# T A O

# Themes Apprentissage & Optimisation

Head: Marc Schoenauer and Michele Sebag

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# Members

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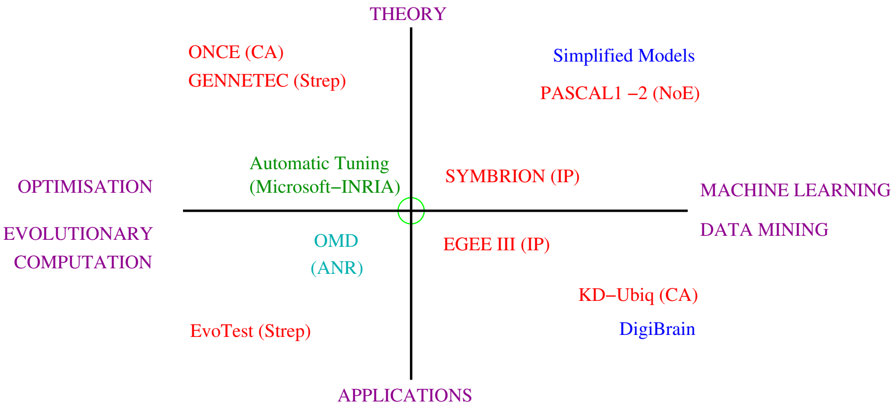
# Scientific Themes / Objectives




Optimization for Machine Learning – Machine Learning for Optimization

# CRE: Multi-Relational Data Mining

Vincent Lemaire, Raphael Feraud, Marc Boullé, MS

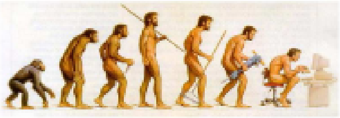
Context

1. Relational DB
2. Flattened
3. Alternatives ?

Relational DM

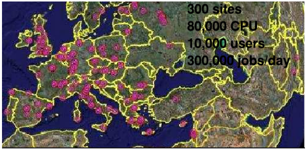
1. Propositionalization
2. Sampling
3. Reinforcement learning

# Autonomic Computing



## EGEE, Enabling Grids for E-SciencE

- 50 countries, 300 sites
- 80,000 CPUs, 5Petabytes
- 10,000 users, 300,000 jobs/ day




http://public.eu-egee.org/

## EGEE-III : WP Grid Observatory

- Job scheduling — ICAC08
- Job profiling — ECML08,KDD09

# Apprentissage numérique supervisé parallèle

Olivier Teytaud

Cadre:

Matrice de facteur explicatifs + matrice de variables à expliquer.

Outils:

- Apprentissage sur grandes bases
- Parallélisation (notamment méthodes d'ensembles/mixture d'experts)
- Travail préliminaire sur données LES

Objectifs:

- Modularité / portabilité / Maintenabilité du code
- Mise à plat de l'état de l'art sur pb réel

# Optimal Decision Under Uncertainty

## Monte-Carlo Tree Search

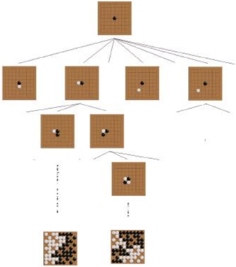
In each position (search tree):

1. Select a move *Multi-armed Bandits*
2. Assess it using a "default partner" *Monte-Carlo*
3. Update reward

Select arg max $\hat{\mu}_i + \sqrt{\frac{log \sum_j n_j}{n_i}}$

## Applications

- MoGo — ICML 2007, Gelly PhD 07
- Active Learning — Simplified Models
- News Web site — won OTEE Pascal Challenge



## Collaborations

INRIA-Sequel
University of Alberta
CEA-DM2S
LRI Parall, Bull, Microsoft

# PASCAL Large Scale Learning Challenge

## ICML 2008

Main lessons learned

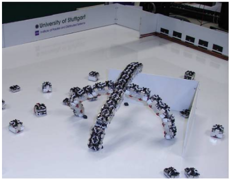
- LSL must go parallel
- Need of parameterless algorithms

# Research Agenda 2009-2011

## Extended Bandits

- Dynamic environments — won OTEE Challenge
- Delayed and partial rewards — PASCAL
- Multi-objective rewards — Exploration vs Safety
- Multi-variate bandits — Junction with RL
- Bounded Reasoning — Finite horizon

## Swarm Robotics




SYMBRION IP; Coll. U. Kyushu, Japan

- Decentralized control
- Robotics Log Mining

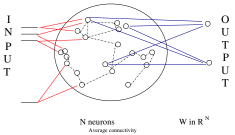
# Longer-term Perspectives

## Hardware-aware Software

Coll. Alchemy, GECCO08, ECML08

Algorithms as fixed point systems

Reservoir computing



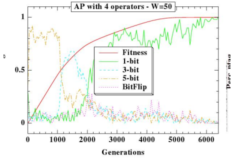

## Crossing the Chasm

Joint INRIA-Microsoft project

PPSN08, GECCO08

Parameter/Alg. Selection

- Multi-Armed Bandits
- Change Test Detection



# Contributions to Evolutionary Computation

- Convergence of Evolution Strategies as Markov Chain — TCS 05
- Consistency of Genetic Programming - regularization — RIA 06
- Lower Bounds for Comparison-based Algs — PPSN 06, ECJ 08
- Derandomization — PPSN 06
- Continuous Lunches are Free ! — GECCO 07, Algorithmica 09
- Robustness w.r.t. condition number — CEC Challenge 05; GECCO 08
- Robustness w.r.t. noise — PPSN 08, Jebalia PhD 08
- Approximate Dynamic Programming — Gelly PhD 07, OpenDP platform 07

Collaborations
ETH Zurich
Lab. Maths UPS
U. Dortmund

Transfert
OMD, EADS, Renault, Dassault, Thalès
EZCT

# Spotlights

Log-Linear Convergence of Evolution Strategies — TCS 05

Drift conditions for Harris-recurrent Markov Chains:

First proof of convergence on actual Self-Adaptive ES

$\Rightarrow$ Optimal rate — ECJ 08

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Genetic Programming ==

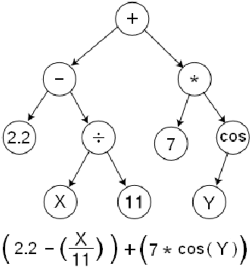
EC on space of programs — RIA 06

Limitation: bloat — uncontrolled solution growth

Results:

- VC(pgm with $k$ nodes) $\leq F(k)$
- Penalization with $R(k).R'(n)$:

  a.s. Universal Consistency and no-bloat



# Contributions to Machine Learning/Data Mining

- Regularisation for Graphical Models — Gelly PhD 07
- Dynamic Multi-Armed Bandits — CAP 07
- Data Streaming with Affinity Propagation — ECML 08

- Ensemble Feature Ranking — Mary PhD 05
- Spatio-Temporal D.Mining / MultiObjective Opt. — IJCAI 05, PPSN06
- Learning Kernels, Learning Ensembles — PPSN06, GECCO 07

- Competence Maps — IJCAI 05, Maloberti PhD 05, ILP 07
- Active Learning in a Graph — IJCAI 07, Baskiotis PhD 08

**Collaborations**

La Pitié Salpétrière
EPFL
U. Laval, Quebec
U. Sapporo, Japan

**Wshops**

2nd Pascal Challenges Wshop 06
Multiple Simultaneous Hypothesis Testing 07
Large Scale Learning Challenge 08

# Spotlights

**Ensemble Feature Ranking** — Mary PhD 05

Theorem: Let $O_t$ be a r.v. ranking / $Pr((Err(i,j,O_t)) < 1/2 - \epsilon)$
Then $\tilde{O} = Aggr(O_1, \ldots O_T)$ is consistent, with
$Pr(|rank_{\tilde{O}}(i) - rank^*(i)| > k)$ exponentially small with $k$ and $T$

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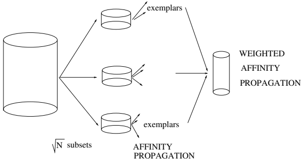
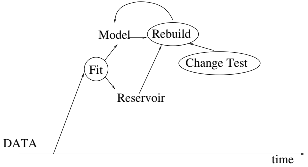
**Data Streaming with Affinity Propagation** — ECML 08

Affinity Propagation: Frey & Dueck 07
$+$ no artefact, stable optimization, $-$ quadratic complexity.




Hierarchical AP ($n^{\frac{3}{2}}$)




Non-stationary AP

# Applications - 1. Representations/Search Spaces

## Shape representations

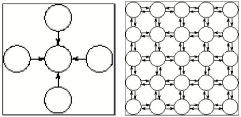
coll. U. San Luis, EZCT

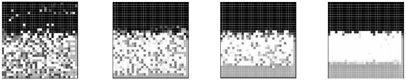
GECCO 05, PhD Kavka, PhD Singh

Voronoï

## Developmental representations

coll. MIT, GECCO 07





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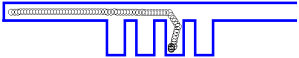
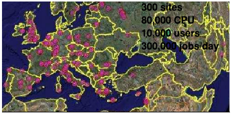
## Reservoir Computing

coll. INRIA-Alchemy, LIMSI

Solving the Tolman maze



# Applications - 2. Autonomic Grid - EGEE III




## Scheduling and Reinforcement Learning

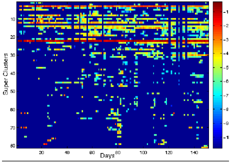
ICAC08

Multi-objective rewards
Continuous representation of users.

$$Q_t(s,a) = Q_{t-1}(s,a) + \alpha(r + \gamma Q_{t-1}(s',a') - Q_{t-1}(s,a))$$

## Job streaming and profiling

ECML08




Build snapshots
Build chronicles

Coll. Lab. Accélérateur Linéaire, UPS

# Perspectives

## Extended Bandits

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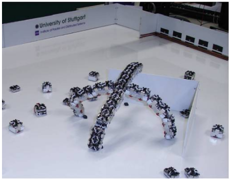

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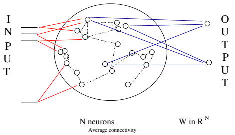
Algorithms as fixed point systems

Reservoir computing

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