

# Historical Developments in Planning and Search

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**Abstract**—Search and planning are key components in artificial intelligence. Planning is a specific method to find an action sequence to reach a goal by using logic and search. These methods are extensively covered in [1]. This report looks briefly into the history of three developments and describes the impact on the field of artificial intelligence.

## 1 REPRESENTATION

Practical needs in the area of robotics and scheduling in combination with research on state-space search and control theory lead to the development of STRIPS, the first major planning system [2]. The main influence of STRIPS was its representation language. By relaxing some of the restrictions from STRIPS, the Action Description Language (ADL) [3] made it possible to encode more realistic problems. Since 1998 the Problem Domain Description Language, or PDDL [4] is being used with several extensions as the standard language for the International Planning Competition and therefore plays a major role in current research.

## 2 PARTIAL ORDER PLANNING

From the mid 1970s to the mid 1990s partial order planning dominated planning research. In partial order planning, all actions are specified to reach the goal, but there is no exact order. This helps to generate more efficient plans that can exploit parallelism [1]. The first clear formal definition was TWEAK [5]. It was simple enough to allow to proof completeness or intractability for certain problems and laid the ground for the widely-distributed implementation of SNLP [6]. Although the research on partial order planning was reduced in the late 1990s, [7] could show with their RePOP planner, that accurate heuristics computed from a planning graph could generate competitive results and scalability in parallelizable domains with the best state-space planners.

## 4 STATE SPACE PLANNING

In 1996 Drew McDermott initiated the UnPOP program to open up research beyond the concentration on partial order planning. The heuristic search planner (HSP) [8] and its extensions made state space search practical for large scale planning problems. Eventually, this led to the development of the fast-forward planning system FF [9], which is the most successful state space searcher up to date and won the 2000 AIPS planning competition. FastDownward [10] also uses forward state space search, but preprocesses the action schemas to make some of the constraints more explicit. LAMA [11] is based on FastDownward with an improved heuristic and won the 2008 challenge.

## 5 CURRENT SITUATION AND OUTLOOK

Planning is an active research area of artificial intelligence and many real-world problems require efficient algorithms to solve these large-scale problems e.g. in industry or robotics. [13] has shown that for NP-hard domains constraint based approaches work well, while for domains where solutions can be found without backtracking, search based methods should be used. The International Planning Competitions are still continuing with the next one planned for 2018 [12].

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