

# THE HISTORICAL DEVELOPMENT OF PLANNING TECHNIQUES IN ARTIFICIAL INTELLIGENCE

June 6, 2017

This paper discusses three types of planners, each of which belongs to a different approach to Artificial Intelligence (AI) planning and search. The paper also highlights their significance in the field of AI planning.

**Satplan:** Henry Kautz and Bart Selman (1992) formalized planning as propositional satisfiability in which a planning problem was “simply a set of axioms with the property that any model of the axioms corresponds to a valid plan”, rather than a theorem to be proved. This approach had a number of advantages, including the ease of describing any intermediate state of the world and the clarity of the modal truth criteria (Kautz & Selman, 1992). Later, Kautz and Selman (1996) improved their Satplan by combining one of the best stochastic algorithms, “Walksat”, and parallel encodings. Satplan was a significant contribution to AI because it was competitive with other planning technologies at the time, and because it was the first significant evidence that stochastic local search was a powerful technique for planning (Kautz & Selman, 1996). There have been quite a few improvements in SAT solvers since then, which contributed to Satplan’s winning the International Planning Competition in both 2004 and 2006 (Russell & Norvig, 2010).

**Graphplan:** Avrim Blum and Merrick Furst (1997) brought novelty to AI planning with ideas from graph algorithms. Their Graphplan was an approach to planning for STRIPS-style domains by constructing and analyzing a Planning Graph. Graphplan combined features of total-order planners and partial-order planners but outperformed these plans thanks to the graph structure. Its efficiency was attributed not only to the quick creation of the graph but also to other factors: pairwise mutual exclusions relations reducing the search space dramatically, the consideration of parallel plans, memoization, and time savings resulting from avoiding instantiations during the searching phase (Blum & Furst, 1997).

**Heuristic Search Planner:** While Drew McDermott revived the interest in state-space planning, Bonet and Geffner’s Heuristic Search Planner (HSP) was the first to make state-space search practical for large planning problems (Russell & Norvig, 2010). The original HSP proved to be competitive with Graphplan and Satplan in AIPS98 Planning Competition (Bonet & Geffner, 1999). HSP searched in forward direction and used a domain-independent heuristic extracted from the representation of the problem. Bonet and Geffner (1999) made an improvement later in their HSP-R which searched backward and computed the heuristic function only once rather than for every new state as HSP did. Another important contribution to AI planning by Bonet and Geffner (1999) was explaining why Graphplan was worked so well: Graphplan was “best understood as a heuristic search planner with a precise heuristic function and search algorithm.” HSP derivative planners continued to be competitive with Satplan and Graphplan in subsequent planning competitions (Russell & Norvig, 2010).

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