Historical developments in field of AI Planning and Search

This report some of the important historical developments in the field of AI planning and search, relationships amongst them and also their impact on the field of AI as a whole. The developments which are discussed in the report are STRIPS, Planning Graphs and Binary Decision Diagrams.

STRIPS (Fikes and Nilsson, 1971)[2]

STRIPS, the first major planning system illustrates the interaction of state-space search, theorem proving and control theory.
The model attempts to find a sequence of operators in a space of world models to transform the initial world model into a model in which the goal state exists. It attempts to model the world as a set of first-order predicate formulas and is designed to work with models consisting of a large number of formulas.
Formally, the problem space for STRIPS is defined by the initial world model, the set of available operators and their effects on world models, and the goal statement. The available operators are grouped into families called schemata. Each operator is defined by a description consisting of two main parts: the effects the operator has and conditions under which the operator is applicable. A problem is said to be solved when STRIPS produces a world model that satisfies the goal statement.
The representation language which is used by STRIPS has been far more influential than its algorithmic approach. The Problem Domain Description Language (PDDL) was introduced as a computer-parseable, standardized syntax for representing planning problems and has been used as the standard language for International Planning since 1998.

Planning Graphs (Avrium Blum and Merrick Furst, 1997)[3]

In 1997, a new approach to planning in STRIPS-like domains was developed. It involved constructing and analyzing a brand new object called a Planning Graph. They developed a routine called GraphPlan which obtains the solution to the planning problem using a Planning Graph construct.
A planning graph is a directed graph organized into levels representing fluents and ground actions which are alternated until a termination condition is reached. The idea is that rather than greedily searching, we first create a Planning Graph object. The Planning Graph is useful because it inherently encodes useful constraints explicitly, thereby reducing the search overhead in the future. Planning Graphs can be constructed in polynomial time and have polynomial size. On the other hand, the state space search is exponential and is much more work to build. Planning graphs are not only based on domain information, but also the goals and initial conditions of the problem and an explicit notion of time.
Another application of a planning graph is in heuristic estimation.
Research on AI planning had concentrated on the so-called non-linear or partial-order planning algorithms until the introduction of the Graphplan algorithm. This algorithm had two

characteristics that separated it from earlier ones: it finds plans of a fixed length (that is incrementally increased until a plan is found), and it uses reachability information for pruning the search tree. These differences brought the performance of Graphplan to a level not seen in connection with earlier planners.

Binary Decision Diagrams[4]

The success of Graphplan led the research community to look at techniques outside the traditional AI planning toolbox. A strand of research that is based on a different way of exploring state spaces uses ordered binary decision diagrams(OBDDs), compact data structures for Boolean expressions widely studied in the hardware verification community. So far, OBDD-based algorithms for classical planning have been rather good on certain benchmarks, but they also have had serious problems with memory consumption, which is an inherent problem of OBDDs.
OBDDs have successfully been used for classical planning, but their benefits fully show up when a lot of uncertainty and incompleteness is involved.

Citations

1. Artificial Intelligence : A Modern Approach by Stuart J. Russell & Peter Norvig
2. STRIPS paper
3. GraphPlan paper
4. An overview of recent algorithms for AI planning
5. AI Planning Historical Developments