Historical Developments in AI Planning and Search

Planning is used commonly in AI systems to solve problems in deterministic, fully observable and static environments. Algorithms in planning systems operate on explicit propositional or relational representations of states, actions and goals to derive effective heuristics.

The first major development in the field of AI planning and search was the development of the STRIPS planning system for the Shakey robot project at the Stanford Research Institute[1]. STRIPS made use of a representation language like the "classical" one described in AIMA, working similar to Peter Norvig's example of a robotic vacuum cleaner in a state space of grids, where each grid either has dirt or no dirt and has actions it could take to achieve the goal state. STRIPS was modelled after the General Problem Solver[2], by using means-ends analysis to extract differences between the present state-space and the goal, in order to identity relevant actions that can reduce the degree of difference. In doing so, STRIPS also constructs a problem-solving tree where nodes represent sub problems and uses an evaluation function that chooses the next move by applying heuristics such as the estimated difficulty of remaining sub goals and current difference, which is known to us as A* Search today.[3]

While planning graphs, constructed incrementally by appending individual layers that contain a superset of all literals or actions possibly occurring at that time step and encoded with mutual exclusion relations already existed, the establishment of the Graphplan System[4] in 1997 revitalized the field of planning by outperforming other partial-order planners by orders of magnitude. For instance, LPG won the 2002 AIPS planning competition using the planning graph method with a local search technique.[5] Graphplan accepts as input a planning problem expressed in the STRIP language and produces a sequence of actions that can lead to the goal state. Using the planning graph, Graphplan is able to iteratively progress through the planning graph, proving that there are no solutions of length i-1 and uses incompatibility information such as mutual exclusion between different nodes and actions in the same planning graph level to prune searches within the graph.

The third major development was the introduction of the Problem Domain Description Language (PDDL) in 1998[6], first developed by Drew McDormott and his fellow researchers, who were inspired by STRIPS. PDDL offers a computer-parsable, standardized syntax, by representing initial and goal states as conjunctions of literals and actions in terms of their preconditions and effects. Classical planning problems such as the Air Cargo problem were described in PDDL in AIMA, and PDDL itself, has since been used as the standard representation used by the International Planning Competition. The adoption of a formal language in describing planning domains enables researchers to make direct comparison between planning techniques that lead to greater progress in the field.[7]

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