Some important historical developments in the field of AI planning and search

STRIPS (Fikes and Nilsson, 1971) was the first major planning system. It was a state-space search developed as the planning component for the Shakey robot project. Even though the impact of the algorithm itself was quite limited, the representation language used by STRIPS has been very influential and served as the basis for ADL (Action Description Language) (Pednault, 1987) and inspiration for PDDL (Problem Domain Description Language) which is the commonly used standardised planning language today (McDermott et al., 1998).

The algorithms used to solve planning problems underwent some significant changes over the years. In the 1970s planners usually divided a goal into subgoals, computed subplans to solve these and strung the results together to compile the whole plan (Sacerdoti, 1975). This linear planning approach was successful in general but failed for some fairly simple problems. It became necessary to include the detection of conflicts (Tate, 1975) and the protection of achieved conditions from interference (Sussman, 1975), leading to partial-order planning, the most successful planning approach until the 1990s. It spawned a multitude of planners, for example TWEAK (Chapman, 1987), SNLP (Soderland and Weld, 1991), and UCPOP (Penberthy and Weld, 1992).

Almost 20 years after the introduction of partial-order planning, the planning graph concept was introduced by Blum and Furst, 1997 with their GRAPHPLAN system. It moved away from a search-based approach in favour of a constraint-based approach which was, at the time, orders of magnitude faster than comparable partial-order planners. This revitalised the field of planning as a whole and also led to a resurgence of interest in search-based planners. Bonet and Geffner, 1999 were the first to make state-space search feasible for large scale problems by using their HSP (Heuristic Search Planner). This led to several improvements and variations such as HSPr (Bonet and Geffner, 1999), FASTDOWNWARD (Helmert, 2006) and the most successful one to date, FF (Hoffmann, 2001).
After this point in time, both search-based and constraint-based planners seem to be viable and are continuously being improved. Based on the problem at hand, one or the other might prove superior. According to Helmert (2001), constraint-based approaches dominate for NP-hard problems, whereas search-based algorithms shine when no backtracking is required to find the solution or in domains where many objects exist.

References

Fikes, R. E., & Nilsson, N. J. (1971). STRIPS: A new approach to the application of theorem proving to problem solving. *Artificial intelligence*, *2*(3-4), 189-208.

Pednault, E. P. (1987). Formulating multiagent, dynamic-world problems in the classical planning framework. *Reasoning about actions and plans*, 47-82.

McDermott, D., Ghallab, M., Howe, A., Knoblock, C., Ram, A., Veloso, M., ... & Wilkins, D. (1998). PDDL-the planning domain definition language.

Sacerdoti, E. D. (1975). *The nonlinear nature of plans* (No. SRI-TN-101). STANFORD RESEARCH INST MENLO PARK CA.

Tate, A. (1975, September). Interacting Goals And Their Use. In *IJCAI* (Vol. 10, pp. 215-218).

Sussman, G. J. (1975). *A computer model of skill acquisition* (Vol. 1). New York: American Elsevier Publishing Company.

Chapman, D. (1987). Planning for conjunctive goals. *Artificial intelligence*, *32*(3), 333-377.

Soderland, S., & Weld, D. S. (1991). *Evaluating nonlinear planning*. Department of Computer Science and Engineering, University of Washington.

Penberthy, J. S., & Weld, D. S. (1992). UCPOP: A Sound, Complete, Partial Order Planner for ADL. *Kr*, *92*, 103-114.

Blum, A. L., & Furst, M. L. (1997). Fast planning through planning graph analysis. *Artificial intelligence*, *90*(1), 281-300.

Bonet, B., & Geffner, H. (1999, September). Planning as heuristic search: New results. In *European Conference on Planning* (pp. 360-372). Springer Berlin Heidelberg.

Helmert, M. (2006). The Fast Downward Planning System. *J. Artif. Intell. Res.(JAIR)*, *26*, 191-246.

Hoffmann, J., & Nebel, B. (2001). The FF planning system: Fast plan generation through heuristic search. *Journal of Artificial Intelligence Research*, *14*, 253-302.

Helmert, M. (2001). "On the complexity of planning in transportation domains." *In ECP-01.*