PHD PROPOSAL IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

KNOWLEDGE COMPILATION FOR INCOMPLETE COMBINATORIAL OPTIMIZATION TECHNIQUES

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Net salary: 2096€ per month with some teaching (64 hours per year on average)

Duration: 36 months

DESCRIPTION

In combinatorial optimization, the objective is to find an assignment of a set of decision variables that satisfy 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 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 problem 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 simultaneously 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 to 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.

APPLICATION PROCEDURE

Formal applications should include detailed cv including recent academic marks and ranks, up to three recommendation letters stating your ability for research, a short research statement. Samples of published research by the candidate if any will be a plus.
> applications should be sent by email to: advisor email
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