Historical Developments in Planning and Search

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Synopsis

This review biefly introduces 3 major planning strategies around the year 2000. The strategies represent different approaches ranging from planning graphs, over POP (partial order planning) to heuristical state space search

Graphplan

Between 1995-1997 Graphplan emerged and extended the perspective on planning. Even in complex domains, a solution plan can be generated in polynomial time and space and is guranteed go find the shortest path.
Instead of representing the possible state space, a compact representation of all the possible states/actions are stored together with a mutex list for each level. While other approaches use the planning graph only to get a heuristic by estimating the distance to goal, Graphplan extracts the solution direct from the built graph. Starting from the goal, conflict free states/actions are choosen greedy till the initial state is reached.

RePOP

After the success of Graphplan and state space planning system in the 1990s, partial order planning was quite unpopular. There was a prevailing pessimism about the scalability of POP systems. This changed after the establishment of RePOP in 2001. In parallel planning domains like Gripper, Logistics, Rockets, it outperforms Graphplan while having more execution flexibility.
POP strategies are able to decompose problems into sub-problems. But as states are not represented directly, it´s hard to estimate the distance to the goal.
RePOP is build on top of UCPOP and succeeded in exploiting the same technics that are responsible for the effectivness of state search and CSP approaches. Namely, an effective heuristic search control, with the use of a reachability analysis detecting indirect conflicts early.
On the downside, RePOP is inefficient in serial domains like Travel, Grid or 8-puzzle.

Fast-Forward

The Fast-Forward Planning System, abbreviated FF, was published 2005, and is based on a forward search in the search space. It´s guided by a heuristic function that is automatically extracted from the domain description. It was the most succesful automatic planner in the AIOS-2000 planning systems competition.
Like other planners it derives an admissable heuristic function by relaxing the planning problem. In this case, the delete lists of all actions are ignored, leading to a simpler problem which can be solved efficiently. This approach is similiar to HSP, but some improvements were made to gain a better performance. First, FFs heuristic evaluation is also taking positiv interactions between facts into account. Second, as evaluating states is costly, FF uses an enforced form of hill-climbing to reach the goal by evaluating as few states as possible. Further, the relaxed plan can also help to identify the most useful succesors, leading to action pruning.
It must be mentioned that FF´s performance decreases as the number of variables are growing. Typically it got stuck in local minima that can´t be escaped.

References

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