

AI Planning and Search: Research Review

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Three major developments in the field of AI planning and search were:

1. The development of a planning language, starting with STRIPS
2. The development of planning graph techniques, starting with Graphplan
3. Which led to development of reachability heuristics, for heuristic search planners

STRIPS:

From 1966 to 1972, the Artificial Intelligence Center at SRI International was building a robot system nicknamed “Shakey”. This project led to many developments in AI, one of which was the development of a planning language called STRIPS. The team first controlled the robot by issuing specific commands for specific solutions, but this eventually gave way to a generalized plan using STRIPS. The main benefit can be found in the original paper from the team: “The value of the generalized subroutine is that it can be stored away (or “learned”) and then used again in other situations perhaps as part of a plan for a more complex task”.¹ By specifying an initial state, goal state, and sets of actions with pre and post-conditions, STRIPS could be adapted to many new situations, expanding the problems that robots and computers could solve.

Planning Graphs:

In 1997, a paper was published in *Artificial Intelligence* by Blum and Furst called “Fast Planning Through Planning Graph Analysis”. These two men from Carnegie Mellon University created a planning system that was much faster than anything else at the time. They did this by using a new data structure called Planning Graphs, and a new planning algorithm called Graphplan that took advantage of this new structure. Graphplan was able to beat existing planning algorithms: “Four major factors seem to account for most of Graphplan’s efficiency. They are, in order of empirically-derived importance: Mutual Exclusion, ..., Consideration of Parallel Plans, ..., Memoizing, ..., Low-level costs”². Just as the development of STRIPS was the foundation to the development of Planning Graphs, Graphplan led to the development of heuristic search planners.

Heuristic Search Planners:

Graphplan showed the power of reachability heuristics that calculated the cost of reaching goal states from current states. In a February 2000 paper published in *Artificial Intelligence* called “Planning as heuristic search”, Bonet and Geffner showed that a simple reachability heuristic that assumed action predictions were independent, managed to best all other existing algorithms in a large set of problems. Because this planner recomputed costs from the ground up at every state, the paper also outlined a list of potential ways to improve the runtime, such as moving backwards from the goal or improving mutexes. Despite these limitations, heuristic search planners were widely adopted in planning competitions and dominated for a decade.

¹ “Shakey the Robot”, edited by Nils J. Nilsson, April 1984, p. 88

² “Fast Planning Through Planning Graph Analysis”, Blum & Furst, 1997, p. 15