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Referee Report on Doctoral Thesis

Modelling and Solving Problems Using SAT Techniques

by RNDr. Tomas Balyo

To whom it may concern,

the thesis presents new results for two different topics in the context of SAT based planning.

The first topic is concerned with different encodings of planing into SAT. The author describes a slight variant of the standard SASE encoding and a new Reinforced Encoding, which actually is a combination of the well-known direct encoding and SASE. These basic encodings are complemented by a new existential encoding, called “Relaxed Relaxed Existential”. The idea of these more advanced existential encodings is to combine multiple actions into one step. The potential order of actions has to be restricted and the dissertation describes various trade-offs in ordering the actions. The two new encodings presented by the author turn out to have orthogonal strength and accordingly a portfolio style version, called Selective Encoding, is presented, which selects one of the two for a given instance, based on the number of transitions. The extensive experimental evaluation shows that this latter encoding is best. Soundness of all encodings is proved in detail, as well as complexity in terms of CNF size. Completeness is discussed briefly.

The second topic of the thesis is about reducing plans, which is the process of removing redundant actions, to shorten the plan. The problem is described precisely as well as existing polynomial but greedy approaches. The author suggests to use a SAT encoding for checking for reducibility of plans (for the first time). Again correctness and complexity of the encoding are shown. This encoding leads to a greedy algorithm itself but can be refined to an optimal algorithm by using a partial MAXSAT solver in order to obtain minimal length plans by reduction or by using a partial weighted MAXSAT solver to even obtain minimal cost plans. The experimental evaluation shows first that there are indeed cases where the greedy methods are not optimal and, surprisingly, that the potentially exponential methods based on MAXSAT in practice often perform better than previously existing polynomial reductions.

The thesis is well written and easy to follow: concepts are described in sufficient details, important algorithms are shown in pseudo code. Both parts of the thesis contain novel ideas and contribute to the state-of-the-art in SAT based planing. I think similar ideas can be transferred to important related areas, in particular to SAT based bounded model checking, which has high industrial relevance.

The thesis clearly shows the ability of the author to perform creative scientific work.

Regards,

Prof. Dr. Armin Biere