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AIND - Planning

Three Developments in AI Planning and Search

The situation calculus and resulting planning graph that we implemented in this assignment were instances of classical planning, a paradigm in which we assume the world or environment is fully observable, deterministic, and static with single agents. However, recent advances in AI planning and research have been designed to handle situations that are only partially observable, potentially stochastic, and dynamic where more than one agent may exist. Three of these developments in AI planning and research that are extending the applicability and scope of planning and search algorithms include partial-order planning, HTN planning, and nondeterministic, probabilistic planning.

1. Partial Order Planning

This planning paradigm is perhaps the least of a deviation away from general, classical planning, but represents an important step when generating AI that may navigate a partially-observable, rather than fully-observable world. While a similar cohort of algorithms, such as breadth first search and depth first search may be used with partial order planning, one may simply reframe the search space or frontier of these algorithm as the "partial order plans." The clear benefit here is both the massive reduction in the size of the search space and a more realistic mapping of a natural environment where the search space is *not* fully observable.

2. HTN Planning

Known as hierarchical task network planning, this type of planning allows the agent to take advice from a domain designer in the form of a high level action or HLA that can be implemented in various ways by lower level actions. (Russel and Norvig) This type of approach aims to reduce problems into tasks rather than goals. There are three types of tasks, which include

1. primitive tasks, similar to actions in classical planning
2. compound tasks, that are just compositions of primitive tasks, and
3. goal tasks, that are similar to the goals in classical planning.

The take home message here, is that these tasks are more general. They may also possess constraints in the form of "task networks." The flexibility of HTN planning lies in the different approaches that may be used for HTN based algorithms. Like classical planning, HTN algorithms may be naturally ordered in a particular sequence, from the current time point to the goal state. However, this is not a strict requirement in HTN planning. In fact, there may be partially ordered approaches to establish a planning algorithm, and even completely unordered approaches. By having a slightly more flexible framework around ordering tasks, this reduces a significant amount of direct, "hard-coding" behavior of an AI agent.

3. Planning in Nondeterministic and Probabilistic Domains

In order to handle nondeterministic, probabilistic systems, the idea of a planning graph needs to be modified to accommodate probabilistic transition systems. However, in order to satisfy the existence of a a probabilistic transition system where edges suddenly have variable weight, the goal-state must be reframed as either "reward maximization" or a "cost minimization." As a consequence of this, the resulting algorithms must be redesigned to find optimal plans under a discounting reward scheme within a stochastic transition system.

Sources:

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2. Probabilistic Planning, Chapter 5. http://www2.informatik.uni-freiburg.de/~ki/teaching/ss05/aip/s05.pdf
3. Russel and Norvig. Artificial Intelligence: A Modern Approach. 3rd Edition. 2010.