Historical developments in the field of AI Planning and Search

Planning is the ability for an intelligent system, to increase its autonomy and flexibility through the construction of sequences of actions to achieve its goals. Planning techniques have been applied in a variety of tasks including robotics, process planning, web-based information gathering, autonomous agents and spacecraft mission control.

The first major planning system was STRIPS[1], which was designed for Shakey Robot project at Stanford. It provided the framework for attacking the classical planning problem in which the world was regarded as being in a static state and is transformable to another static state only by a single agent performing a set of actions. The key contribution here was the STRIPS operator[2] representation and algorithm for modeling the effects of an operator based on the assumption that it only affects aspects explicitly mentioned in the operator's addition and deletion lists. GPS (General Problem Solver) a state-space search system that used means–ends analysis is deployed to identify the operator that are relevant in reducing differences between present world model and the goal. A search tree is constructed to represent hierarchy of goals, sub-goals and models, and an evaluation function is used to choose the next move by applying heuristics.

Most planning systems since STRIPS have used different variations of the STRIPS language. But this made comparisons amongst them difficult. Pednault[3] improved the expressive power of STRIPS by allowing the effects of an operator to be conditional. This is the main idea behind ADL or Action Description Language. Unlike STRIPS, ADL supports both positive and negative literals, goals may involve conjunctions and disjunctions and has an Open World assumption where unmentioned literals are unknown. The Planning Domain Definition Language[4] (PDDL) is an attempt to standardize AI planning languages. Drew McDermott first developed it in 1998 as a computer parsable standardized syntax for representing ADL, STRIPS and other languages. Adoption of this common formalism for describing planning domains allowed for more direct comparison of systems and approaches and supported faster progress in the field.

Early planners generally worked with a totally ordered action sequences. This linear planning and partial planning techniques were incomplete. The field of planning was revitalized with Blum and Furst's GRAPHPLAN[5] system. It takes a planning problem expressed in STRIPS as input and produces a sequence of operations for reaching a goal state. Use of a planning graph reduced the amount of search needed to find the solution from exploration of the state space graph. The algorithm in a loop checks if all goal literals are present in the current level with no mutex links, if this is true then a solution is extracted otherwise the graph is expanded by adding the actions for the current level and state literal for the next level. This process terminates when a solution is found or it is learned that no solution exists.

References

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