Research review on planning

Xiaoyang Yao

1. Linear Planning

Linear planning was introduced in the 1970's. [1] The basic idea behind it is to work on one goal until it is completely solved before moving on to the next goal. Linear planning algorithms can apply on problems that can be decomposed into subgoals. They are advantageous if goals are independent. The searching space is largely reduced since goals are solved one at a time.

General Problem Solver (GPS) is one of the linear planning algorithm. [2] It introduced the concept of means-ends analysis whose basic idea is to search only relevant aspects of the problem. To achieve this, the algorithm find difference between goal state and current state, and then find operator to reduce the difference.

However, linear planning algorithms have two disadvantages. First, it may produce suboptimal solutions because of suboptimal goal ordering. Second, it is incomplete, meaning that a solution is not guaranteed to be found when it exists. This may happen when the goals are not independent, such as the Sussman anomaly.

2. Non-linear planning

Non-linear planning algorithms solved the incompleteness issue by allowing interleaving of actions from different subplans within a single sequence. The basic idea is to use a set of unordered operators instead of a stack of ordered operators. Thus, conflicts between subgoals could be avoided. The advantage of non-linear planning is that they are complete and optimal. The major disadvantage of this algorithm is the larger search space, since all possible orderings of subgoals need to be considered. This usually leads to a more complex algorithm.

WARPLAN is a non-linear planning algorithm written by David Warren that implements a solution known as goal-regression planning to the interleaving problem. It was also the first planner to be written in a logic programming language (Prolog).

3. Temporal planning

One deficiency of linear and non-linear planning is that they don't account for time. However, in the real world, actions occur with a duration of time and can overlap with other actions. When multiple things can be happening at a time, it is necessary to model the duration and concurrency of actions and events. Algorithms that solve this group of problems are called temporal planning algorithms. [3]

[1]. Stuart J. Russell, Peter Norvig (2010), Artificial Intelligence: A Modern Approach (3rd Edition).
[2]. Ernst, G.W. and Newell, A. (1969). GPS: a case study in generality and problem solving. Academic Press. (revised version of Ernst's 1966 dissertation, Carnegie Institute of Technology.)
[3]. Cushing, Weld, Kambhampati, Mausam, and Talamadupula, Evaluating Temporal Planning Domains, Proceedings of ICAPS, pages 105-112, AAAI Press, 2007.