Portfolio
Structure of the laboratory: Cross-disciplinary actions

April 2024

Contents

Interdisciplinarity is core to the laboratory. Cross-disciplinary actions are especially designed to encourage and support research activities that span across several departments. The laboratory has identified a set of interdisciplinary research themes of particular importance based on its strengths.

1- TRANSVERSAL ACTION ON ARTS & SCIENCES

The LISN Arts-Sciences transversal action aims to foster collaboration between scientific research and the fields of design, contemporary artistic creation and mediation. Its purpose is to develop a research and creation approach that can serve as a catalyst for interdisciplinary work and as an incubator for exploratory projects.

Over the 2018-2020 period, LIMSI had a transversal action called VIDA (Virtuality, Interaction, Design and the Arts), that gave rise to various collaborative projects and events.[1] Although a similar structure did not exist at LRI, several teams were actively involved in actions involving arts and science for creation, research and dissemination. When LISN was created in 2021, the Arts-Sciences transversal action was initiated to promote the study of creative processes in Arts, the exchange of practices between artists and scientists, training for science and art students, and mediation in the dialogue between science and society. These activities are conducted in coordination with other actors on the Saclay plateau, such as La Diagonale Paris-Saclay, La scène de recherche de l'ENS-Paris Saclay, or SAS Science-Art-Société.

A survey of Arts-Sciences projects over the evaluation period shows the involvement of three departments (AAC, IAH, STL) and 8 teams (AMI, ASARD, AVIZ, Ex-Situ, GALaC, ILDA, M3, VENISE). The main projects of these teams are highlighted in their self-evaluation report. Not only can Art-science projects contribute to disseminating scientific knowledge to a wider public, they also stimulate scientific research and allow the emergence of new approaches in research-creation. Art practice is at the core of the research of several members, especially in the AMI and Ex-situ teams that study interaction in the context of dance, music, and performing arts. Numerous publications have been produced in connection with artistic projects, and several articles were awarded prizes or honorable mentions. LISN members participated in many events and public presentations. For instance, S. Fdili Alaoui created several interactive dance pieces, including SKIN, and RCO. N. Delprat received the CNRS Images price in 2018 for the project ELEMENTA (Virtual materiality and body consciousness), and was selected for a Medicis Residency at the French Academy in Rome in 2022. E. Pietriga (ILDA) created visualizations related to space exploration and astronomy for Project Sanctuary that aims at sending a *"time capsule of information art"* to the Moon.

Four research teams included a project involving the arts and sciences in their portfolio, underlining the importance of this theme for researchers. The musical juggling project by F. Hivert and N. Thiéry (GALaC) is at the intersection of juggling, music and combinatorics research. This long-standing collaboration has given rise to more than 60 performances, and led to a PhD thesis. Vera Icona, by M. Gouiffès (AMI) in collaboration with V. Caye, is an interactive installation that reflects on the use of computer vision for surveillance. Le Créartathon

[1] These projects are archived online on the VIDA website: https://vida.lisn.upsaclay.fr/

Figure 1: A Selection of Arts-Sciences projects conducted by LISN members. From left to right: Creartathon 2021 (Ex-Situ: J. Koch, W. Mackay, N. Taffin); Musical juggling performance (GALAC: F. Hivert, V. De Lavenère); flyer for the theater piece *Qui a hacké Garoutzia ?* (M3: L. Devillers); Rêverie augmentée (AMI: N. Delprat, ASARD: N. Ladevèze).

was organized in 2021 and 2022 by J. Koch, W. Mackay, N. Taffin (Ex-Situ). This summer school gathered students in arts, design, HCI and AI to create new intelligent artifacts. Finally, L. Devillers (M3) wrote a play entitled *Qui a hacké Garoutzia ?*, with S. Abiteboul and G. Dowek, that reflects with humour on the relationships between humans and AI.

This selection of projects illustrates the diversity of production and of modes of action in research-creation at the laboratory (see Figure 1), that cover performing arts, installation art, and literature. Additional projects are available on the lab's website. The transversal action on arts and sciences will be pursued and strengthened at LISN. Regular events to present and discuss collaboration practices in arts and science are planned starting in 2024, to facilitate the emergence of new collaborations.

2- TRANSVERSAL ACTION "MACHINE LEARNING FOR PHYSICS" AND "PHYSICS FOR MACHINE LEARNING"

When LISN was created from the former LRI and LIMSI labs, it was decided to evaluate the relevance of a transversal project between the Mechanics – Energetics Department (2 teams, COMET and DATAFLOT) and the A&O team since there were some common research interests and scientific interactions between the three teams that appeared clearly relevant. Indeed, Machine Learning (ML) provides a set of methodological tools for processing information, opening up important prospects for research in fluid mechanics, and turbulence in particular. It provides a set of methods for extracting information from data, and powerful regression methods well suited to the high-dimensional non-linear problems encountered in fluid mechanics. Many situations can indeed be formulated as optimization or regression problems, such as model reduction, control or shape optimization, which can be accelerated by machine learning. The potential of ML in fluid mechanics can be expressed at several levels (data mining, modeling, simulation-ML coupling, closure models, etc.).

Conversely, fluid mechanics, and physics in general, can motivate ML research themes along several axes. These include the imposition of constraints to be satisfied by a learned model, in the form of invariance of the model's prediction with respect to certain symmetry groups, the guarantee of certain properties or bounds on predictions (certification, robustness), particularly in a learning situation with little data, and so on. As data from physical simulations are abundant, noise-free and controllable, they can serve as very clean benchmarks, which is crucial for the development of new ML architectures.

To promote interactions and shared projects, several actions were undertaken:

- A new mailing list dedicated to the topic of "Machine learning for Physics" and "Physics for machine learning" was set up, with enlisted members from the three teams. This mailing list serves to disseminate important information relative to the topic, such as relevant conferences, calls, seminars, etc. In particular, internal seminars from each team are advertised on the list when the topic is relevant.
- To further promote interactions, the three teams have organized a half-day of cross presentations in June 2022 to present their respective research topics and identify concrete research issues of common interest. This event featured 22 presentations and has attracted about 50 members from all teams.

In the framework of this transversal action, the following salient outcomes can be mentioned:

- The ANR Speed project was funded (2020-2024), mainly involving members of DATAFLOT and A&O. The project aims at developing methodologies for learning efficient and reliable models of physical and dynamical systems from a few noisy observational data. This project involves two PhD students, co-advised by a member of each team. As a qualitative illustration, we show in Figure 2 the comparison of the prediction of a scalar-valued quantity of interest in time from a numerical simulation of a fluid flow. The approach developed in the Speed project (DDE, in green) compares favorably with the ground truth (solid blue), in sheer contrast to other techniques from the literature (ANODE, ODE, LSTM).
- The ANR Thermal project (2022-26) has been funded to explore physics at very high turbulence levels using an HPC code (in-house SUNFLUIDH solver), and classical or machine-learning-based diagnostic tools applied to experimental or numerical data. In particular, we aim to develop improved physics-guided ML techniques using small DNS datasets to provide experimentalists with hidden quantities. Looking further ahead, we plan to hybridize ML models with traditional NS solvers for on-the-fly learning. The project involves members of COMET and DATAFLOT, together with experimentalists from the Physics Laboratory

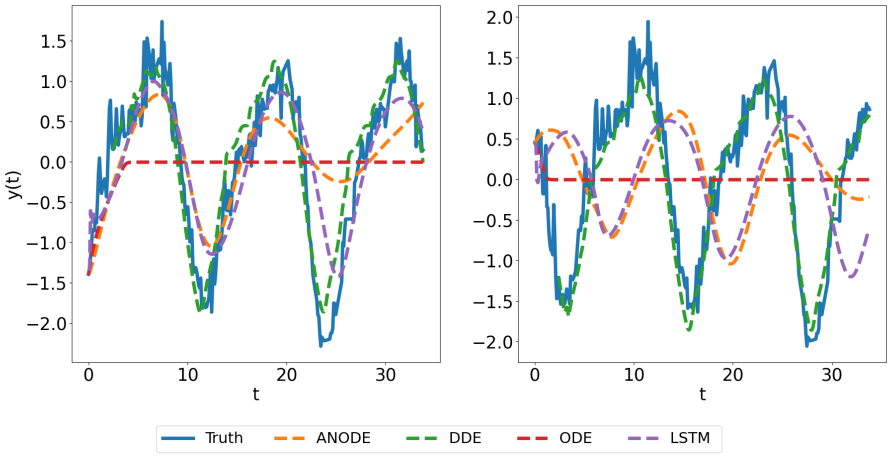

Figure 2: Prediction of time-evolution of a QoI with different techniques for two different initial conditions from a testset.

at ENS-Lyon, and a total of two PhD students and one post-doc.

- An ANR project has been submitted (Scalp, 2024) by members of DATAFLOT and A&O teams. The project aims at developing neural network architectures to synthesize multi-scale data (tens of orders of magnitude apart), such as those obtained from turbulent flows.
- A second ANR Project has been submitted (MEANDERS, 2024) by members of all three teams (COMET, DATAFLOT and A&O). The goal of this research project is to employ machine learning techniques to address some of the long-standing problems in turbulence by locating relevant structures at different scales, describing intermittency mechanisms, and developing reliable reduced-order models.

3- TRANSVERSAL ACTION ON SOCIAL SCIENCES & DIGITAL SCIENCES

The "*SHS & numérique*" (Social Sciences and Digital Sciences) transversal action aims to foster collaboration between various humanities and social sciences fields represented at LISN (linguistics, sociology, economics, psychology...) and digital approaches which can be fruitful for these domains and in return can benefit them as well. Its purpose is to develop a framework for interdisciplinary discussions and future projects. Although this type of dialogue between SSH domains and digital sciences has long existed at both LIMSI and LRI, this new initiative, created with the advent of LISN in 2021, has provided a framework for linking interdisciplinary events otherwise specific to one department or field to the laboratory's objectives. This action is also part of broader initiatives at the Paris-Saclay perimeter level, led by entities such as the MSH Paris-Saclay and the DATAIA Institute.

For the period covered by the report, activities include scientific events co-organized with MSH Paris-Saclay, focusing on the interaction between humanistic language studies, social sciences and digital sciences. We have organized the following main events:

- The workshop AIGLE "Artificial Intelligence and Globalization - Data Labor and Linguistic Specificities" (Figure 3) took place at the headquarters of the Ministry of the Economy in Paris on 27 October 2022 and was co-organized by Paola Tubaro with sociologists and economists from Université Paris-Saclay and Institut Polytechnique de Paris in the framework of the ANR HUSh (The HUman Supply cHain behind smart technologies, 2020-2024). The workshop brought together researchers from the social sciences, linguistics and engineering to discuss the issue of micro-labor and the benefits of approaching the subject from an interdisciplinary perspective.
- The workshop "Romance languages in a rapidly changing world" (Figure 4), co-organized by Ioana Vasilescu and Paola Tubaro, took place on 26 June 26 2023 at ENS Paris-Saclay as part of the 53rd Linguistic Symposium on Romance Languages (LSRL 53, INALCO, 27-29 June 2023) also supported by LISN.

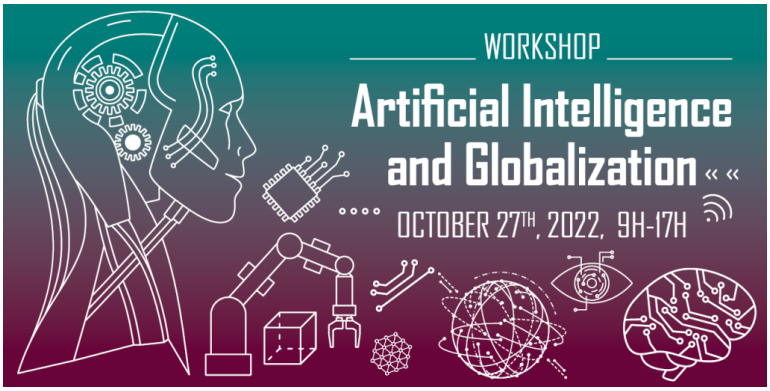

Figure 3: Announcement of the AIGLE workshop

Figure 4: Announcement of the "Romance languages in a rapidly changing world" workshop.

We also undertook dissemination activities to inform stakeholders and policy-makers, e.g., presentations on evidence-based practices for technology dedicated to autism at webinars organized by the Lillab (Living Lab at the La Salpêtrière hospital in Paris) on 15 December 2021, and for the National Assembly on 27 January 2022.

As a result of this interdisciplinary axis, several projects have been launched that bring together linguists, speech processing and NLP researchers such as OTELO, which represents a collaboration with researchers from Institut Polytechnique de Paris (Fabian Suchanek), and received the Excellence Award from MSH Paris-Saclay and the DATAIA Institute in 2020 and ANR DIPVAR, both led by Ioana Vasilescu; as well as sociologists, economists, linguists and speech processing researchers such as TRIA and ANR VOLI, both led by Paola Tubaro.

4- TRANSVERSAL ACTION ON RESPONSIBLE RESEARCH

The Transversal Action on Responsible Research brings together the members of the laboratory whose research focuses on the design and development of methods related to scientific integrity. Three sub-themes are particularly prominent: Environmental Impacts of Digital Technology, AI Ethics, and Open Science (transparency and reproducibility). Several activities have been organized both jointly and on each axis.

Series of seminars associated with the topic:

- Responsible Research Action Workshop on 8 December 2021 with keynotes on each sub-theme and joint discussions:
  - Impacts of Digital Technology: Gauthier Roussilhe, Navigating the Estimates of Negative and Positive Impacts of the Digital Sector;
  - Reproducibility/Open Science: Bertram Ludaescher, Reproducibility in Science;
  - Ethics Keynote: Laurence Devillers, CNPEN Opinion Submitted on 11/09 to the Prime Minister on Chatbots and Ethics.

- First transversal action seminar "Éthique & IA" on nudge and ethics given by M-A Dilhac (University of Montreal) in June 2021 at LISN;
- Anne-Cécile Orgerie (IRISA), 5 October 2021: Understanding and Improving the Energy Efficiency of Distributed Systems;
- Danilo Carastan Dos Santos (UGA), 13 December 2022: Some Experiences in Machine Learning and Data Science for High-Performance Computing Resource Management.
- Workshop at the Bernardins organized by LISN "Nudge and conversational agents: ethical, affective and societal issues", on 19 October 2023;
- Numerous information and training meetings on the CODALAB challenge organization platform (I. Guyon).

Teaching Activities:

- SPOC responsible research for PhD students - 8 short lessons - Organized by Emmanuelle Frenoux and Anne-Laure Ligozat in the SaclAi-School project coordinated by Sarah Cohen-Boulakia;
- Reprohackathon teaching unit in Master 2: learning how to reproduce a figure published in a paper based on the Material and Methods Section;
- Computer science epistemology and digital ethics by Laurence Devillers (M1 Science of Language at Sorbonne University).

Participation in national and international events:

- Co-organization of the GreenDays 2023 by S. Cohen-Boulakia;
- Keynote by Anne-Laure Ligozat: "Côté obscur de l'IA : quels bénéfices réels de l'IA pour faire face aux crises environnementales";
- Keynote by Laurence Devillers with Justine Cassel (CMU/INRIA) in the Global Forum on AI for Humanity (2018): "Human and artificial intelligence";
- Participation in the GFAIH (2019) in the context of the organization of a Global Partnership on AI (GPAI): Keynote by Laurence Devillers on "Nudging with affective computing system", session 5 and Co-organisation of a workshop by Andreas Dengel (DFKI) & Laurence Devillers (CNRS): "Human-Machine Co-Creation, Co-Learning and Co-Adaptation";
- GPAI (Global Partnership on AI): Laurence Devillers, Member on the future of work (2020-2022), participation to the GPAI conference 2021 on Human-machine co-evolution;
- Keynote by Laurence Devillers on "AI and Robot Era", Entretiens d'Abu Dhabi, in the conference "Artificial Intelligence Towards a Better Life", (30 September 2018);
- Keynote by Laurence Devillers at Academy of Sciences with the sherpas of G7 Science "AI, robots and Ethics"(26 March 2019);
- Keynote by Laurence Devillers at EUA (European University Association) annual conference: EUA Hot Topic Session: Artificial Intelligence at Sorbonne University (12 April 2019);
- Keynote by Laurence Devillers at the Belgium AI Week, "Artificial Intelligence, Robots and Emotions" (18 March 2021);
- Keynote by Laurence Devillers at the Belgium European AI week on "AI-enhanced Nudging/Standardization" (18 March 2022);
- Keynote by Laurence Devillers at World AI Cannes Festival: Human-Machine affective interaction and Ethics (15 April 2022);
- Roundtable with Laurence Devillers at Vivatech – Orange 2022: "IA/ DATA: how to build digital trust?" (15 June 2022);
- Keynote by Laurence Devillers on "AI and Ethics" at the Global AI Summit, AI for the Good of Humanity, Saudi Arabia (13-15 Sept. 2022);
- Keynote by Laurence Devillers on "Emotional Robots and people: challenges for education", Meeting with the Minister dr. Emilija Stojmenova Duh(Government Office for Digital Transformation), Invited Panel presentation: Nudging mechanism: technological and ethical issues (International Scientific Conference on Philosophy of Mind and Cognitive Modelling in Education – PCE 2022 (University of Maribor), Slovenia (29-30 September 2022);
- Roundtable with Laurence Devillers: Regulating GAFAMS, economic events, Aix-en-Provence (July 2023);
- Keynote by Laurence Devillers on "Socio-affective robots: ethical issues" at Robotcup (July 2023);
- Keynote by Laurence Devillers on "Ethical Issues of Generative AI" at Clarin 2023, (October 2023);
- Panel "Des clefs pour comprendre": Is artificial intelligence intelligent? at the French Academy of Sciences, 28 November 2023, Laurence Devillers.

Public Interviews:

For the printed press:

- For Le Monde: Climate Change: The Dark Side of Artificial Intelligence and Research Facing the Challenge of Digital Energy Sobriety, 1 May 2023, Anne-Laure Ligozat; Robot ethics 20 March 2020; and Artificial intelligence: "The European Union has much to gain by developing a framework for the use of AI", 15 September 2023, Laurence Devillers;
- For Libération: Can AI save the planet?, 19 June 2023, Anne-Laure Ligozat;
- For Le Journal du Dimanche: Towards an ethical metaverse, 27 April 2022; How ChatGPT can help teachers?, 21 February 2023; and Progressive, liberal... What are ChatGPT's political convictions?, 23 May 2023, Laurence Devillers;
- For Les Échos: Carbon neutrality is a marketing argument, 9 June 2022, Anne-Laure Ligozat; Machines are light years away from capturing our emotions, 30 August 2018, Laurence Devillers;
- Chronicles on Ethics and AI for La Croix, from September 2021 to June 2022, and for Les Échos, from September 2023, Laurence Devillers.

For radio and TV shows:

- For Radio France: France Culture - Humans confide in robots, October 2018; France Culture - What do robots teach us about ourselves, 7 April 2018; and France Inter - Grand bien vous fasse ! - How AI will continue to revolutionize our lives, 12 April 2023, Laurence Devillers;
- In the radio show "Cause commune": The reproductibility of software environments for research, 13 September 13th 2022, Sarah Cohen-Boulakia. Transcript.
- On French TV: Intelligence artificielle : des robots et des hommes, 15 December 2022, and C à vous: "ChatGPT", 2 March 2023, Laurence Devillers.

For books:

- For the book *Humans at the Risk of Artificial Intelligence*, Pierre Rabhi and Juliette Duquesne, 2021: Anne-Laure Ligozat;
- For the book *Healthcare and Artificial Intelligence (1)*, editors B. Nordlinger, C., Villani, D., Rus, D., EN Edition Springer Nature, 18 March 2020: L. Devillers, "Social and Emotional Robots: Useful Artificial Intelligence in the Absence of Consciousness", p261-267, version in French, editors B. Nordlinger, C., Villani, editor CNRS (18 October 2018);
- For the book *Healthcare and Artificial Intelligence (2)*, editors B. Nordlinger, C., Villani, 0., de Fresnoye, Edition CNRS, 2022: L. Devillers, "Conversational agents influence our judgment: the nudge of healthcare chatbots" (p311-321) and Junien L. Devillers, "" AI and parity sex/gender";
- For the book *Les robots émotionnels: et l'éthique dans tout cela ?*, Edition of L'Observatoire, 2020: Laurence Devillers ;

Other:

- For the Interstices web site: How to Evaluate the Net Benefits of AI Solutions for the Environment?, 24 November 2022, Anne-Laure Ligozat;
- For a podcast: IA Café Podcast on AI Impacts, 25 March 2023, Anne-Laure Ligozat;
- TEDx Talk: Human-Machine: emotion, illusion and ethics!, 11 November 2020, Laurence Devillers;

Members of committees:

- EcoInfo GDS: Emmanuelle Frenoux, Anne-Laure Ligozat;
- Ethics committees: Gilles Adda, Laurence Devillers, Christine Froidevaux;
- National reproducibility network: Sarah Cohen-Boulakia, Fatiha Saïs, George Marchment, Clemence Sebe.

Impact:

Local:

- Associate professor position opened in 2024 on Responsible Digital Technology at Université Paris-Saclay;

- 2 Master internships co-supervised on environmental impacts of reproducible scientific workflows ar taking place at LISN.

National:

- The decree creating the National Advisory Committee on Digital Ethics (*Comité consultatif national d'éthique du numérique*), which we proposed, has just been published in the Journal Officiel. CNRS had called for its creation and the text is now in force. It has been recognized at the highest level of government, and makes our nation the first to set up an independent national committee dedicated to "reflection on the ethical issues raised by advances in science, technology, uses and innovations in the digital field, and their various impacts, notably social, economic, environmental, individual or educational.
- In collaboration with the Blaise Pascal Foundation, of which Laurence Devillers is president, the Transversal Action put together a set of AI and ethics capsules to raise awareness of digital ethics among schoolchildren;

Cooperations:

- Ethics and AI: HUMAAINE (Laurence Devillers). Research collaborations with the DATAIA Institute (project with economists on Bad nudge Bad robot), SYSTEMIC/THALES (moral mapping of AI systems for the AI trust project), and RITM (economics and law). These collaborations have led to highly interdisciplinary research involving computer science (AI), linguistics, economics, law, philosophy and even theology, with collaborations with the Bernardins, Sorbonne University and the Blaise Pascal Foundation for mediation in mathematics and computer science.

Some publications:

- Ethical Considerations on Affective Computing: An Overview. Devillers, L., Cowie, R. *journal TACC*, IEEE, 2023;
- Intelligence Augmentation: Future Directions and Ethical Implications in HCI. Vargo, A., Tag, B., Hutin, M., Abou-Khalil, V., Ishimaru, S., Augereau, O., Dingler, R., Iwata, M., Kise, K., Devillers, L., Dengel, A.*IFIP Conference on Human-Computer Interaction*, Springer, 2023;
- AI & Human Values. Devillers, L., Fogelman-Soulié, F., Baeza-Yates, R. In *Reflections on Artificial Intelligence for Humanity*; 2021; Springer, Braunschweig, B., Ghallab, M. (Eds.), pp 76–89;
- Augmented Human and Human-Machine CoEvolution: Efficiency and Ethics. Dengel, A.; Devillers, L.; Schaal, L. M. In *Reflections on Artificial Intelligence for Humanity*; 2021; Springer, Braunschweig, B., Ghallab, M. (Eds.), pp 203–227;
- Les agents conversationnels influencent notre jugement : le nudge des chatbots en santé. Devillers, L., *Médecine et intelligence artificielle (Tome 2)*, sous la direction de B. Nordlinger, version anglaise et française, éditions 2022.