Research Review about historical developments in the field of AI planning and search

AI planning history includes a lot of interesting researches, but in my research review I will describe **STRIPS** algorithm, **GRAPHPLAN** algorithm and **Binary Decision Diagrams(BDD)**.

AI planning arose from investigations into state-space search, theorem providing and control theory and from practical need of robotics, scheduling and other domains. **STRIPS** the first major planning systems, illustrates interaction of these influences [1]. STRIPS was designed as a planning component of the software for “the Shakey robot” project. STRIPS is often cited as providing a seminal framework for attacking the "classical planning problem" in which the world is regarded as being in a static state and is transformable to another static state only by a single agent performing any of a given set of actions. The planning problem is then to find a sequence of agent actions that will transform a given initial world state into any of a set of given goal states. For many years, automatic planning research was focused on that simple state-space problem formulation, and was frequently based on the representation framework and reasoning methods developed in the STRIPS system [2]. The representation language used by STRIPS has been more influential than its algorithmic approach. Based on STRIPS representation language were build Action Descriptive language (ADL) and later Problem Domain Descriptive Language (PDDL).

GRAPHPLAN is a simple, elegant algorithm that yields an extremely speedy planner in many cases orders of magnitude faster than previous systems. The algorithm is based on a paradigm we call Planning Graph Analysis. In this approach, rather than immediately embarking upon a search as in standard planning methods, the algorithm instead begins by explicitly constructing a compact structure we call a Planning Graph. A Planning Graph encodes the planning problem in such a way that many useful constraints inherent in the problem become explicitly available to reduce the amount of search needed. Furthermore, Planning Graphs can be constructed quickly: they have poly- nominal size and can be built in polynomial time. It is worth pointing out that a Planning Graph is not the state-space graph, which of course could be huge. In fact, unlike the state-space graph in which a plan is a path through the graph, in a Planning Graph a plan is essentially a flow in the network flow sense. Planning Graphs offer a means of organizing and maintaining search information that is reminiscent of the efficient solutions to Dynamic Programming problems. Planning Graph Analysis appears to have significant practical value in solving planning problems even though the inherent complexity of STRIPS planning, which is at least PSPACE-hard is much greater than the complexity of standard Dynamic Programming problems [4].

Most recently, there been interest in representation of plans as **Binary Decision Diagrams(BDD)**, compact data structures for Boolean expressions widely studied in the hardware verification community. There are techniques for providing properties of binary decision diagrams, including the property of being a solution to a planning problem. In such systems a symbolic representation of the search space based on Binary Decision Diagrams, which allows for the application of search techniques derived from symbolic model checking. The symbolic representation makes it possible to analyze sets of transitions in a single computation step. These sets can be compactly represented and efficiently manipulated despite their potentially large cardinality. This way it is possible to overcome the enumerative nature of the other approaches to conformant planning, for which the degree of nondeterminism tends to be a limiting factor [5].

References

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[3] Daniel S. Weld. Recent advances in ai planning. AI Magazine, 20(2), 1999.

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