Artificial Intelligence Nanodegree Project 3 Research Review

The field of artificial intelligent planning has involved significantly over the last 50 years. In this research review, we will discuss some of the key early historical developments in AI planning and search between 1970 and 2000.

In the late 1960s to early 1970s, AI planners developed were typically total order planners [1]. Total order planners are planners that searches through a solution space where all plans are ordered from end-to-end. One of the most prominent total-order planners developed was STRIPS (Stanford Research Institute Problem Solver). STRIPS is the planning component for a robot known as "Shakey the Robot" that allows the robot to determine the sequence of actions required to move boxes from one room to another in a multi-room world [2]. While the STRIPS planner was advanced for its time, the biggest contribution of the STRIPS planner to the field of AI is the planning language introduced by STRIPS. STRIPS defines how states, goals, and actions should be represented that provides a foundation for future representative languages in AI planning.

Around 1975, it became apparent that there were certain problem types where total order planners, such as the STRIPS planner, were unable to solve. One such problem was the Sussman anomaly. Partial-order planning was introduced as a better AI planning strategy that was able to solve a wider variety of problems, including the Sussman anomaly[4]. In partial order planning the planners searches through a solution space where only parts of the plans are ordered. Partial order planning uses the principle of least commitment, where possible [5]. Typically, this results in smaller search space and more efficient solutions [3].

Partial order planning was the predominant AI planning framework explored for the next two decades [1]. In mid to late 1990s, the field of AI planning experienced a revival of sorts with the development of graph-based and SAT-based planning algorithms. GRAPHPLAN developed by Blum and Furst introduces the concept of planning graph to the field of AI and was found, in many cases, to be orders of magnitude faster than earlier non graph-based planners [6]. The planning graph consists of alternating layers of proposition and action levels. One of the key components of planning graph that makes it efficient as a planning data structure is the concept of mutual exclusion links (mutex) [6]. These mutual exclusion links account for conflicts between nodes on the same level.

Despite the differences among total order planners, partial order planners, and graph-based planners, these planners all uses special purpose algorithms designed for planning [6]. SAT-based planning introduced in the late 1990s question the need for the design of special purpose algorithms for planning. The key idea behind SAT-based planning is to convert planning problem into SAT problem and to solve the resulting SAT problem using known general-purpose SAT solvers. The efficiency of SAT-based planning is hence dependent on the efficiency of state-of-the art SAT based solvers[6].

References:

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