

Research Review

Planning as Satisfiability

Kautz and Selman (1992) pointed out that planning can be treated as satisfiability as opposed to being traditionally regarded as a deductive process of finding sequence of actions from the initial conditions to the goal states. The formalization of planning as satisfiability has major advantages as it can handle arbitrary facts of the world, any intermediate state of the world, as well as arbitrary constraints on the plan (1992). GST, a randomized greedy algorithm, and Davis-Putnam backtracking algorithm can both be used to solve satisfiability problems. It's also shown that by adding additional axioms that explicitly rule out impossible conditions, the GST can perform better.

HSP: Heuristic Search Planner

HSP is different than other popular planning methods such as GraphPlan and SatPlan as they build suitable structures first and then search for solutions (Bonet and Geffner, 2000). Heuristic search is a forward search that uses a heuristic function that estimates the distance to the goal as a guidance to search the search space. The heuristic function can be derived from the specification of the planning task automatically by relaxing the problem to a simpler problem. One way is to ignore the delete list of the action and this results in a lower bound to the optimal solution and hence it is an admissible heuristic. Bonet and Geffner also pointed out that the heuristic function can enable the use of A* algorithm to Strips planning problems. And as alternatives to A*, weighted A* algorithm or hill-climbing search can be used (Bonet and Geffner, 1997).

FF Planning System

Contrary to many previous planning systems such as partial-order planning and planning graph analysis, which focused on generic problem solving methods, the FF system was inspired by the existing benchmarks and focused on a restricted subset of planning (Hoffman and Nebel, 2001). As a result, the FF system produces solutions very fast in planning benchmark domains and won

the planning competition at AIPS-2000. Similar to HSP, FF uses forward search as well as heuristic evaluation by ignoring delete lists. In addition, it uses an enforced form of hill-climbing that incorporates local and systematic search as the search method (Hoffman and Nebel, 2001). For each state, the hill-climbing calls the relaxed GraphPlan, which estimates the goal distance and provides helpful actions. To prune the search tree, it selects the most promising successors to each node and cut out branches if some goals are satisfied too early. Hoffman also pointed out that their FF work can be extended to ADL(Action Description Language) by a preprocessing approach and adjustments to pruning and search methods.

References

- Bonet, B, Loerincs, H and Geffner, H (1997). A robust fast action selection mechanism for planning, in: Proc. AAAI-97.
- Bonet, B and Geffner, H (2000). Planning as Heuristic Search. *Artificial Intelligence* 129 (2001), 5-33.
- Hoffmann, J and Nebel, B (2001). The FF Planning System: Fast Plan Generation Through Heuristic Search. *JAIR* 14 (2001), 253-302
- Kautz, H and Selman, B. (1992). Planning as Satisfiability. In *ECAI 92*, pp. 359-363