With this essay a brief overview on the history of AI planning and search between the 1970's and early 2000's is presented and differences between Partial Order Planning and State Space Planning are explained.

The history of AI planning and search

In 1971 Richard E. Fikes and Nils J. Nilsson released a paper titled 'STRIPS: A New Approach to the Application of Theorem Proving to Problem Solving', which up until today layed the foundation for most of the research in the field of AI planning and search.
It was the first time that a problem solving model was described using a language of operators with pre- and postconditions, that operate on the world model. The idea behind STRIPS was to search for "some composition of operators that transforms a given world model into one that satisfies some stated goal condition." [Yikes and Nilsson (1971)] Instead of exploring the complete space of operator combinations - which would grow too large too quickly even for simple problems - the idea behind STRIPS is to identify operators that reduce the difference between the current world state and the goal state. To identify such operators, STRIPS already used heuristic evaluation functions such as the number of remaining goals. When an operator has been found, the subproblem of getting to a world state that satisfies the operators preconditions has to be solved. This process is then applied iteratively, until all goals have been satisfied.

The work of Fikes and Nilsson built the basis for many domain-independent planning algorithms that were developed between 1971 and the 90's: HACKER, INTERPLAN, NOAH and TWEAK, just to name a few. [Chapman (1987)] Except for the addition of constraints, none of the above approaches improved STRIPS in any significant way, though. [Chapman (1987)] They were all based on the idea of Partial Order Planning, which is to find a plan that satisfies all goal requirements, but does not specify an exact order of actions where it is not required. Partial Order Planners work by searching for a solution among the set of partial-order plans. This makes sense, because sub-problems are often independent of each other. In 1997 Avrim L. Blum and Merrick L. Furst developed a novel approach to solving planning problems that was based on a structure called Planning Graph. [Blum and Furst (1997)] The algorithm first creates a graph structure from the problem at hand, that can then be used for heuristic evaluations and to search for a partial-order plan. While Partial Order Planning algorithms have several benefits - e.g. being easier to parallelize - faster methods emerged in the late 90's, such as State Space Planners and Constraint Satisfaction Solvers, so that Partial Order Planning received less attention. [Russel and Norvig (2010)]

After the hype around Partial Order Planning, the interest in State Space Planning rose with the release of Drew McDermott's UnPOP program in 1996, which was successively improved upon by several other projects. One of them was the Heuristic Search Planner (HSP) that was developed by Bonet and Geffner in 1999. The idea was similar to preceding work in the field: to have a general mechanism to extract heuristics and a general program that is able to solve problems domain-independently while being competitive even with domain-specific solvers. [Bonet and Geffner (2000)] Contrary to searching a solution among the set of partial-order plans, State Space Planners search among the set of world states, though. Nonetheless the algorithm presented by Bonet and Geffner, as well as most others, were still using the initial formulation of the STRIPS encoding. The authors themselves critized however, that "few real problems can actually be encoded efficiently in Strips" [Bonet and Geffner (2000)] and proposed to make use of richer problem representations in the future.

With the new millenial, Partial Order Planning received some attention again. The RePOP algorithm incorporated novel heuristics that were also used in State Space Planning in order to improve upon UCPOP from 1992. The evaluation showed that RePOP performed well in parallel planning domains, but had unsatisfactory performance in serial domains. [Nguyen and Kambhampati (2001)]

References

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