Planning algorithms reviews

Review of Total-ordered, Partial-ordered-planning, and graphed planning algorithms.

Total order planning (TOP) algorithms of the 1970s were soon discovered to be incomplete. They cannot solve simple problems, such as the Sussman anomaly, found by Allen Brown during his experimentation with the HACKER system. The complete planner must allow for interleaving of actions from different subplans within a single sequence. David Warren provided one solution to this problem with his WARPLAN algorithm in 1974. WARPLAN utilized goal regression planning, a technique in which steps in a totally ordered plan are reordered so as to avoid conflict between subgoals. WARPLAN was notable in that it was the first planner to be written in a logic programming language (Prolog). It was only 100 lines of code, a small fraction of the size of planners of the time, making it one of the best example of economy gained by using logic programming.

The ideas underlying partial-order planning came and dominated the next 20 years of research. They include the detection of conflicts and the protection of achieved conditions from interference. Most notable POP planner in this period was the UCPOP, developed by J. Scott Penberthy and Daniel S. Weld in 1992. UCPOP was the first planner for problems expressed in ADL. It operated with actions that have conditional effects, universally quantified preconditions and effects, and with universally quantified goals. UCPOP also incorporated the number of unsatisfied goals heuristics. Better heuristics were introduced, but UCPOP was seldom able to find plans with more than a dozen or so steps. POP fell into disrepute, paving the way for faster methods to emerge.

Avrim Blum and Merrick Furst revitalized the field of planning with GRAPHPLAN in the late 1990s. GRAPHPLAN is a general-purpose planner for STRIPS-style domains, based on ideas used in graph algorithms. Given a problem statement, GRAPHPLAN explicitly constructs and annotates a compact structure called a Planning Graph. It has the property that useful information for constraining search can quickly be propagated through the graph as it is being built. The nodes are actions and atomic facts, arranged into alternate levels. The edges are of two kinds: from atomic facts to actions for which it is a condition, and from an action to the atomic facts it makes true or false. GRAPHPLAN then iteratively extends the planning graph, exploits backward chaining and pruning as many actions and states thanks to incompatibility information in the search for a plan.

References

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