ANITI

ARTIFICIAL & NATURAL INTELLIGENCE
TOULOUSE INSTITUTE

Automated Reasoning and Decision Making

Christian Artigues and Thomas Schiex

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Université Fédérale
Toulouse Midi-Pyrénées

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MEMBERS

THEME DESCRIPTION

ONGOING WORK

HIGHLIGHTS and MAIN RESULTS

DISSEMINATION and ANIMATION

Members I

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Chairs

1. Hélène Fargier: Knowledge compilation for solving problems with uncertainty and preferences
2. João Marques-Silva: Deep Learner Explanation & Verification
3. Thomas Schiex: Design using intuition[1] and logic[2]
4. Louise Travé-Massuyès: Synergistic transformations in model based and data based diagnosis
5. Leila Amgoud: Empowering Data-driven AI by Argumentation and Persuasion (E. Lorini)

Members II

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Co chairs

1. Christian Artigues (LAAS), Romain Guillaume (IRIT), Cédric Pralet (ONERA), Jérôme Mengin (IRIT)
2. Martin Cooper (IRIT), Emmanuel Hébrard (LAAS)
3. Sophie Barbe (INSA/INRAE), David Simoncini (IRIT), Georges Katsirelos & Simon de Givry (INRAE)
4. Nathalie Barbosa Roa (Vitesco Technologies), Elodie Chantery (LAAS), Xavier Pucel (ONERA).
5. Emiliano Lorini (IRIT, AR for planning, explaining using epistemic logic, SAT, QBF)

Members III

Associated researchers

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1. Knowledge compilation for solving problems with uncertainty and preferences: Elise Vareilles (ISAE), Paul Gaborit (EMAC)
2. Deep Learner Explanation & Verification: Mohamed Siala (LAAS)
3. Design using intuition[1] and logic[2]: David Allouche (INRAE)
4. Synergistic transformations in model based and data based diagnosis: Yannick Pencolé (LAAS), Stéphanie Roussel (ONERA), Gregor Gossler (INRIA)
5. Argumentation: Andreas Herzig, Frederic Maris and Dominique Longin

Members IV

PhD students and Post-doc

1. Louis Rivière, Tom Portoleau* (PhD), Nicolas Schmidt (Post-doc)
2. Yacine Izza (Post-doc), Thomas Gerspacher* (PhD), Valentin Antuori * (PhD)
3. Valentin Durante, Pierre Montalbano, Manon Ruffini*, Jelena Vucinic*, Younes Bouchiba* (PhD),
4. 1 CIFRE planned, 1 post-doc planned, Valentin Bouziat* (PhD)
5. Fabian Romero, Jorge Luis Fernandez Davila

* Not funded by ANITI

Theme Description I

Modeling and solving NP-hard problems

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Thread 5.1 :Algorithms and complexity

- (weighted) CP / SAT / MIP / Graphical models solving
- Discrete feasibility, optimization, quantified, counting
- Prime implicates/implicants, non-standard logics (epistemic)
- With (checkable) proofs, certification
- Search with simplification, relaxation of NP-hard problems instances
- Knowledge compilation for decision under uncertainty and preferences
- Computational complexity analysis
- In-house solvers: data-structures, implementation and benchmarking
- Automated reasoning for ML (proofs, exact loss optimization,. . .)
- ML for Automated reasoning (learning models, heuristics, . . .)
- Models and algorithms for complex design, scheduling, planning, diagnosis

Theme Description II

Automated Reasoning and Decision Making in Practice

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Thread 5.2 :Applications to complex systems along their life

- **Design**: Designing proteins with automated reasoning (and learning), product configuration
- **Offline and online decision making**: reactive and proactive scheduling in assembly manufacturing
- **Diagnosis**: Automated Reasoning for modeling and finding preferred diagnosis

Ongoing work

Core research

- Benchmarking Knowledge Compilers (KC)
- Approximate/Partial KC
- KC for scheduling assembly workshops under uncertainty
- KC map of Temporal Constraint Satisfaction Problems (resource constrained project scheduling), conditional preferences
- Accelerating Weighted CP solving (heuristics, nogood-recording, convex relaxations)
- Bi-level (min-max) discrete optimization for protein design
- Learning discrete optimization interpretable problems from data
- Reasoning about inconsistency and optimizing with NP oracles
- Efficient computation of prime implicants for explaining ML models
- Simplification of NP-hard problems instances (preprocessing)
- Joint diagnosability maximisation and subsystem connection minimization via system decomposition and test selection

Ongoing work

ongoing or potential collaborations

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Intra theme collaborations

- Max-SAT/Weighted CSP for model-based diagnosis (2-4).
- Knowledge compilation for diagnosis, optimal test selection (1-4, two meetings).
- Learning preferences from data for interactive solving (1-3)
- Learning and rigorously solving with probabilities and logic (2-3)
- Hybrid CP/SAT/GM/MILP methods (1-2-3)
- Game theory and KC

Inter theme possible collaborations

- Convex relaxations for discrete graphical models optimization
- MILP approximations of non linear continuous optimization problems
- ML for Automated Reasoning, Automated Reasoning for ML

HIGHLIGHTS and MAIN RESULTS

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- Large scale experimental comparison of MDD compilers (KC)
- A KC map for conditional preference statements-based languages
- An information-based decision tree model for proactive/reactive scheduling
- Clause learning for Graph coloring (JAIR)
- Explanation of Naive Bayes in polynomial time and polynomial delay (NeurIPS)
- Successful protein designs with Toulbar2: self-assembling, nanobody, enzymes.
- New release of the Toulbar2 solver (AIJ)
- Mistral solver wins 2 bronze medals at MiniZinc Challenge 2020
- CPAIOR'20, CP'19 chairs, AAAI Fellow, ACP Summer school

SCIENTIFIC ANIMATION OF THE THEME

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- Organization of the ACP / GDR IA / GDR RO summer school 2020 : *Combinatorial optimization, constraint programming and machine learning*
- Organization of a scientific workshop every 2 months to favor collaborations
- Co-direction of Master students between threads