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Planning Research Review

AI Planning was first discovered by researches investigating state-space search, theorem proving and control theory to solve practical needs of robotics, scheduling and other problems. (Russell & Norvig, 2010) The first major planning system developed was STRIPS(Standford Research Institute Problem Solver) by Fikes and Nilsson in 1971, designed as a planning software component for the Shakey robot project at SRI. (Richard E. Fikes, 1971) The STRIPS control structure was modeled on the General Problem Solver (GPS) (Newell, Shaw, & Simon), which is a state space search system that used means-ends analysis. Over the years, the representation language used by STRIPS have inspired future planning developments, and is the base language for most automated planning problem instances today.

The Action Description Language (ADL), an advancement of STRIPS is an automated planning and scheduling system designed primarily for robots. It was proposed by Edwin Pednault, an IBM Research Staff Member in the Data Abstraction Research Group in 1987. One of ADL's major improvements over STRIPS is to allow the effects of an operator to be conditional. It also adheres to the open world principle where everything not occurring in the conditions are assumed unknown instead of being false in STRIPS. In contrast to STRIPS which only allows positive literals and conjunctions, ADL relaxes these constrains by allowing negative literals and disjunctions. (Edwin, 1987)

In 1998, the Planning Domain Definition Language (PDDL) is proposed to standardize AI planning languages. Inspired by STRIPS and ADL, it was developed in 1998 by Drew McDermott and his colleagues to make the 1998/2000 International Planning Competition possible. (McDermott, 1998). The goal is to create a basic foundation in the planning domain which will facilitate communication among researchers and encourage development by providing a well understood platform. Formalization aims to support faster progress in the Planning domain by attracting more development in the field. (Fox & Long, 2002). The most recent version of PDDL 3.1 introduced object-fluents, which adopted the language to modern expectations by improving its expressiveness. (Kovacs, 2001)

Ordered sequential actions was the primary focus employed by planners in the early 1970s by computing subplans for each individual goal and joining the subplans together in some order. This linear planning approach by Sacerdoti (1975) is found to be incomplete and unable to solve simple problems. A complete planner's single sequence must allow interleaving actions from different subplans, which led to the discovery of goal-regression planning technique. WARPLAN, a 100 line program created in a logic programming language (Prolog) is based on that technique.

Partial order planning became the focus of the next 20 years, which led to the development of TWEAK (Chapman, 1987), Systematic NonLinear Planner(SNLP) (Soderland and Weld, 1991) and UCPOP (Penberthy and Weld, 1992). It fell out of favor when faster methods emerged in the 1990s. (Russell & Norvig, 2010)

State space planning came back into the spotlight after the unveiling of Drew McDermott's UNPOP program (1996), which introduced the ignore-delete-list heuristic. Fast Downward, a forward-state space search planning system which translates the input into an alternative representation which makes implicit constraints of a propositional planning task explicit, won the 4th International

Planning Competition at ICAPS 2004. (Helmert, Journal of Artificial Intelligence Research, Volume 26, 2006).

Constraint based approaches such as GRAPHPLAN and SATPLAN are found to be best for NP-hard domains based on analysis by Helmert. They, however are not feasible in domains with many objects as many actions have to be created. Search based approaches fared better in domains where feasible solutions could be found without backtracking. (Helmert, 2001).

As AI planning is currently under active research, new approaches are constantly being developed. We can expect to solve more complex planning problems in the near future, factoring in the recent advancement in hardware as well as the discovery of better planning algorithms.

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