Review: Historical Developments in AI Planning

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AI planning is a branch of artificial intelligence to devise a plan of actions for intelligent agents to execute in order to achieve certain goals. It has made major progresses in terms of the size and complexity of problems that can be solved.[1] This review paper focuses on three main types of algorithms in the development history of AI planning, the so-called linear planning algorithm, partial-order or nonlinear planning algorithm, and Graphplan algorithm.

Linear Planning

Planners in the early 1970s generally used linear planning.[2] Linear planner builds a plan as a linear sequence of actions.The planning algorithms maintains a goal stack. The idea is to work on one goal and move to the next goal until the current one is completely solved. Linear planning allows for efficient search if the goals do not interact. Also, since the goals are solved one at a time, linear planning results in reduced search space. However, it may create suboptimal solutions and it does not work well when the goals are not independent.

Partial-Order Planning

In the 1980s and 90s, partial-order planning (or nonlinear planning) was seen as the best way to handle planning problems with independent subproblems.[2] In contrast to totally ordered actions in linear planning, partial-order planning does not specify the specific order of the actions. It builds up a plan as a set of steps with some temporal constraints. For some specific tasks, such as operations scheduling, partial-order planning with domain specific heuristics is very efficient. However, partial-order planning suffers from larger search space and more complex algorithms compared to linear planning.

Graphplan

Graphplan is an algorithm developed by Avrim Blum and Merric Furst in 1995.[3] It has two major characteristics: 1. it finds plans of a fixed length and 2. it uses reachability information for pruning the search tree.[1] These characteristics led to great performance of Graphplan, not seen in earlier planners. It solves classical planning problems much faster. However, Graphplan typically needs to exhaustively search for plans at every encoding length until a solution is found, leading to prohibitively large space and time requirements for certain problems.[4]

Overall, the three planning algorithms represent three development stages of classical AI planning. As can be seen, the algorithms become more powerful, complex, and complete, so does the field.

References:

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