Aniti / Knowlege Compilation

Ph. D. offer in Artificial Intelligence (3IA ANITI, Toulouse, France)

« Knowledge Compilation for Incomplete Combinatorial Optimization Techniques »

In combinatorial optimization, the objective is to find an assignment to a set of decision variables that satisfies a set of constraints and that optimizes a given objective function. Such problems are often tackled by incomplete search techniques such as local search, tabu search, iterated local search, greedy-randomized adaptive search and on various kinds of metaheuristics. Incomplete search techniques do not offer the guarantee to find an optimal solution, but their main strength is their capacity to find good quality solutions even for large-size instances and even if the computation time is limited.

One common difficulty of incomplete techniques is the need to define strategies to escape from local optima and avoid revisiting the same solutions over and over. For instance, in tabu search, a *tabu list* is introduced to forbid considering some solutions or some local moves during a given time-period. This tabu list acts as a kind of memorization that helps the search process being less blind. However, it is usually exploited as a short-term memory, meaning that tabu configurations usually become non-tabu again later in the search process.

In this thesis, we aim at exploring Knowledge Compilation techniques for boosting incomplete search algorithms thanks to long term and efficient memory data structures. The idea is to learn conflicting solutions (that violate some constraints or that are suboptimal) and to exploit them to (i) avoid reconsidering the same solutions and (ii) guide search.

Several direction of research shall be explored:

On-the-fly knowledge compilation: Most of the time, KC techniques compile the static part of a probleme *offline* and then answer *online* to various requests. Contrarily to this mainstream approach, the challenge is here to perform *on-the-fly knowledge compilation*, to be able to simutaneously search for an optimal solution and learn conflicts.

Approximate compilation: The idea here would be to prune (or to enlarge!) the conflict data basis in order to get a smaller compiled form. One relevant aspect for instance is to keep the forbidden solutions that would be met the most frequently if they were not forbidden, or which were the hardest to obtain.

Conflict-based heuristics: forbidding some solutions, it might become impossible to make a sequence of local moves. On this point, we propose to use the compiled conflict basis to guide the search : the basis can be requested to extract a non-conflicting assignment, which can serve to quickly move to a (currently) non-forbidden assignment. Other standard requests such as model counting could also be used, to make the search process move towards solutions which are far from the conflicting solutions.

Application to the aerospace field: Last, one key objective is to apply these techniques to OR problems (e.g. vehicle routing, assignment or scheduling problems) raised by the aerospace field. For each kind of problems considered, the study shall determine whether some specific knowledge compilation techniques should be used to improve the efficiency of the approach.

The ideal candidate will have a strong background in combinatorial optimization (e.g. SAT/CSP solvers) and OR. This research will be conducted within the stimulating environment of the Artificial and Natural Intelligence Toulouse Institute.

The monthly net salary starts from 2 000 euros

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References

- Hélène Fargier, Pierre Marquis, Alexandre Niveau, Nicolas Schmidt: A Knowledge Compilation Map for Ordered Real-Valued Decision Diagrams. AAAI 2014: 1049-1055.
- Alberto Venturini, Gregory M. Provan: Incremental Algorithms for Approximate Compilation. AAAI 2008: 1495-1498.
- Tarik Hadzic, John N. Hooker, Barry O'Sullivan, Peter Tiedemann: Approximate Compilation of Constraints into Multivalued Decision Diagrams. CP 2008: 448-462.
- Gilles Audemard, Jean-Marie Lagniez, Laurent Simon: Just-In-Time Compilation of Knowledge Bases. IJCAI 2013: 447-453.
- Adnan Darwiche, Pierre Marquis: A Knowledge Compilation Map. J. Artif. Intell. Res. 17: 229-264 (2002).
- Gilles Audemard and Jean-Marie Lagniez and Bertrand Mazure and Lakhdar Sais : Integrating Conflict Driven Clause Learning to Local Search. Proceedings 6th International Workshop on Local Search Techniques in Constraint Satisfaction, 2009.
- Armin Biere, Marijn Heule, Hans van Maaren and Toby Walsh (Eds.) : Conflict Driven Clause Learning, Chapter 4, Handbook of Satisfiability. IOS Press, 2009.
- Michel Gendreau and Jean-Yves Potvin : Handbook of Metaheuristics. Springer Publishing Company, 2010.
- Andreas Schutt, Thibaut Feydy, Peter J. Stuckey and Mark G. Wallace : Solving RCPSP/max by lazy clause generation. Journal of Scheduling 16(3) : 273-289 (2013).

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Application

To complete your application, you are invited to provide (as pdf files)

- a detailed curriculum, including recent academic marks and ranks,
- up to three recommendation letters stating your ability for research,
- a short research statement,
- a list of publications if any.