Report on Otakar Trunda's doctoral thesis

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The thesis addresses a very relevant a hot research topic, learning heuristics for Automated Planning (AP) using Machine Learning (ML) techniques. Specifically, the thesis aims at constructing heuristics that generalize over problems of the same domain, what is called a system of Type II HL (Heuristic Learning); that is, learning domain-specific heuristics using domain-independent methods (ML techniques). Two research lines are followed, one lies in using data analysis to improve existing heuristics and the other one in automatically creating new heuristics from scratch, the latter the main topic of the Ph.D. work.

The document is very well written, and it is easy to follow. Chapter 1 clearly introduces the basic notions and concepts to position the contribution within the state of the art. The document also presents a good coverage of related work. It is particularly commendable the work the candidate has done in analyzing the characteristics and properties of heuristics in forward search algorithms to come up with ways of improving heuristics that are suitable to the Type II HL framework. I particularly liked the view of the process of heuristic estimation as a function of the two components, the dividing component and the estimating component. It is a good idea to come up with these two components as it also enables to structure the contribution of the thesis around two main pillars, namely the feature extractor and the analysis of the heuristics' accuracy and adjustments. In general, I think that the thesis is very well organized and that the reading flows smoothly throughout the document. Another positive aspect of the work is that it performs a comprehensive study that evaluates the advantages and disadvantages of existing techniques for sampling state spaces, calculating target distances, extracting state characteristics, etc. This is very helpful determine how suitable the existing techniques are for the Type II HL framework, and how they can be reused or adapted for the purpose of the doctoral thesis.

Graph-based feature extractor. This is an interesting and novel idea to encode a STRIPS planning state into an integer feature vector. The proposal is well motivated around the idea of the object graph for a state and the corresponding graph feature vector. As a suggestion, it might be interesting to investigate the D2L approach (see references [1,2] below). D2L uses the domain description, a set of planning problems and their solutions, and computes a set of common features representative of the states which are later used to express general policies. While D2L does not extract state features but domain features, it may be worth analyzing the pool of features that it automatically generates from a general grammar applied to the domain predicates and checking if these features are expressed by the graph feature vectors of this proposal. Perhaps this analysis could serve to study the theoretical guarantees of particular domains and be extended to a more general inspection of the expressive power dependent on 'alpha'.

[1] Blai Bonet, Guillem Francès, Hector Geffner. Learning Features and Abstract Actions for Computing Generalized Plans. AAAI 2019: 2703-2710.

[2] Guillem Francès, Blai Bonet, Hector Geffner. Learning General Planning Policies from Small Examples Without Supervision. AAAI 2021: 11801-11808.

Experiments. The thesis presents exhaustive and careful experimentation in two planning domains, the zenotravel and blocksworld domains. The results show that the learned heuristics fit the two models very well. The results of running the NN-based heuristic including the value of hFF in the graph-based feature vector are appealing. In terms of the number of problems solved, higher values of alpha make up for the gain of the hFF value in the blocksword but not in the zenotravel domain. It is also interesting to observe that when the average range of Delta-sets drops significantly in the zenotravel domain, the increase in the number of more problems is not very high (both with and without hFF). This leads to the conclusion that the value of alpha is much more impactful in the blocksworld than in zenotravel. As for future work, I foresee that investigating the properties and characteristics of the domains that exploit better the parameter alpha would be an interesting research line.

Conclusion: Based on the quality of the presented document presented, the work is qualified as very good, and I suggest that the student's doctoral thesis defense be accepted.