Research Review of Historical Development in AI Planning and Search

In this review paper, three important developments will be considered:

STRIPS (Stanford Research Institute Problem Solver):

Developed by Richard Fikes and Nils Nilsson in Stanford Research Institute (SRI) in 1971, it was the main planning component of Shakey robot project. With the interest of addressing problems in the field of robotics, such as re-arranging objects and in navigating, the researchers tried to develop a model, which 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 [1]. In STRIPS, the world model is represented by a set of well-formed formulas of the first-order predicate calculus. Hence the world is represented in a "static" state and can be transferred to another static state by a single agent via a set of actions. As we have also see in the course, the planning problems were represented by an initial state, goal states, and a set of actions.

In their seminal paper, as a future direction the researchers list STRIPS "learn", i.e.; define new operators for itself based on previous problem solutions [1]. Despite its limitations at it time, STRIPS opened the door for class of planning languages and frameworks, such as ADL and PDDL: Some of the restrictions in STRIPS were relaxed by ADL, which was developed by Edwin Pednault in 1986 and ADL (The Action Description Language) made it possible to formulate some real-world problems. Furthermore, PDDL was introduced in 1998 to attempt to standardize planning domain and problem description languages [2].

Planning Graphs and GraphPlan

Avrim Blum and Merrick Furst introduced the GRAPHPLAN System in 1997 to plan STRIPS-like domains. It was orders of magnitude faster than the partial order planners of the time [2] and was based on a new object called Planning Graph. The Planning Graph encodes useful constraints explicitly and hence via GraphPlan reduces the search overhead by providing a polynomial approximation of the search tree. GraphPlan is guaranteed to find the shortest partial-order plan or states that no valid plan exists [3]. As a result, other graph planning systems emerged.

Heuristic Search Based Plans and HSP

As it was observed that calculating the cost at each stage to reach the end goal and directing the search accordingly was a major breakthrough, heuristic approaches emerged. In fact, "Drew McDermott's UNPOP program (1996 was the first to suggest a distance heuristic based on a relaxed problem with delete lists ignored" [2]. After that, HSP (Heuristic Search Planner) by Bonet and Geffner was the first to applying it to a large planning problems. Some popular heuristics are critical path heuristics, ignoring deleted list, relaxed plan, landmark, etc.[5]

References:

[1] Richard E. Fikes, Nils J. Nilsson (Winter 1971). "STRIPS: A New Approach to the Application of Theorem Proving to Problem Solving". Artificial Intelligence. 2 (3–4): 189–208.

[2] Artificial Intelligence: A Modern Approach (2nd edition) by Stuart Russell and Peter Norvig

[3] A. Blum and M. Furst (1997). Fast planning through planning graph analysis. Artificial intelligence. 90:281-300

[4] AI Planning Historical Developments, by Ryan Shrott,
 https://medium.com/towards-data-science/ai-planning-historical-developments-edcd9f24c991

[5] Evolution of Planning in AI by Harpeet Sethi, https://www.linkedin.com/pulse/evolution-planning-ai-harpreet-sethi/