

Planning System Research Summary

Introduction

In this report, I'm going to give a brief review on the development of planning system and outlined some of the planning systems that played key role in the research.

The first period in Planning system is around 1970s. During this period, planning systems are linear planner and in totally ordered manner. Among them, The most influential planning system is STRIPS(Fikes and Nilsson, 1971)

The major influence of the system is its representation language, which later becomes the mainstream in modern planning system.

In early days of AI planning system, systems usually combine two essentially different kinds of searches into a single search for a proof of the theorem representing the goal. Also, the system has to explicitly describe object not affected by operator, which is tedious for some successor state.

To solve the issues and redundancy mentioned above, STRIPS separate search from theorem prove and used first order logic to represent the world.

Planning in STRIPS is PSPACE-complete, which, basically, means that the problem can be solved in polynomial amount of space.

Still , the model during that period is focusing on totally ordered plan,in which actions are sequenced all at once for the entirety task and planners during that period are linear planner. This type of planner will encounter obstacles when facing problems like Sussman Anomaly(the work done by a planner in achieving one goal is undone in the achievement of another goal.).

During the next twenty years, the community is dominated by partial- order planning, and the first clear exposition of this type of planning was TWEAK(Chapman, 1987)

As we can see, linear planner is face trouble dealing with Sussman Anomaly, where as non-linear planner can solve the problem quite easily. During this period, there are already planner solving the Sussman Anomaly,yet , they were developed in an ad hoc fashion. No attempt has been made to justify the transformations that they perform, or to enable them to generate all transformations. Chapman discuss the TWEAK system with detailed procedure, and the solution can be summarized in three categoris.

The first one is a plan representation. Chapman uses Constraint posting, which defines plans by incrementally specifying partial descriptions (constraints) that the plan must fit. The second solution is that, if the solution of a problem exists, the TWEAK will find it, otherwise, it will terminate. The last solution is the top-level control structure. TWEAK begins work on a problem with a first incomplete plan whose initial situation is the initial situation of the problem and which has no steps or constraints. It then enters a loop in which some goal not yet achieved is chosen and the procedure of the last section is applied, yielding a new plan.

Unlike most other planners, TWEAK utilizes the notion of a partial order on its steps while a plan is incomplete. This concept makes TWEAK nonlinear in that the order of steps need not be specified entirely until completion of the plan.

In the next period, the state- space search became popular, and the best to date is FF(Hoffmann, 2001;Hoffmann and Nebel, 2001; Hoffmann, 2005)

three new approaches in plan generation help improve the efficiency of this planning system, the first one is based on planning graphs. the second one is the planning as satisfiability. the third one is heuristic-search planning

similar to other planners during this period, the system relies completely on forward state space search and evaluation of states by ignoring delete lists. It uses the GRAPHPLAN algorithm to find an explicit relaxed solution to each search state. and this system employs local search strategy, combining hill climbing with complete search. And powerful heuristic pruning techniques are also applied to the planner, based on examining relaxed solutions.

In summary, there are lots of activities going on in AI planning ,the above three example are just a tip of the iceberg. The area is evolving and lots of interesting discoveries are going on there.

Reference

1. planning for connective goals (David Chapman)
2. <https://www.cs.duke.edu/brd/Teaching/Previous/AI/Lectures/Planning/planning.html>
3. FF: the fast forward Planning system
4. STRIPS(Fikes and Nilsson,1971)
5. https://en.wikipedia.org/wiki/Sussman_Anomaly
6. Artificial Intelligence a modern approach chapter 10