# Post-Doctorate Research Proposal

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During the period of the PhD research, a number of articles have been published in journals and proceedings of leading conferences on Artificial Intelligence. The research considered several search problems and improved some well-known algorithms for solving the problems using the rational metareasoning approach:

- Semimyopic measurement selection for optimization under uncertainty [8];
- Rational value of information estimation for measurement selection [7];
- Adaptive deployment of value-ordering heuristics in constraint satisfaction problems [5];
- Monte Carlo tree search based on simple regret [6, 3];
- Decreasing heuristic evaluation time in a variant of A* [4].

In addition to the algorithm improvements, the studies demonstrated a number of common rational metareasoning techniques which can be extended to other problem types. In particular,

- [8], a journal paper published inthe highly ranked IEEE-SMC-B, includes definition and heuristic solution of the selection problem, as well as introduces a less restricting and more powerful value of information estime — the blinkered estimate — used in later publications as well as employed by other researchers.
- [7], another journal paper, describes a novel and efficient value of information estimation scheme for optimization problems.
- [3] provides distribution-independent upper bounds for semi-myopic VOI estimates in Monte-Carlo sampling.
- [4] introduces a novel area of application of rational metareasoning—optimal search in optimization problems.

Aspects of methodology of rational metareasoning initially presented in the conference publications [6, 3] on VOI-aware Monte Carlo Tree Search and [4] on rational deployment of heuristics in A* are, despite significant theoretical and empirical results, just the first steps in the exploration of the corresponding research fields. Some important results had to be omitted due to inevitable space limitations of conference proceedings. Additional work which has been and being done in the above-mentioned research directions justifies publication of extended journal versions of the papers with new theoretical results and expanded empirical evaluations.

In particular, the advances in Monte Carlo Tree Search are based on distribution-independent VOI bounds. In the publication [3], the improved sampling scheme had been empirically evaluated on the domain of Computer Go. Another domain where MCTS recently proved to be efficient is online

planning in Markov Decision Processes. Some results for MCTS in MDP were obtained, but not yet published. The results address both a different family of distributions appearing in the planning problems, and empirical evaluation of the scheme on additional domains. Recent work of other authors on sampling-based planning [2, 1] provides additional insights and should be referenced in the analysis.

The published work on A* [4] reports results on rational lazy deployment of two heuristics in Lazy A*, a variant of A*. Only some results of the theoretical analysis were published. In addition, the same novel approach can be applied to A* when only a single heuristic available, and to another variant of A*, IDA*, in the presence of multiple heuristics. Work on new theoretical results, analyzing rational selection of the order of heuristic, and of the most appropriate deployment scheme, is underway. Empirical evaluation of the heuristic deployment scheme on additional domain families and combination of heuristic was done and can be further usefully extended, but has not yet been published.

Journal papers including the already obtained results and work underway are planned for submittion to publications in [...] during the coming year.

# References


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