Research Review. Historical developments in the field of AI planning and search

STRIPS

During the late 1960s and early 1970s in SRI (Stanford Research Institute) a group of researchers worked on a robot Shakey (Nillson [1]), it was sponsored by ARPA and NASA. Project became a motivation and background for A* search algorithm (Hart et al. [2]) and STRIPS (Fikes and Nilsson, [3]). For many years later, automatic planning research was focused on simple state-space problem formulation, and was frequently based on the representation framework and reasoning methods developed in the STRIPS system [4], also its representation language has been far more influential than its algorithmic approach [5]. Its language later evolved into ADL (Action Description Language, *Pednault 1986*) and was later replaced by PDDL (Problem Domain Description Language, [8]).

Partial-order planning

Back in early 1970s plans were generally using ordered action sequences, but approach was found to be incomplete as it could not find solution to simple problems like Sussman anomaly [6]. New suggestion emerged – NOAH planner (Sacerdoti, 1975,1977) and INTERPLAN (Tate, 1977) – those were first partial-order planners. Partial-order planning dominated the next 20 years of research [5] but it was first formalized only 10 years later after it appeared, in a TWEAK system (Chapman [7]). Although partial-order planning approach was fast and complete, it suffered from complexity of node evaluations and proved to be computationally intensive.

Graphplan

It is an algorithm for automated planning developed in 1997 [9]. Graphplan takes as input a planning problem expressed in STRIPS and produces, if one is possible, a sequence of operations for reaching a goal state [10]. It was orders of magnitude faster than the partial-order planners of the time [5]. Graphplan always returns a shortest possible partial-order plan, or states that no valid plan exists [9]. Eventually other algorithms followed (IPP [11], STAN [12]) but Graphplan is a breakpoint in between partial-order planning and graph planning algorithms.

References

[1] N.J. Nilsson, Shakey the Robot, SRI Tech. Note 323, Menlo Park, CA (1984).

[2] P.E. Hart, N.J. Nilsson and B. Raphael, A formal basis for the heuristic determination of minimum cost paths, 1EEE Trans. Syst. Sci. Cybern. 4 (2) (1968) 100-107.

[3] R.E. Fikes and N.J. Nilsson, STRIPS: a new approach to the application of theorem proving to problem solving, Artif Intell. 2 (1981) 189-208.

[4] Richard E. Fikes and Nils J. Nilsson, STRIPS a retrospective, Artificial Intelligence 59 (1993) 227-232

[5] Stuart J. Russell and Peter Norvig, Artificial Intelligence. A Modern Approach. Third Edition, 393-394

[6] G.J. Sussman (1975) A Computer Model of Skill Acquisition

[7] Chapman, D., "Planning for Conjunctive Goals," Artificial Intelligence, 32 (July 1987) 333- 378.

[8] McDermott, Drew; Ghallab, Malik; Howe, Adele; Knoblock, Craig; Ram, Ashwin; Veloso, Manuela; Weld, Daniel; Wilkins, David (1998). "PDDL-The Planning Domain Definition Language". Technical Report CVC TR98003/DCS TR1165. New Haven, CT: Yale Center for Computational Vision and Control.

[9] A. Blum and M. Furst (1997). Fast planning through planning graph analysis. Artificial intelligence. 90:281-300.

[10] GRAPHPLAN Wikipedia https://en.wikipedia.org/wiki/Graphplan

[11] J. Koehler, B. Nebel, J. Hoffmann, and Y Dimopoulos. Extending planning graphs to an ADL subset. In Proceedings of the Fourth European Conference on Planning, pages 273–285. Berlin, Germany: SpringerVerlag, Sept 1997.

[12] Fox, M., and Long, D. 1998. The automatic inference of state invariants in TIM. Forthcoming.