Artificial Intelligence Nanodegree

Research Review

Project 3 – Implement a Planning Search

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Several focal areas of AI emerged between the 1950s and the 1970s. AI Planning started after the works by A. Newell and H. A. Simon, pioneers of *heuristic search*, an efficient procedure for finding solutions in large, combinatorial spaces. They were the fathers of the General Problem Solver (GPS, 1959). *Shakey the robot* (Stanford Research Institute, 1966~1972) overall control structure was modeled on that of GPS.

Classical Planning

STRIPS (STanford Research Institute Problem Solver) was an automated planner developed by R. Fikes and N. Nilsson in 1971. STRIPS was designed as the planning component of the software for the "Shakey the robot" project. STRIPS attempts to find a sequence of operators (actions) in a space of world models to transform a given initial world model into a model in which a given goal formula can be proven to be true. STRIPS world models were represented as arbitrary collections of first-order predicate calculus formulas. STRIPS employed a resolution theorem prover to answer questions of particular models and used means-ends analysis to guide it to the desired goal-satisfying model. STRIPS use closed-world assumption.

ADL (Action Description Language - Pednault, 1986) is an advancement of STRIPS allowing positive and negative literals, open-world assumption, quantified variables in goals, goals made of conjunctions and disjunctions, conditional effects, support for equality, support for types.

PDDL (Planning Domain Definition Language – Ghallab - McDermott, 1998) was introduced as the standard encoding language for "classical" planning tasks. PDDL supports STRIPS-style actions, conditional effects, object creation and destruction, domain axioms over stratified theories, hierarchical actions (composed of subactions and subgoals), management of multiple problems in multiple domains using differing subsets of language features.

Partial order planning

In linear planning, a plan consists of an ordered set of actions. A partial order planning algorithm is any algorithm that can place two actions into a plan without specifying which comes first. Search takes place in the *plan* space instead of the *state* space: in the search tree each node represents a *partial plan* and each edge represents a *plan refinement*. The first non-linear, partial order planner was NOAH (Sacerdoti, 1975), capable of solving optimally the *Sussman Anomaly* problem. Partial order planning fell out of favor in the late 1990s as faster methods emerged.

The resurgence of state-space planning

Nineties marked the reemergence of state-space planning. Some remarkable planners: McDermott's UNPOP program (1996, the first to suggest the ignore-delete-list heuristic), Bonet and Geffner's Heuristic Search Planner (HSP) and HSPR (1999). A successful state-space searcher is FF (Hoffmann and Nebel, 2001), winner of the AIPS 2000 planning competition. FASTDOWNWARD (Helmert, 2006) is a forward state-space search planner that preprocesses the action schemas into an alternative representation which makes some of the constraints more explicit.

References

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