Important historical developments in the field of AI planning and search

Bhinesh Patel

Three important developments in the field of AI planning and search are discussed. AI planning arose from investigations into state-space search, theorem proving, and control theory and from the practical needs of robotics, scheduling, and other domains.

STRIPS - During the late 1960s and early 1970s (Fikes and Nilsson, 1993), an enthusiastic group of researchers at the SRI AI Laboratory focused their energies on a single experimental project in which a mobile robot was being developed that could navigate and push objects around in a multi-room environment. When the robot moved, its television camera shook so much that it became affectionately known as "Shakey the Robot". Though the robot was quite rudimentary by today's standards, the project led to the development of STRIPS (STanford Research Institute Problem Solver). STRIPS is often cited as providing a seminal framework for attacking the "classical planning problem" in which the world is regarded as being in a static state and is transformable to another static state only by a single agent performing any of a given set of actions. For many years, automatic planning research was focused on that simple state-space problem formulation, and was frequently based on the representation framework and reasoning methods developed in the STRIPS system. The Action Description Language or ADL (Pednault, 1986), relaxed some of the STRIPS restrictions and made it possible to encode more realistic problems. The Problem Domain Description Language or PDDL (Ghallab *et al.*, 1998) was introduced as the standard language for the International Planning Competition since 1998.

Partially Ordered Plans (POP) - Planners in the early 1970s generally considered totally ordered action sequences. This approach called Linear Programming (Sacerdoti, 1975), was soon discovered to be incomplete. It did not allow for interleaving of actions from different subplans within a single sequence. One solution to the interleaving problem was goal-regression planning, a technique in which steps in a totally ordered plan are reordered so as to avoid conflict between subgoals. This was introduced by Waldinger (1975) and also used by Warren's (1974) WARPLAN. The constructions of Partially Ordered Plans (then called task networks) were pioneered by the NOAH planner (Sacerdoti, 1975, 1977) and by NONLIN system (Tate, 1975b, 1977). Partial order planning (POP) dominated the next 20 years of research with TWEAK (Chapman, 1987) the first formal exposition, a planner that was simple enough to allow proof of completeness and intractability. Chapman's work led to widely distributed implementations SNLP (Soderland and Weld, 1991) and UCPOP (Penberthy and Weld, 1992). Partial order planning fell out of favor in the late 1990s as faster methods emerged.

Planning Graphs - Avrim Blum and Merrick Furst (1995, 1997) revitalized the field of planning with their GRAPHPLAN system, which was orders of magnitude faster than the partial order planners of the time. Other graph planning systems, such as IPP (Koehler at al., 1997), STAN (Fox and Long, 1998) and SGP (Weld et al., 1998), soon followed. A planning graph can be used in many ways to guide a search for a solution. The winner of the 2002 AIPS planning competition, LPG (Gerevini and Serina, 2002, 2003), searched planning graphs using a local search technique inspired by WALKSAT. Helmert (2001) analyzes several classes of planning problems and shows that constraint based approaches such as GRAPHPLAN are best for NP-hard domains but have trouble in domains with many objects because that means they must create many actions.