Research Review
Masa Watanabe

SATPLAN (Kautz and Selman, 1992, 1996) and GRAPHPLAN (Blum and Furst, 1995) are two methods for planning. The original SATPLAN differed from the traditional method of solving planning problems through deduction and set out to solve these problems through satisfiability.(Kautz and Selman, 1992, 1996) GRAPHPLAN, following SATPLAN, introduced a new approach of using planning graphs to construct a propositional structure (Blum and Furst, 1995). Finally, BLACKBOX combines the advantages of the two planners to create a further enhanced planner competitive in several planning domains (Kautz and Selman, 1998).

As mentioned above, SATPLAN uses satisfiability rather than deduction. This means treating a problem not as a theorem but rather a set of axioms to be satisfied. A valid plan will fit any model of the axioms. SATPLAN works in two stages: the propositional structure (such as the initial and goal state) and the search (the actions). This approach allowed for more flexibility in solving planning problems and more accuracy for constraint-based planning systems (Kautz and Selman, 1992, 1996).

GRAPHPLAN followed SATPLAN in using a two stage system. The system uses a Planning Graph to return the shortest possible partial-order plan. The planning graph makes use of the mutual exclusions of the previous level to prune nodes, efficiently producing a propositional structure. The algorithm also “memoizes” the level so that it can identify any future identical sets of subgoals that are unsolvable, adding to its efficiency. An additional feature that enhances its speed is its ability to ability to terminate if no valid plan exists in the shortest-possible time. After identifying where the planning graph levels off (where the proposition structure of 2 back to back levels are identical), the system is able to identify whether a valid plan exists (Blum and Furst, 1995).

Both GRAPHPLAN and SATPLAN perform better in certain domains as a result of their respective advantages. SATPLAN has a better search algorithm while GRAPHPLAN constructs a more efficient propositional structure. The key difference between the two systems to note is that SATPLAN uses axioms (CNF) while GRAPHPLAN uses planning graphs. However, the correlation between the axioms and planning graphs are uncanny. In fact, Kautz and Selman noted that the resulting formula of the planning graph is very close the original convention of SATPLAN (Kautz and Selman, 1998).

BLACKBOX takes their respectives strengths to create an even more effective, flexible planner. Using the GRAPHPLAN’s planning graph in the propositional stage, translating that into a CNF and feeding into a SATPLAN engine in the search stage allowed for significant improvements in performance. The natural progression of the planning graph into a CNF helped reduce the efficiency loss in translating from one to the other. The pruning of unreachable nodes in the planning graph proved more efficient for the SAT engines than producing a CNF through the SATPLAN approach (Kautz and Selman, 1998).

As work continues to improve all three systems individually, the collective progress of planning systems will be exponential. The improvements in GRAPHPLAN’s planning graph generation phase can be directly incorporated into BLACKBOX as will developments in SAT engines. The unification of GRAPHPLAN and SATPLAN allows the evolution of both planning systems to contribute to the evolution of BLACKBOX. BLACKBOX is evidence of the progress towards IJCAI Challenge for unifying planning framework (Kautz and Selman, 1998).

References:

Blum, A. and Furst, M.L. (1995). Fast planning through planning graph analysis. Proc. IJCAI-95, Montreal, Canada

Kautz, H. and Selman, B. (1992). Planning as satisfiability. Proc. ECAI-92, Vienna, Austria

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