Review of historical developments of AI planning and search

AI planning means devising a plan of action to achieve one's goals. There are 4 key developments in this field: PDDL, Partial-order planning, state-space planning and planning graphs.[1]

1. Developments of PDDL

In 1971, STRIPS was designed as the planning component of software for Shakey robot. The representation language used by STRIPS is close to what we call the "classical" language. The Action Description Language, or ADL (Pednault, 1986) relaxed some of STRIPS restrictions and made it possible to encode more realistic problems. The Planning Domain Definition Language (PDDL) is an attempt to standardize Artificial Intelligence (AI) planning languages. It was first developed by Drew McDermott and his colleagues in 1998 (inspired by STRIPS and ADL among others) mainly to make the 1998/2000 International Planning Competition (IPC) possible, and then evolved with each competition.[2]

2. Developments of Partial-order planning

In early 1970s, planner generally considered totally ordered action sequences. The planner is incomplete. It cannot solve some very simple problems, such as the Sussman Anomaly, 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. In 1975, partial-order planning was proposed. Partial-order planning is complete by detection of conflicts and the protection of achieved conditions from interference. Partial-order planning dominated the next 20 years of research, but it has the disadvantage of not having an explicit representation of states in the state-transition model. That makes some computations cumbersome. By 2000, forward-search planners had developed excellent heuristics that allowed them to efficiently discover the independent subproblems that partial order planning was designed for. As a result, partial-order planners are not competitive on fully automated classical planning problems.

3. Resurgence of state-space planning

In 1996, the ignore-delete-list heuristic was first proposed by McDermott in state-space planning UNPOP program. In 1999, Bonet and Geffner's Heuristic Search Planner (HSP) were the first to make state-space search practical for large planning problems. After that, planners (like FF, FASTDOWNWARD, LAMA), based on state-space planning, won AIPS Planning Competition a lot of times.

4. Developments of planning graphs

A data structure closely resembling the planning graph had been developed slightly earlier by Ghallab and Laruelle (1994), whose IXTET partial-order planner used it to derive accurate heuristics to guide searches. Nguyen (2001) thoroughly analyze heuristics derived from planning graphs. A planning graph can be used in many different ways to guide the search for a solution. Planning graph can be used to give better heuristic estimates. These heuristics can be applied to any of the search techniques we have seen so far. Alternatively, we can search for a solution over the space

formed by the planning graph, using an algorithm called GRAPHPLAN.

Reference:

[1] Stuart Russell, Peter Norvig , AI A Modern Approach, 2010 3rd Ed.

[2] Planning Domain Definition Language,

https://en.wikipedia.org/wiki/Planning_Domain_Definition_Language