Review of the Bachelor Thesis "Abstractions Exploiting Statistical Information" by Vasily Levitskiy

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Title of the thesis: Abstractions Exploiting Statistical Information
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The thesis focuses on the construction of abstraction-based heuristic functions for state-space search in classical planning. The idea introduced in this thesis is novel and very interesting: Instead of building abstractions that make multiple states from the original planning tasks indistinguishable from each other in the abstract state space, the work proposes to preserve at least some information about the diversity of states merged into a single abstract state by assigning probability to actions applicable in the abstract state reflecting the diversity of the original states. This means that finding plans in the resulting abstract state spaces needs to be solved as probabilistic planning problems, i.e., it leads to the formulation via MDPs. This is in itself unusual because we start with a deterministic planning task and end up with a heuristic function that has to be evaluated by solving a probabilistic planning task. Nevertheless, this makes the approach even more intriguing and it would be interesting to see how informative it can get and how well it scales (especially since the compilation to MDPs requires n additional auxiliary states where n can be the number of actions in the worst case).

The thesis clearly describes the proposed method and it seems the student successfully implemented it. Although the implementation in Python makes it harder to compare to the state-of-the-art implementation of abstraction heuristics (which is in C++), I think it would be sufficient if the comparison was made only in terms of heuristic values.

Unfortunately, the work has also many deficiencies. The text often does not cite the appropriate literature. I would not mind that definitions of some well-known notions like labeled transition systems, SAS$^+$ planning tasks, MPDs, or abstractions are left without any reference (although one could cite at least one of the many books dealing with these topics), but the work fails to cite relevant literature when making non-trivial claims about these notions. For example, the fact that abstractions preserve plans would deserve a proper reference, or the equivalence between LTS of a projection and a projection of LTS (in fact, it is just alluded and not explicitly stated), or the existence of an optimal policy for MDPs (here, the work should also state explicitly the conditions).

What is the main disappointment is the experimental section which seems to be written hastily, without attention to detail and without clear objective. The problem starts with missing description of the full set-up used. It is not clear what dataset exactly what used and why (my impression is that only a certain subset from the standard benchmark set was used). Some parts are left almost without any explanations For example: What is "gamma importance"? What is shown in Fig 5.3, what does "5", "4-5", and so on mean? What are the numbers next to data points in Fig. 5.4? There does not seem to be any connection between the individual subsections and the conclusions made are often confusing. For example, in Section 5.3, what does it mean that "there isn't even a need to have a big projection most of the time"? If

the student meant to say that it is more important to project onto "relevant" variables (in the sense of preserving paths) than on building large abstractions, then this is a trivial, well-known, fact that has nothing to do with the proposed method. So, it is not clear to me what is conclusion here in regards to the proposed method (let alone how one can make any conclusions from the presented experimental evaluation). To mention another example, the comment above Fig. 5.8 states that Fig. 5.8, showing higher heuristic estimates for the proposed method over the baseline, "proves" that the proposed method is an improvement. However, the proposed method is not admissible whereas the baseline is, therefore such conclusion is confusing at best, and misleading at worst.

Lastly, the work completely misses any discussion of the related work. There is a wealth of publications on abstraction heuristics as it is one of the most successful techniques for classical planning. The work mentions only projections, but there many other techniques that aim at solving the problem of "too abstract" abstractions. This is, after all, the main argument of the work: Abstractions tend to loose information by making some states indistinguishable, so we try to remedy this problem by preserving some of the information in the probabilities over applicable actions. However, the work does not mention any other method that tries to deal with this problem in any other way—and there are plenty, in fact, projections are known to be the weakest form abstractions.

For these reasons, I evaluate the thesis with the grade C.