
- (3) A. D. Brucker and Burkhart Wolff. Semantics, calculi, and analysis for object-oriented specifications. *Acta Informatica*, 46(4):255–284, 2009.
- (4) A. D. Brucker and Burkhart Wolff. On theorem prover-based testing. *Formal Aspects of Computing (FAOC)*, 25(3):683–731, 2012.
- (5) A. Cavalcanti and Marie-Claude Gaudel. Testing for refinement in Circus. *Acta Informatica*, 48(2):97–147, 2011.
- (6) M. Daum, J. Dörrenböcher, and Burkhart Wolff. Proving fairness and implementation correctness of a microkernel scheduler. *Journal of Automated Reasoning*, 42(2–4):349–388, 2009.
- (7) R. Mateescu, Pascal Poizat, and G. Salaün. Adaptation of Service Protocols using Process Algebra and On-the-Fly Reduction Techniques. *IEEE Transactions on Software Engineering*, 38(4):755–777, 2011.
- (8) Alain Denise, Marie-Claude Gaudel, Sandrine-Dominique Gouraud, R. Lassaigne, Johan Oudinet, and Sylvain Peyronnet. Coverage-biased random exploration of large models and application to testing. *STTT, International Journal on Software Tools for Technology Transfer*, 14(1):73–93, 2012.
- (9) Delphine Longuet, M. Aiguier, and P. Le Gall. Proof-guided test selection from quantifier-free first-order specifications with equality. *Journal of Automated Reasoning, special issue on Tests and Proofs*, 45(4):437–473, 2009.
- (10) Johan Oudinet, A. Denise, and Marie-Claude Gaudel. A new dichotomic algorithm for the uniform random generation of words in regular languages. *Theoretical Computer Science*, 502:165–176, 2012.
- (11) A. C. Viana, S. Maag, and F. Zaïdi. One step forward: Linking wireless self-organising networks validation techniques with formal testing approaches. *ACM Computing Survey*, 43(2):1–39, January 2011.

Other journals

- (12) M. Aiguier and Delphine Longuet. Some general results about proof normalization. *Logica Universalis*, 4(1):1–29, 2010.
- (13) Johan Oudinet. Exploration aléatoire de modèles. *Journal Européen des Systèmes Automatisés (JESA)*, 43(7–9):905–919, November 2009. Colloque francophone sur la Modélisation des Systèmes Réactifs.

Invited conferences

- (14) A. Cavalcanti and Marie-Claude Gaudel. Specification coverage for testing in Circus. In *Unifying Theories of Programming 2010*, volume 6445 of *Lecture Notes in Computer Science*, pages 1–45, Shanghai, China, November 2010. Springer Verlag. Invited lecture.
- (15) Marie-Claude Gaudel. Checking models, proving programs, and testing systems. In M. Gogolla and Burkhart Wolff, editors, *International Conference on Tests and Proofs*, volume 6706 of *Lecture Notes in Computer Science*, pages 1–13. Springer, 2011. Invited lecture.

- (16) Marie-Claude Gaudel. Counting for random testing. In Burkhart Wolff and Fatiha Zaïdi, editors, *International Conference on Testing Software and Systems*, volume 7019 of *Lecture Notes in Computer Science*, pages 1–8. Springer Berlin/Heidelberg, 2011. Invited lecture.
- (17) Marie-Claude Gaudel, Alain Denise, Sandrine-Dominique Gouraud, R. Lassaigne, Johan Oudinet, and Sylvain Peyronnet. Coverage-biased random exploration of large models. In *ETAPS Workshop on Model Based Testing*, volume 220 of *Electronic Notes in Theoretical Computer Science*, pages 3–14, March 2008. Invited lecture.

Conference articles

Major international conferences and workshops

- (18) S. Böhme, R. Leino, and Burkhart Wolff. HOL-Boogie — an interactive prover for the Boogie program verifier. In O. A. Mohamed, C. A. Muñoz, and S. Tahar, editors, *21th International Conference on Theorem proving in Higher-Order Logics (TPHOLs 2008)*, volume 5170 of *Lecture Notes in Computer Science*, pages 150–166, Montreal, Canada, 2008. Springer-Verlag.
- (19) A. D. Brucker, L. Brügger, P. Kearney, and Burkhart Wolff. Verified firewall policy transformations for test case generation. In *International Conference on Software Testing*, pages 345–354. IEEE Computer Society, 2010.
- (20) A. D. Brucker, L. Brügger, P. Kearney, and Burkhart Wolff. An approach to modular and testable security models of real-world health-care applications. In *Proceedings of the ACM Symposium on Access control models and technologies*, pages 133–142. ACM, 2011.
- (21) A. D. Brucker, L. Brügger, and Burkhart Wolff. Model-based firewall conformance testing. In K. Suzuki and T. Higashino, editors, *Testcom/FATES 2008*, volume 5047 of *Lecture Notes in Computer Science*, pages 103–118, Tokyo, Japan, 2008. Springer-Verlag.
- (22) A. D. Brucker, Abderrahmane Feliachi, Yakoub Nemouchi, and Burkhart Wolff. Test program generation for a microprocessor — a case-study. In *Proceedings of the 6th Intl. Conf. on Test and Proof (TAP '13)*, volume 7942 of *Lecture Notes in Computer Science*, pages 76–95. Springer, 2013.
- (23) A. D. Brucker and Burkhart Wolff. Extensible universes for object-oriented data models. In J. Vitek, editor, *Proceedings of the European Conference of Object-Oriented Programming (ECOOP 2008)*, volume 5142 of *Lecture Notes in Computer Science*, pages 438–462, Paphos, Cyprus, July 2008. Springer-Verlag.
- (24) A. D. Brucker and Burkhart Wolff. A formal proof environment for UML/OCL. In *Proceedings of Formal Aspects of Software Engineering (FASE 2008)*, volume 4961 of *Lecture Notes in Computer Science*, pages 97–101. Springer Berlin / Heidelberg, 2008.
- (25) A. D. Brucker and Burkhart Wolff. HOL-TestGen: An interactive test-case generation framework. In M. Chechik and M. Wirsing, editors, *Fundamental Approaches to Software Engineering*, volume 5503 of *Lecture Notes in Computer Science*, pages 417–420, Heidelberg, 2009. Springer-Verlag.
- (26) A. Carneiro, T. Hérault, T. Largillier, S. Peyronnet, and F. Zaïdi. Supple: A flexible probabilistic data dissemination protocol for wireless sensor networks. In *MSWIM'2010 - The 13th ACM International Conference on Modeling Analysis and Simulation of Wireless and Mobile Systems*, pages 385–393, Turkey, October 2010. ACM.
- (27) A. Cavalcanti, Marie-Claude Gaudel, R. Hierons, and M. Nuñez. Conformance relations for distributed testing based on CSP. In Fatiha Zaïdi and Burkhart Wolff, editors, *International Conference on Testing Software and Systems*, volume 7019 of *Lecture Notes in Computer Science*, pages 48–63. Springer, 2011.
- (28) A. Cavalli, T.-D. Cao, W. Mallouli, E. Martins, A. Sadovykh, S. Salva, and F. Zaïdi. Webmov : A dedicated framework for the modelling and testing of web services. In *ICWS 2010 - IEEE International Conference on Web Services*, pages 377–384, Miami, July 2010. IEEE Computer Society.
- (29) M. Daum, J. Dörrenbächer, M. Schmidt, and Burkhart Wolff. A verification approach for system-level concurrent programs. In *Verified Software: Theories, Tools, Experiments*, volume 5295 of *Lecture Notes in Computer Science*, pages 161–176. Springer Berlin / Heidelberg, September 2008.

- (30) H. P. de León, S. Haar, and Delphine Longuet. Conformance relations for labeled event structures. In *Test and Proof*, volume 7305 of *Lecture Notes in Computer Science*, pages 83–98. Springer, 2012.
- (31) Abderrahmane Feliachi and H. L. Guen. Generating transition probabilities for automatic model-based test generation. In *International Conference on Software Testing, Verification and Validation (ICST)*, pages 99–102, Los Alamitos, CA, USA, April 2010. IEEE Computer Society.
- (32) Abderrahmane Feliachi, Marie-Claude Gaudel, and Burkhart Wolff. Isabelle/Circus: A process specification and verification environment. In *VSTTE proceedings*, volume 7152 of *Lecture Notes in Computer Science*, pages 243–260, 2012.
- (33) Delphine Longuet and M. Aiguier. Integration testing from structured first-order specifications via deduction modulo. In *International Conference Theoretical Aspects of Computing*, volume 5684 of *Lecture Notes in Computer Science*, pages 261–276. Springer, 2009.
- (34) Huu Nghia Nguyen, Pascal Poizat, and Fatiha Zaïdi. A symbolic framework for the conformance checking of value-passing choreographies. In *International Conference on Service Oriented Computing (ICSOC 12)*, volume 7636 of *Lecture Notes in Computer Science*, pages 525–532. Springer, November 2012.
- (35) L. Bentakouk, P. Poizat, and F. Zaïdi. A formal framework for service orchestration testing based on symbolic transition systems. In *21th IFIP International Conference on Testing of Communicating Systems*, volume 5826 of *Lecture Notes in Computer Science*, pages 16–32, Eindhoven, November 2009. Springer.
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- (37) Makarius Wenzel. Shared-memory multiprocessing for interactive theorem proving. In *ITP*, volume 7998 of *Lecture Notes in Computer Science*, pages 418–434. Springer, 2013.
- (38) Sylvain Conchon, A. Goel, S. Krstic, Alain Mebsout, and Fatiha Zaïdi. Cubicle: A parallel SMT-based model checker for parameterized systems. In *24th International Conference, CAV 2012*, volume 7358 of *LNCS*, pages 718–724, Berkeley, July 2012. Springer.
- (39) Y. Yan, Pascal Poizat, and L. Zhao. Repairs vs. Recomposition for Broken Service Compositions. In *Proceedings of the International Conference on Service Oriented Computing (ICSOC 10)*, volume 6470 of *Lecture Notes in Computer Science*, pages 152–166. Springer, 2010.
- (40) Y. Yan, Pascal Poizat, and L. Zhao. Self-Adaptive Service Composition through Graphplan Repair. In *Proceedings of the International Conference on Web Services (ICWS 10)*, *work-in-progress papers*, pages 624–627. IEEE Computer Society, 2010.

Major national conferences and workshops

- (41) Rania Kheffifi, P. Buche, J. Dibie-Barthelemy, and Fatiha Saïs. Détection de redondances dans les tableaux guidée par une ontologie. In A. Khenchaf and P. Poncelet, editors, *EGC'11: Extraction et Gestion des Connaissances*, *Revue des Nouvelles Technologies de l'Information*, pages 563–568, Brest, France, jan 2011. Hermann-Editions.
- (42) Rania Kheffifi, Pascal Poizat, and Fatiha Saïs. Modélisation et interrogation d'espaces d'informations personnelles sensibles au contexte. In *Extraction et gestion des connaissances (EGC'2012)*, volume RNTI-E-23 of *Revue des Nouvelles Technologies de l'Information*, pages 573–574. Hermann-éditions, 2012.

Other conferences and workshops

- (43) B. Barras, L. D. C. González-Huesca, H. Herbelin, Y. Régis-Gianas, E. Tassi, Makarius Wenzel, and Burkhart Wolff. Pervasive parallelism in highly-trustable interactive theorem proving systems. In *MKM/Calculus/DML*, volume 7961 of *Lecture Notes in Computer Science*, pages 359–363. Springer, 2013.
- (44) F. Bassino, Julien Clément, Julien Fayolle, and P. Nicodème. Construction for clumps statistics. In *Fifth Colloquium on Mathematics and Computer Science*, pages 179–194, 2008.

- (45) A. D. Brucker, L. Brügger, and Burkhart Wolff. Verifying test-hypotheses — an experiment in test and proof. In B. Finkbeiner, Y. Gurevich, and A. K. Petrenko, editors, *Model-based Testing*, volume 202 of *Electronic Notes in Theoretical Computer Science*, pages 15–28, Budapest, Hungary, 2008. Elsevier Science Publishers.
- (46) P. Buche, J. Dibié-Barthelemy, Rania Kheffi, and Fatiha Saïs. An Ontology-Based Method for Duplicate Detection in Web Data Tables. In A. Hameurlain, S. W. Liddle, K.-D. Schewe, and X. Zhou, editors, *Database and Expert Systems Applications*, volume 6860 of *LNCS*, pages 511–525, Toulouse, France, aug 2011. Springer-Verlag.
- (47) A. Cavalcanti and M.-C. Gaudel. A note on traces refinement and the conf relation in the unifying theories of programming. In *Unifying Theories of Programming*, volume 5713 of *Lecture Notes in Computer Science*, pages 42–61, Trinity College Dublin, September 2008. Springer Verlag.
- (48) A. Cavalli, S. Maag, E. M. de Oca, and F. Zaïdi. A formal passive testing approach to test a MANET routing protocol. In *5th IEEE PerCom Workshop on Pervasive Wireless Networking*, pages 1–6, Texas, March 2009. IEEE.
- (49) M. E. Maarabani, A. Cavalli, I. Hwang, and Fatiha Zaïdi. Verification of interoperability security policies by model checking. In *High Assurance Systems Engineering (HASE)*, pages 1–7. IEEE, November 2011.
- (50) D. Matthews and M. Wenzel. Efficient parallel programming in Poly/ML and Isabelle/ML. In *ACM SIGPLAN Workshop on Declarative Aspects of Multicore Programming (DAMP 2010)*, pages 53–62. ACM, 2010.
- (51) Abderrahmane Feliachi, Marie-Claude Gaudel, and Burkhart Wolff. Unifying theories in Isabelle/HOL. In *Unifying Theories of Programming 2010*, volume 6445 of *Lecture Notes in Computer Science*, pages 188–206, Shanghai, China, November 2010. Springer Verlag.
- (52) Delphine Longuet. Global and local testing from message sequence charts. In *ACM Symposium on Applied Computing*, pages 1332–1338. ACM, 2012.
- (53) F. Zaïdi, A. Cavalli, and E. Bayse. Network protocol interoperability testing based on contextual. In *24th Annual ACM Symposium on Applied Computing*, pages 2–7, Hawaii, USA, March 2009. ACM.
- (54) Fatiha Zaïdi, Mounir Lallali, and S. Maag. A component based testing technique for a MANET routing protocol. In *ACS/IEEE International Conference on Computer Systems and Applications*, pages 1–7. IEEE, May 2010.
- (55) Huu Nghia Nguyen, Pascal Poizat, and Fatiha Zaïdi. Online verification of value-passing choreographies through property-oriented passive testing. In *14th IEEE International High Assurance Systems Engineering Symposium (HASE 12)*, pages 106–113. IEEE Computer Society, November 2012.
- (56) Huu Nghia Nguyen, Pascal Poizat, and Fatiha Zaïdi. Passive conformance testing of service choreographies. In ACM, editor, *27th ACM Symposium on Applied Computing (SAC 2012)*, pages 1528–1535. ACM, March 2012.
- (57) Johan Oudinet, Alain Denise, and Marie-Claude Gaudel. A new dichotomic algorithm for the uniform random generation of words in regular languages. In *Conference on random and exhaustive generation of combinatorial objects (GASCom)*, Montreal, Canada, September 2010. 10 pages.
- (58) Johan Oudinet, Alain Denise, Marie-Claude Gaudel, R. Lassaigne, and Sylvain Peyronnet. Uniform Monte-Carlo model checking. In *Fundamental Approaches to Software Engineering*, volume 6603 of *Lecture Notes in Computer Science*, pages 127–140. Springer Verlag, 2011.
- (59) Julien Fayolle. Analysis of the size of antidictionary in DCA. In *Combinatorial Pattern Matching*, volume 5029 of *Lecture Notes in Computer Science*, pages 107–117. Springer, 2008.
- (60) Makarius Wenzel. Isabelle as document-oriented proof assistant. In *Conference on Intelligent Computer Mathematics / Mathematical Knowledge Management (CICM/MKM 2011)*, volume 6824 of *Lecture Notes in Computer Science*, pages 244–259. Springer, 2011.
- (61) Makarius Wenzel. Asynchronous proof processing with Isabelle/Scala and Isabelle/jEdit. In C. S. Coen and D. Aspinall, editors, *User Interfaces for Theorem Provers (UITP 2010)*, *FLOC 2010 Satellite Workshop*, volume 285 of *Electronic Notes in Computer Science*, pages 101–114. Elsevier, July 2012.

- (62) Makarius Wenzel, Isabelle/JEdit — a Prover IDE within the PIDE framework. In J. J. et al, editor, *Intelligent Computer Mathematics — 11th International Conference (CICM/MKM 2012)*, volume 7362 of LNCS, pages 468–471. Springer, 2012.
- (63) Marie-Claude Gaudel. Software testing based on formal specification. In P Borba, A. Cavalcanti, A. Sampaio, and J. Woodcock, editors, *Testing Techniques in Software Engineering, Second Pernambuco Summer School on Software Engineering, PSSE 2007, December 3-7, 2007, Revised Lectures*, volume 6153 of *Lecture Notes in Computer Science*, pages 215–242. Springer, 2010.
- (64) Matthias P. Krieger, A. Knapp, and Burkhard Wolff. Automatic and efficient simulation of operation contracts. In E. Visser, J. Jarvi, and G. Economopoulos, editors, *Ninth International Conference on Generative Programming and Component Engineering (GPCE'10)*, pages 53–62. ACM, 2010.
- (65) Pascal Poizat and Y. Yan. Adaptive Composition of Conversational Services through Graph Planning Encoding. In *Proceedings of the International Symposium On Leveraging Applications of Formal Methods, Verification and Validation (ISoLA 10)*, volume 6416 of *Lecture Notes in Computer Science*, pages 35–50. Springer, 2010.
- (66) Rania Kheffifi, Pascal Poizat, and Fatiha Saïs. Modeling and querying context-aware personal information spaces. In *Database and Expert Systems Applications - 23rd International Conference DEXA 2012*, volume 7447 of *Lecture Notes in Computer Science*, pages 103–110. Springer, 2012.
- (67) Y. Yan, Pascal Poizat, and L. Zhao. Repairing service compositions in a changing world. In *Selected papers from the 8th ACIS conference on Software Engineering Research, Management & Applications (SERA 10)*, volume 296 of *Studies in Computational Intelligence*, pages 17–36. Springer, 2010.
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- (69) A. D. Brucker, Matthias P. Krieger, and Burkhard Wolff. Extending OCL with null-references. In J. Cabot, J. Chimiak-Opoka, F. Jouault, M. Gogolla, and A. Knapp, editors, *The Pragmatics of OCL and Other Textual Specification Languages*, volume 6002 of *Lecture Notes in Computer Science*, pages 261–275. Springer, 2009. Best-Paper Award at the OCL 2009 Workshop.
- (70) A. D. Brucker, Matthias P. Krieger, Delphine Longuet, and Burkhard Wolff. A specification-based test case generation method for UML/OCL. In *Proceedings of the Workshop on OCL and Textual Modelling (OCL 2010)*, volume 6627 of *Lecture Notes in Computer Science*, pages 334–348, 2010.
- (71) Matthias P. Krieger and A. D. Brucker. Extending OCL operation contracts with objective functions. In *Proceedings of the International Workshop on OCL and Textual Modelling (OCL 2011)*, volume 44 of *Electronic Communications of the EASST*, 2011.

Books and book chapters

- (72) A. Cavalli, M. Lallali, S. Maag, G. Morales, and F. Zaidi. *Emergent Web Intelligence*, chapter Modeling and Testing of Web Based Systems: Advanced Semantic Technologies, pages 355–392. Advanced Information and Knowledge Processing. Springer Verlag, 2010.

Edited books

- (73) A. Cavalcanti, D. Déharbe, Marie-Claude Gaudel, and J. Woodcock, editors. *Theoretical Aspects of Computing - ICTAC 2010, 7th International Colloquium, Natal, Rio Grande do Norte, Brazil, September 1-3, 2010. Proceedings*, volume 6255 of *Lecture Notes in Computer Science*. Springer, 2010.
- (74) M. Gogolla and Burkhart Wolff, editors. *Tests and Proofs - 5th International Conference, TAP 2011, Zurich, Switzerland, June 30 - July 1, 2011. Proceedings*, volume 6706 of *Lecture Notes in Computer Science*. Springer, 2011.
- (75) J. Jeuring, J. A. Campbell, J. Carette, G. Dos Reis, P. Sojka, Makarius Wenzel, and V. Sorge, editors. *Intelligent Computer Mathematics — 11th International Conference, AISC 2012, 19th Symposium, Calculemus 2012, 5th International Workshop, DML 2012, 11th International Conference, MKM 2012, Systems and Projects, Held as Part of CICM 2012, Bremen, Germany, July 8-13, 2012. Proceedings*, volume 7362 of *LNCS*. Springer, 2012.
- (76) Burkhart Wolff and Fatiha Zaïdi, editors. *Testing Software and Systems - 23rd IFIP WG 6.1 International Conference, ICTSS 2011, Paris, France, November 7-10, 2011. Proceedings*, volume 7019 of *Lecture Notes in Computer Science*. Springer, 2011.
- (77) Burkhart Wolff, Marie-Claude Gaudel, and Abderrahmane Feliachi, editors. *Unifying Theories of Programming, 4th International Symposium, UTP 2012, Paris, France, August 27-28, 2012, Revised Selected Papers*, volume 7681 of *Lecture Notes in Computer Science*. Springer, 2012.

Dissemination

- (78) Marie-Claude Gaudel. Le test de logiciel : pourquoi et comment. *Rayonnement du CNRS*, pages 33–39, March 2012.

Other publications

- (79) A. D. Brucker, L. Brügger, Matthias P. Krieger, and Burkhart Wolff. HOL-TestGen 1.5.0 user guide. Technical Report 670, ETH Zurich, April 2010.
- (80) A. D. Brucker, L. Brügger, Matthias P. Krieger, and Burkhart Wolff. HOL-TestGen 1.7.0 user guide. Technical Report 1551, Laboratoire en Recherche en Informatique (LRI), Université Paris-Sud 11, France, 2012.
- (81) J. Cabot, R. Clariso, M. Gogolla, and Burkhart Wolff. Preface (OCL 2011 Proceedings). *Electronic Communication of the European Association of Software Science and Technology*, 44, oct 2011.
- (82) Abderrahmane Feliachi. Tests generation from Circus specifications. In *MOdelling and VErifying parallel Processes (MOVEP)*, pages 70–75, June 2010.
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- (89) Burkhardt Wolff, D. Basin, and P. Kearney. Model-based testing of security infrastructures (MBT-SEC). 1.9.2007 - 31.8.2010.
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- (91) F. Zaïdi, M.-C. Gaudel, L. Bentakouk, and M. Lallali. Conception, composition and validation of web services web (WebMOV). 22.11.2007 - 31.08.2010.

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- (93) Fatiha Zaidi. *From Active to Passive Testing*. Thèse d'habilitation (HDR), Université Paris-Sud / LRI, 2010.
- (94) Johan Oudinet. *Approches combinatoires pour le test statistique à grande échelle*. PhD thesis, Université Paris Sud, November 2010. Directeur: Prof. Marie-Claude Gaudel.
- (95) Lina Bentakouk. *Test symbolique de services Web composite*. PhD thesis, Université Paris-Sud, dec. 2011.
- (96) Matthias Krieger. *Test generation and animation based on object-oriented specifications*. Phd thesis, Université Paris Sud, dec 2011.
- (97) Pascal Poizat. *Formal Model-Based Approaches for the Development of Composite Systems*. Thèse d'habilitation (HDR), Université Paris Sud, December 2011. Examineurs: Prof. Philippe Dague, Prof. Marie-Claude Gaudel, Prof. Ernesto Pimentel.
- (98) Paulo Salem da Silva. *Verification of behaviourist multi-agent systems by means of formally guided simulations*. These, Université Paris Sud; Université de Sao Paulo, co-tutelle, nov 2011.



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- (124) Jean-Christophe Filliâtre. Combining interactive and automated theorem proving in Why3 (invited talk). In K. Heljanko and H. Herbelin, editors, *Automation in Proof Assistants 2012*, Tallinn, Estonia, Apr. 2012.
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- (129) G. Baudart, F. Jacquemard, Louis Mandel, and M. Pouzet. A synchronous embedding of Antescofo, a domain-specific language for interactive mixed music. In *Thirteen International Conference on Embedded Software (EMSOFT'13)*, Montreal, Canada, Sept. 2013.
- (130) A. Benveniste, B. Caillaud, and Marc Pouzet. The Fundamentals of Hybrid Systems Modelers. In *49th IEEE International Conference on Decision and Control (CDC)*, Atlanta, Georgia, USA, Dec. 2010.
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- (139) S. Maneth and Kim Nguyen. Xpath whole query optimization. In *36th International Conference on Very Large Data Bases (VLDB'2010)*, volume 3, pages 882–893, 2010.
- (140) Ali Ayad and Claude Marché. Multi-prover verification of floating-point programs. In J. Giesl and R. Hähnle, editors, *Fifth International Joint Conference on Automated Reasoning*, Lecture Notes in Artificial Intelligence, Edinburgh, Scotland, July 2010. Springer.
- (141) Arthur Charguéraud. Pretty-big-step semantics. In M. Felleisen and P. Gardner, editors, *Proceedings of the 22nd European Symposium on Programming*, volume 7792 of *Lecture Notes in Computer Science*, pages 41–60. Springer, Mar. 2013.
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- (143) Dariusz Biernacki, J.-L. Colaço, G. Hamon, and Marc Pouzet. Clock-directed Modular Code Generation of Synchronous Data-flow Languages. In *ACM International Conference on Languages, Compilers, and Tools for Embedded Systems (LCTES)*, Tucson, Arizona, June 2008.

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- (147) Évelyne Contejean, P. Courtieu, J. Forest, O. Pons, and X. Urbain. Automated Certified Proofs with CIME3. In M. Schmidt-Schauß, editor, *22nd International Conference on Rewriting Techniques and Applications (RTA 11)*, volume 10 of *Leibniz International Proceedings in Informatics (LIPIcs)*, pages 21–30, Novi Sad, Serbia, 2011. Schloss Dagstuhl–Leibniz-Zentrum fuer Informatik.
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- (152) François Bobot, Sylvain Conchon, Evelyne Contejean, Mohamed Iguernelala, A. Mahboubi, Alain Mebsout, and Guillaume Melquiond. A Simplex-based extension of Fourier-Motzkin for solving linear integer arithmetic. In B. Gramlich, D. Miller, and U. Sattler, editors, *IJCAR 2012: Proceedings of the 6th International Joint Conference on Automated Reasoning*, volume 7364 of *Lecture Notes in Computer Science*, pages 67–81, Manchester, UK, June 2012. Springer.
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- (160) Paolo Herms, Claude Marché, and B. Monate. A certified multi-prover verification condition generator. In R. Joshi, P. Müller, and A. Podelski, editors, *Verified Software: Theories, Tools, Experiments (4th International Conference VSTTE)*, volume 7152 of *Lecture Notes in Computer Science*, pages 2–17, Philadelphia, USA, Jan. 2012. Springer.
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- (166) Sylvie Boldo. Floats & ropes: a case study for formal numerical program verification. In *36th International Colloquium on Automata, Languages and Programming*, volume 5556 of *Lecture Notes in Computer Science - ARCoSS*, pages 91–102, Rhodes, Greece, July 2009. Springer.
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- (176) Catherine Lelay and Guillaume Melquiond. Différentiabilité et intégrabilité en Coq. application à la formule de d’alembert. In *Vingt-troisièmes Journées Francophones des Langages Applicatifs*, Carnac, France, Feb. 2012.
- (177) Claude Marché and Asma Tafat. Calcul de plus faible précondition, revisité en Why3. In *Vingt-quatrièmes Journées Francophones des Langages Applicatifs*, Aussois, France, Feb. 2013.
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- (179) Jean-Christophe Filliâtre. Gagner en passant à la corde. In *Dix-neuvièmes Journées Francophones des Langages Applicatifs*, Étretat, France, Jan. 2008. INRIA.
- (180) Jean-Christophe Filliâtre and R. E. Sibaïe. Combine : une bibliothèque OCaml pour la combinatoire. In *Vingt-quatrièmes Journées Francophones des Langages Applicatifs*, Aussois, France, Feb. 2013.
- (181) Louis Mandel. Cours de ReactiveML. In *Vingt-et-unièmes Journées Francophones des Langages Applicatifs*, Vieux-Port La Ciotat, France, Jan. 2010. INRIA.
- (182) Louis Mandel and C. Pasteur. Réactivité des systèmes coopératifs : le cas de ReactiveML. In *Vingt-quatrièmes Journées Francophones des Langages Applicatifs*, Aussois, France, Feb. 2013.
- (183) Louis Mandel and Florence Plateau. Abstraction d’horloges dans les systèmes synchrones flot de données. In *Vingtièmes Journées Francophones des Langages Applicatifs*, Saint-Quentin sur Isère, Jan. 2009. INRIA.
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- (187) Romain Bardou and Marché Claude. Perle de preuve: les tableaux creux. In Sylvain Conchon, editor, *Vingt-deuxièmes Journées Francophones des Langages Applicatifs*, La Bresse, France, Jan. 2011. INRIA.
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- (190) Sylvain Conchon, Johannes Kanig, and Stéphane Lescuyer. SAT-MICRO : petit mais costaud ! In *Dix-neuvièmes Journées Francophones des Langages Applicatifs*, Étretat, France, Jan. 2008. INRIA.

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