

Research Review

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Abstract

In this review we go through some historical developments in the field of AI planning and search.

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1 AI Planning

In this short review, we go through the following historical developments in the field of AI planning

- **Stanford Research Institute Problem Solver (STRIPS)** is an automated planner developed by Fikes and Nilsson in 1971.
- **WARPLAN** is the first planner (developed by Warren in 1974) to be written in a logic programming language (Prolog)
- The **Problem Domain Description Language (PDDL)** was introduced by Ghallab *et al.* in 1998.
- The **Graphplan** is an algorithm for automated planning developed by Avrim Blum and Merrick Furst (1995, 1997) which outperformed the partial-order planners of the time.

2 Historical Development

2.1 STRIPS

STRIPS [1], the first major planning system, was designed as the planning component of the software for the Shakey robot project at SRI.

STRIPS adopted GPS (General Problem Solver by Newell and Simon, 1961) strategy of extracting **differences** between the present state and the goal state to identify operators that are *relevant* to reduce these differences. The STRIPS planning is proved to be **PSPACE-complete** (by Bylander in 1992) .

Although STRIPS' algorithm is limited, the representation language used by STRIPS has been very influential and becomes the foundation for PDDL.

2.2 WARPLAN

Planners in the early 1970s generally considered totally ordered action sequences. This approach, called **linear planning** was discovered to be incomplete. A complete planner must allow for **interleaving** of actions from different sub-plans within a single sequence.

In 1975, Waldinger introduced one solution to the interleaving problem: the goal-regression planning which was used in WARPLAN [2] by Warren. Moreover, WARPLAN is the first planner to be written in logic programming language with only 100 lines of code. This was a great example of reduced complexity via using logic programming languages.

2.3 PDDL

Inspired by STRIPS and ADL (a relaxed version of STRIPS), the PDDL [3] was the first modelling language to be used widely and later became the standard language for the International Planning Competition since 1998.

There have been several extensions, the latest version of the language is PDDL3.1 (see [here](#) for more detail) which introduced **object-fluents** and adapted the language even more to modern expectations with a syntactically seemingly small, but semantically quite significant change in expressiveness.

The usage of a common language for representing and solving planning problems encourages greater reuse of research and allows more direct comparison of systems and approaches, and therefore supports faster progress in the field (ref [wiki](#)).

2.4 Graphplan

For a period of 20 years from 1975, partial-order planning was actively researched, that led to the widely distributed implementations SNLP (Soderland and Weld, 1991) and UCPOP (Penberthy and Weld, 1992).

Avrim Blum and Merrick Furst (1997) revitalized the field of planning with their GRAPHPLAN [\[4\]](#) system, which was orders of magnitude faster than the partial order planners of the time.

Following the success of GRAPHPLAN, other graph-planning systems such as IPP (Koehler *et al.*, 1997), STAN (Fox and Long, 1998) and SGP (Weld *et al.* 1998) soon followed. The graph-planning also helped to derive more accurate heuristic function which can be used in many different ways to guide the search for a solution.

We have discussed and implemented a planning-graph in our 3rd project following description from the book AI-Modern Approach [\[5\]](#) by S. Russell and P. Norvig.

3 Conclusion

Planning research has been central to AI since its inception and still be a mainstream in AI research. The field has evolved a lot from ordered actions planning to graph-planning and recently stochastic-planning that helps solving a lot of real problem. We hope that the field continue to advance so that it can find more optimal solution to NP-hard problem.

References

- [1] Richard E. Fikes, Nils J. Nilsson (1971) *STRIPS: A New Approach to the Application of Theorem Proving to Problem Solving* (Artificial Intelligence. 2 (3-4) p. 189-208) [2.1](#)
- [2] David H. D. Warren (1976) *Generating conditional plans and programs* (AISB'76 Proceedings of the 2nd Summer Conference on Artificial Intelligence and Simulation of Behaviour p. 344-354) [2.2](#)
- [3] Drew McDermott *et al.* (1998) *The Planning Domain Definition Language* (AIPS-98 Planning Competition) [2.3](#)
- [4] A. Blum and M. Furst (1997) *Fast planning through planning graph analysis* (Artificial intelligence. 90 p. 281-300) [2.4](#)
- [5] S. Russell and P. Norvig (2009) *Artificial Intelligence: A Modern Approach* (3rd Edition) [2.4](#)