Alexey Ganin

Summary of important historical developments in the field of AI planning and search.

In this paper, I'd like to review three major historical developments around AI planning and search, highlighting their influence on development of AI in general.

Early researchers mostly aimed to apply AI in such areas as problem-solving reasoning, theorem proving, state space search as well as some practical robotics needs. Planning emerged as a sub-field of AI and STRIPS (STanford Research Problem Solver), developed by Richard Fikes and Nils Nilsson in 1971, was the first widely adopted planning system [1]. The STRIPS method operates in a space of world models and tries to find a sequence of operators to transform the initial world model into the model where the goal state exists [2]. The representational language used in STRIPS was used as a basis for the computer-parsable Problem Domain Description Language (PDDL) which was widely adopted in 1998.

In 1995, Avrium Blum and Merrick Furst introduced the Graphplan method, which takes a planning problem expressed in STRIPS as an input and produces a sequence of actions required for achieving the goal state (if such a sequence exists) [3]. The Graphplan algorithm consists of two stages: building a data structure, the plan graph, and backward search. It also includes a pruning mechanism which removes mutually exclusive elements from the search algorithm. Main advantages of that method are compactness of the representation and informative nature of the data accumulated during construction and search. There was a number of various graph search optimization methods suggested which took in account peculiarities of implementation area.

Another important development was an introduction (in 1998) of Heuristics Search Planning (HSP) method which allows deriving a heuristic function from the representation of actions and goals [4]. The method used STRIPS-encoded problem as an input and automatically generated the heuristic function by relaxing some constraints. The concrete implementation techniques varied depending on types of problems, however, the idea remained the same: estimate the amount of work required for achieving the goal while ignoring some (or all) limiting factors. The heuristic function obtained with such method is informative, but its computation is usually NP-hard.

Planning and search were the key elements of AI since the inception. The developments described above were highly influential in the field. STRIPS introduced the problem description language, Graphplan gave us a tool for building a data structure required for the solution, and Heuristics Search Planning provided a solution to automated generation of heuristic functions. They are built upon each other and provided a solid foundation for the future explorations in the field of AI.

References:

[1] Wikipedia – SRIPS. https://en.wikipedia.org/wiki/STRIPS
[2] STRIPS: A New Approach to the Application of Theorem Proving to Problem Solving. Richard E. Fikes, Nils J. Nilson. http://ai.stanford.edu/~nilsson/OnlinePubs-Nils/PublishedPapers/strips.pdf
[3] Fast Planning Through Planning Graph Analysis. Avrim L. Blum, Merrick L. Furst. https://www.cs.cmu.edu/~avrim/Papers/graphplan.pdf
[4] HSP: Heuristic Search Planner https://bonetblai.github.io/reports/aips98-competition.pdf