Research Review - Planning Systems
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Planning systems are problem-solving algorithms that operate on explicit propositional or relational representations of states and actions. The representations make possible the derivation of effective heuristics and the development of powerful and flexible algorithms for solving problems. We discuss the early stage to latest developments in the planning domain below.

Linear Planning

The basic Idea of linear planning is to work on one goal until completely solved before moving on to the next goal. The General Problem Solver (GPS), one of the earliest planners(1960's) used linear planning using recursive procedure calls as the goal-stack mechanism. However this was soon discovered to be incomplete.It cannot solve some very simple problems, such as the Sussman anomaly (see Exercise 10.7), found by Allen Brown during experimentation with the HACKER system (Sussman, 1975). A complete planner must allow for **interleaving** of actions from different subplans within a single sequence.

One solution to the interleaving problem was goal-regression planning, a technique in which steps in a totally ordered plan are reordered so as to avoid conflict between subgoals. This was introduced by Waldinger (1975) and also used by Warren's(1974) WARPLAN .WARPLAN is also notable in that it was the first planner to be written in a logic programming language (Prolog) and is one of the best examples of the remarkable economy that can sometimes be gained with logic programming: WARPLAN is only 100 lines of code, a small fraction of the size of comparable planners of the time.

Partial Order Planning (POP)

Partial-order planning dominated the next 20 years of research, yet the first clear formal exposition was TWEAK (Chapman, 1987), a planner that was simple enough to allow proofs of completeness and intractability (NP-hardness and undecidability) of various planning problems.

The basic idea of POP is to search in plan space and use the least commitment, when possible i.e make choices only that are relevant to solving the current part of the problem. POP was pioneered by NOAH planner (Sacerdoti, 1975, 1977) and by Tate's (1975b, 1977) NONLIN system.

Though POP is sound, complete and typically produced optimal solutions it is significantly more complex (higher per-node cost) and it's hard to determine what is true in a state. Since concurrent actions were allowed it led to a larger search space.

State-Space Planning

The resurgence of interest in state-space planning was pioneered by Drew McDermott's UNPOP program (1996), which was the first to suggest the ignore-delete-list heuristic, UNPOP was reaction to the overwhelming concentration on partial-order planning at the time. Bonet and Geffner's Heuristic Search Planner (HSP) and its later derivatives (Bonet and Geffner, 1999; Haslum et al., 2005; Haslum, 2006) were the first to make state-space search practical for large planning problems. HSP searches in the forward direction while HSPR(Bonet and Geffner, 1999) searches backward. The most successful state-space searcher to date is FF (Hoffmann, 2001; Hoffmann and Nebel, 2001; Hoffmann, 2005), winner of the AIPS 2000 planning competition.

State-space search can operate in the forward direction (progression) or the backward direction (regression). Effective heuristics can be derived by subgoal independence assumptions and by various relaxations of the planning problem.

References

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