I A O

Inference, Apprentissage & Optimisation

Head: Michele Sebag

Joint INRIA project

Members

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Raymond Ros
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Fabien Teytaud
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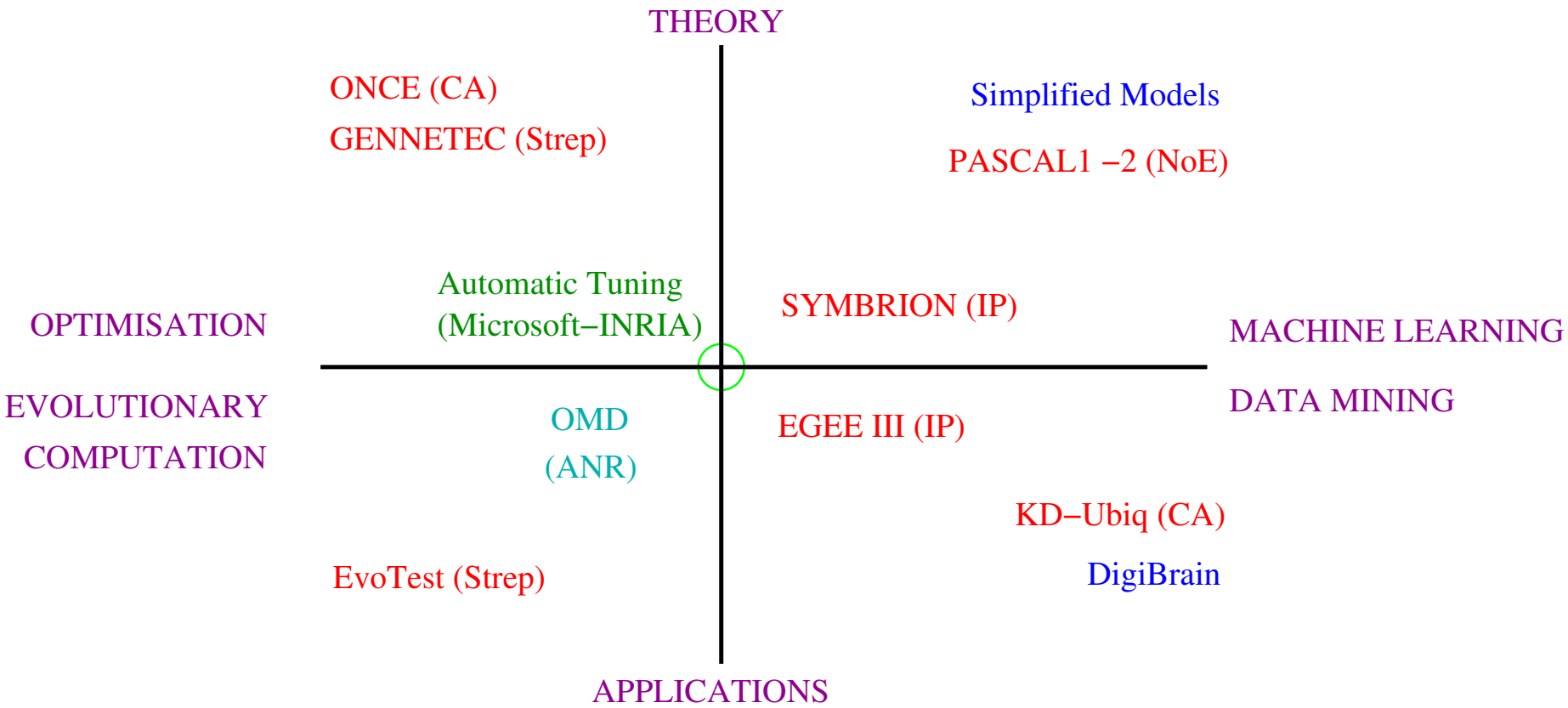
10PhDs defended $\longrightarrow$ 2 MdC; 3 post-docs; 4 engineers

Scientific Themes / Objectives



Optimization for Machine Learning – Machine Learning for Optimization

Optimal Decision Under Uncertainty

Monte-Carlo Tree Search

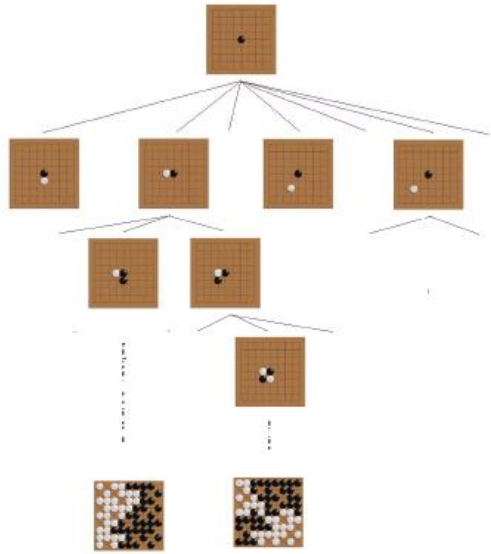
In each position (search tree):

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

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

Genetic Programming == EC on space of programs

RIA 06

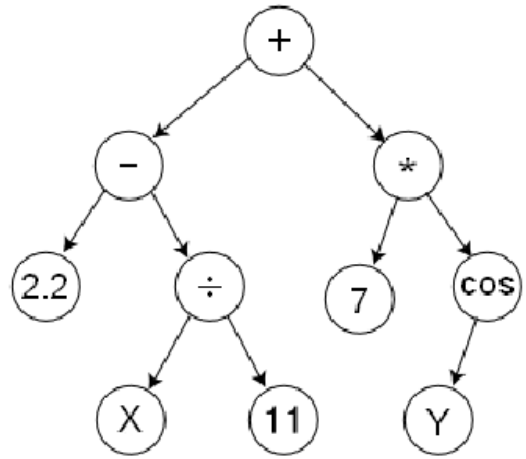
Limitation: bloat

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



$$\left(2.2 - \left(\frac{X}{11}\right)\right) + \left(7 * \cos(Y)\right)$$

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

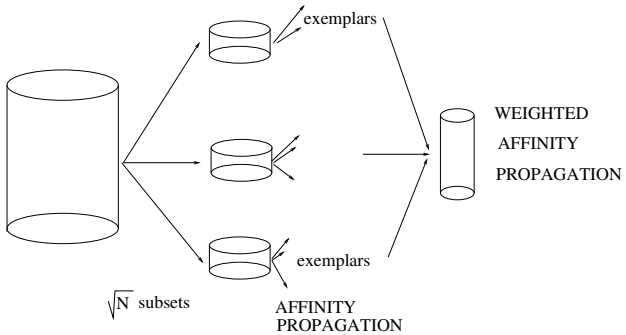
$Pr(|rank_{\tilde{O}}(i) - rank^*(i)| > k)$ exponentially small with k and T

Data Streaming with Affinity Propagation

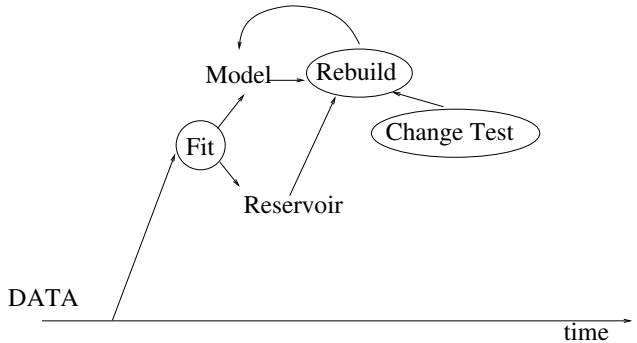
ECML 08

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

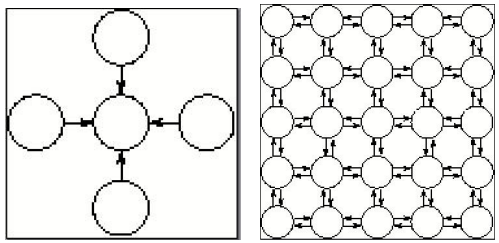
coll. U. San Luis, EZCT

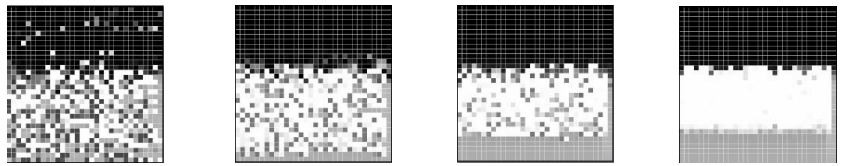
GECCO 05, PhD Kavka, PhD Singh

Voronoï

Developmental representations

coll. MIT, GECCO 07





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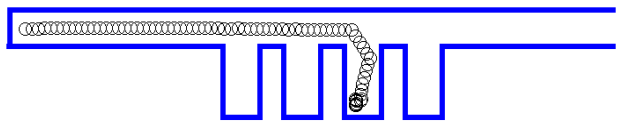
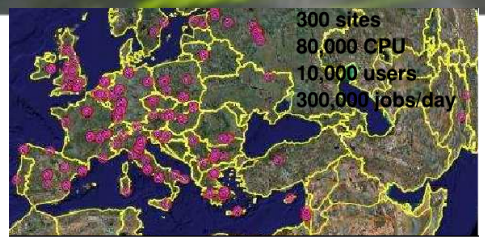
Reservoir Computing

coll. INRIA-Alchemy, LIMSI

Solving the Tolman maze



Applications - 2. Autonomic Grid - EGEE III



Scheduling and Reinforcement Learning

ICAC08

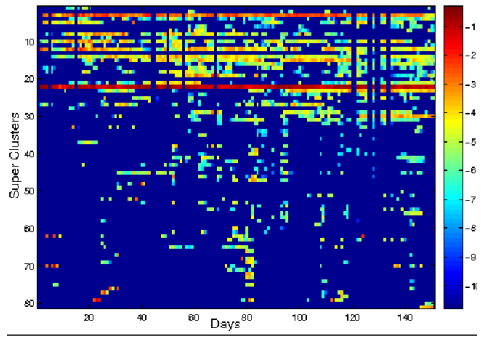
Multi-objective rewards
Continuous representation of users.

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

Job streaming and profiling

ECML08

Build snapshots
Build chronicles



Coll. Lab. Accélérateur Linéaire, UPS

Perspectives

Extended Bandits

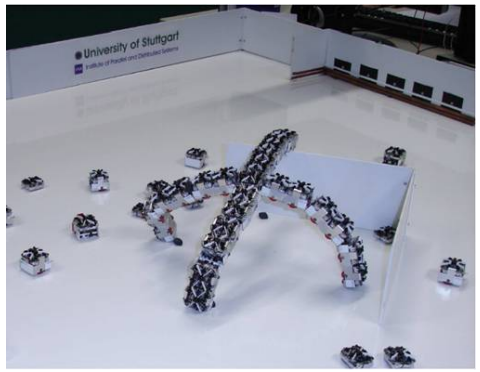
Dynamic environments	won OTEE Challenge
Delayed and partial rewards	PASCAL
Multi-objective rewards	Exploration vs Safety
Multi-variate bandits	Junction with RL
Bounded Reasoning	Finite horizon

Swarm Robotics

SYMBRION IP; Coll. U. Kyushu, Japan

Decentralized control

Robotics Log Mining

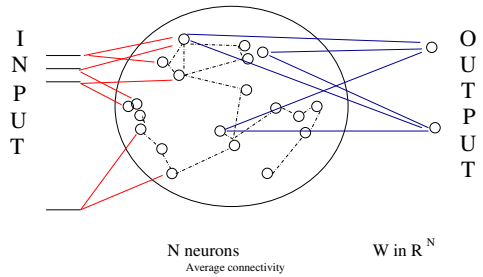


Longer-term Perspectives

Hardware-aware Software

Coll. Alchemy, GECCO08, ECML08

Algorithms as fixed point systems
Reservoir computing

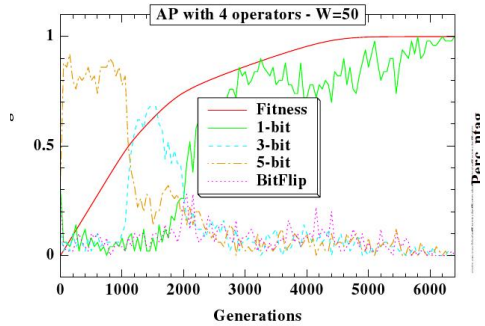


Crossing the Chasm

Joint INRIA-Microsoft project

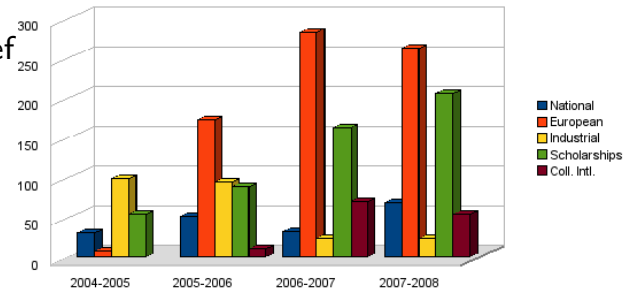
PPSN08, GECCO08

Parameter/Alg. Selection
- Multi-Armed Bandits
- Change Test Detection



Summary 2005-2008

Training	10 PhDs, 2 HdRs
Publications	190 papers (9 A+ ; 43 A) ; 1 patent (IFP)
Animation	2nd Pascal Challenge Wshop 2006 Dagstuhl Seminar on EC theory 2008 Multiple Simultaneous Hypothesis Testing, Pascal Wshop 2007 Large Scale Learning Challenge & Wshop 2008 Franco-Japanese Wshops: Sapporo 2007, Paris 2008. Apprentissage: la carte, le territoire et l'horizon, 2008
Evaluation	Editorial Boards: 8 journals (ECJ MIT, editor in chief PC: All major international conf. in ML & EC
Contracts	1 861 kE



IAO Highlights 2005-2008

A Notable Success of AI

The Economist, Jan. 07

- MoGo Silver Medal, Olympiads 2008
- Sylvain Gelly:
  Award, Chancellerie des Universités
  Runner-up Award Gilles Kahn
- Convergence and Consistency Results for Adaptive ES
- Optimal Design
  Beaubourg permanent exhibition
- Grid Observatory