AI Planning Historical Development Research Review

Planning research has been central to AI since its inception, and papers on planning are a staple of mainstream AI journals and conferences. This short review attempts to provide a general introduction of AI planning historical development.

Total-order planning

Planning arose from AI investigations and practical needs like robotics and scheduling. STRIPS (STanford Research Institute Problem Solver) is the first major planning system, it was designed to control Shaky the robot at SRI (Stanford Research Institute) in 1970s. Shaky equips visual analysis, route finding, object manipulation abilities, and most importantly, is the first machine to be able to reason about its own actions. STRIPS planner gave Shaky the ability to analyse goals and break them down into plan of all needed actions. It attempts to find a sequence of operators in a space of world models to transform a given initial world model into a model in which a given goal formula can be proven to be true.

Like STRIPS, planners around this time will compute a subplan for each subgoal and then string the subplans together in some order, which is called linear planning. They cannot solve simple problems like Sussman anomaly, and require interleaving of actions from different subplans within a single sequence. WARPLAN is an example that allows interleaving. Still all planners at this stage produce an exact ordering of actions, aka total-order planning.

Partial-order planning

NOAH (Nets of Action Hierarchies) planner, introduced in 1975, is considered the pioneer in partial-order planning. Then TWEAK, also in 1980s, SNLP and UCPOP in 1990s. Partial-order planners leave decisions about the ordering of actions as open as possible, they specify all actions that need to be taken, and specify an ordering of the actions only where necessary. In this way, they can avoid premature commitments to a particular order for achieving subgoals.

Partial-order planning fell out of favor in the late 1990s.State-space planning was pioneered with UNPOP, which was first to suggest the ignore-delete-list heuristics. Then, HSP (Heuristic Search Planner) made state-space search practical for large planning problems.
Graph-planning system was then revitalized with orders of magnitude faster than partial-order planning.

Binary decision diagrams

Binary decision diagrams are used in the hardware verification community, it is a data structure used to represent a Boolean function. In his 1998 paper, Cimatti presented a planner using Binary decision diagram attempting to solve non-determinstic problems. The planner will first

generate Universal Plans. It will then generate plans that are guaranteed to achieve the goal in spite of non-determinism, otherwise, the planner will generate plans which encode iterative trial-and-error strategies, which are guaranteed to achieve the goal under the assumption that if there is a non-determinstic possibility for the iteration to terminate, this will not be ignored forever. At last, the implementation of the planner is based on symbolic model checking techniques which have been designed to explore efficiently large state spaces. The implementation exploits the compactness of OBDDs (Ordered Bionary Decision Diagram) to express in a practical way universal plans of extremely large size.

In conclusion, this short review listed three important development in artificial intelligence planning history: STRIPS for providing a framework for next generation planners to base on, NOAH that keeps the order of the action as open as possible, and finally planners that use binary decision diagram that allows more compacted expression. I hope this short review is able to shine some light on the AI planning history for you!

References:

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