AI planning and search historical developments

In this write-up, I will describe three major developments in the AI planning domain including their impact on the field of AI and the relationships between them.

STRIPS (Stanford Research Institute Problem Solver) is regarded as a first major planning system which was developed in 1971 by Richard Fikes and Nils Nilsson at Stanford Research Institute. The automated planner models a world model as an arbitrary set of first-order predicate calculus formulas and is intended to work with models consisting of large number of formulas. The model works by searching for a sequence of operators in a space of world models in order to transform a given initial world model into a goal model in which the goal existence can be proved. The search towards the goal-satisfying model is guided by means-ends analysis and supported by deductive mechanism based on a resolution theorem prover (Fikes, Nilsson, 1971).

STRIPS relies on a simple state-space formulation as it considers the world a static state which is transformable to another static state only by a single agent executing a set of actions. Additionally, the framework assumes that at any time only one action can occur and nothing except for effects of the planned actions changes and an action results in an immediate effect. All those assumptions make STRIPS extremely limited in the scope of planning issues it tackles and also in the complexity of problems it can solve (Fikes, Nilsson, 1993). However, in spite of its simplistic approach, the STRIPS framework bas been used as the basis for multiple automatic planning research for many years, especially its representation language.

In 1997 a new approach in STRIPS-like domain has been proposed – GRAPHPLAN – a new planner based on a paradigm referred to as planning graph analysis. Instead of embarking on a greedy search, GRAPHPLAN starts a problem solving process with constructing a compact structure called planning graph. A planning graph encodes the planning problem taking into account constraints inherent in the problem by reducing the amount of search needed. Due to the fact that a planning graph does not constitute a state-space graph it can be constructed quite quickly in polynomial time with polynomial size. A planning graph embeds not only domain knowledge, but also the goals and initial conditions of a given problem and explicit notion of time. The method guarantees to return always a shortest-possible partial-order plan (Blum, Furst, 1997).

Before GRAPHPLAN, most planning researchers were working under the framework of 'plan-space search'. Since GRAPHPLAN outperformed those prior planners by orders of magnitude, emergence of GRAPHPLAN prompted researchers to start thinking about fundamentally different frameworks. As a result, many planning systems created afterwards have been influenced by GRAPHPLAN, and those are: IPP, STAN, SGP, Blackbox, Medic [4].

Another breakthrough in the planning domain occurred in 1998 when Heuristic Search Planner has been presented. The algorithm bases on the ideas of heuristic search and performs forward search from an initial state to the goal state which is guided by heuristic function providing an estimate of the distance to the goal (Bonnet, Geffner, 1998). The heuristic function is computed from Strips encodings. The most common way to obtain the heuristic is to solve the 'relaxed' planning problem. The high level solving process of the algorithm goes as follows: the algorithm at each step expands a set of actions and their resulting state that could occur according to the preconditions held in the previous state (Bonnet, Geffner, 1998).

In this paper three major advancements in the AI planning field have been discussed. The first one has been STRIPS which served as a foundation and general language framework allowing for more advanced concepts' developments later on. Next one was the Planning Graph which encompassed the planning problem in a completely new structure providing a new perspective on the planning problem solving approach. And the final one, the HSP, provides an automated method for deriving domain-independent heuristics.

References:

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