

Research Review on Historical Developments in the field of AI Planning and Search

The history of developments in Artificial Intelligence (AI) planning demonstrate how both theoretical and practical considerations have led to new discoveries in the field. The actual history is far more detailed and complicated than presented here. However, the examples discussed demonstrate some of the problems in creating artificial intelligence agents and some of the common solutions that researchers have developed in response to such problems.

STRIPS¹, developed by Fikes and Nilsson in 1971, was the first major planning system that was used. STRIPS provided a framework for attacking the “classical planning problem²” in which the world is a static state and can only be changed in another state by an agent, in this case a robot, that would perform a sequence of actions. STRIPS used a situation calculus representation to help achieve the automatic planning for the robot.

STRIPS was highly influential and influenced the development of other systems. However, STRIPS and similar planning agents had a problem when a problem required decomposition into subproblems and then re-assembling. STRIPS and similar agents which operated under the principle of linear planning all had this defect. An agent must be able to account for interleaving of actions from different subplans. One of the solutions to this problem was goal-regression planning which was demonstrated in WARPLAN³. WARPLAN was designed to approach the problem through plans as opposed to STRIPS which approached the problem through world states. WARPLAN was still a total-order planner similar to STRIPS but approached the problem in a different manner by using plans.

In contrast to WARPLAN and STRIPS as well as other agents, partial-order planning provided an alternative that could use either world states or plans as the paradigm for the agent to act but didn't require total ordering⁴. Partial-order planners are sometimes referred to as non-linear planner and total-order planners are sometimes called linear planners. Partial-order planners like the NOAH⁵ Planner would solve each goal state independently and subsequently combine each partial order. Each goal could be solved independently and in any order which is why NOAH and similar agents are often referred to as non-linear planners.

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 Richard E. Fikes, Nils J. Nilsson (1993). Strips, A Retrospective. *Artificial Intelligence*. 59(1–2):227–232.

³ David H. D. Warren (1974). Warplan: A System for Generating Plans. Technical Report Memo 76, Department of Computational Logic, University of Edinburgh.

⁴ S. Minton, J. Bresina, M. Drummond (1994). Total-Order and Partial-Order planning: A Comparative Analysis. *J. Artificial Intelligence Res.* 227-262

⁵ Sacerdoti, E. D. (1975). 'The nonlinear nature of plans', Proceedings of the 4th International Joint Conference on Artificial Intelligence (IJCAI), Tbilisi, USSR, 206–14.