Planning in AI

Planning is an important ability for intelligent systems, increasing their autonomy and flexibility through the construction of sequence of actions to achieve their goals. It involves the representation of actions and world models, reasoning about the effects of actions, and techniques for effectively searching the sample space.

Planning Domain Definition Language

PDDL stands for Planning Domain Definition Language which is a standard encoding language for classical planning tasks. The **PDDL** is an attempt to standardize Artificial Intelligence (AI) planning languages [1]. It was first developed by Drew McDermott and his colleagues in 1998 [2]. Components of a PDDL planning task are

• Objects: Things in the world that interest us.

• Predicates: Properties of objects that we are interested in; can be true or false.

• Initial state: The state of the world that we start in.

• Goal specification: Things that we want to be true.

• Actions/Operators: Ways of changing the state of the world.

Stanford Research Institute Problem Solver (STRIPS)

STRIPS is an automated planner, the goal was to find a series of operators in a space of models to alter an initial state into a model in which a given goal can be proven to be true [3]. The impact of STRIPS in the artificial intelligence field was greater in terms of the representation language it created, which is very close to the conventional planning language. This language describes a set of applicable operators that allowed to transform one state into a different state.

Example:

Tidily arranged actions descriptions, restricted language

Action: Buy(x)

Precondition: At(p), Sells(p,x)

Effect: Have(x)

Uses restricted language that implies an efficient algorithm

Precondition is conjunction of positive literals

Effect is conjunction of literals

A complete set of STRIPS operators can be translated into a set of successor-state axioms

Total Order Planning and Partial Order Planning

Planning can be characterized as search through a space of possible plans. A total order planner searches through a space of totally ordered plans [4].

Partial-order planning focuses on relaxing the temporal order of actions. In a refinement step, the position of a new action must not be totally ordered with respect to the plan's other actions. However, the commitment may include a decision on additional ordering relations that are necessary to ensure the consistency of the refinement. All unnecessary choice options for potential orderings are ruled out by the propagation process

Steps in partially ordered planning are

Start step has the initial state, description as its effect

Finish step has the goal description as its precondition, causal links from outcome of one step to precondition of another, and temporal ordering between pairs of steps

Binary decision diagrams

Binary decision diagrams (BDDs) and their refinements are data structures for representing Boolean functions, that is, functions that take Boolean as inputs and produce a Boolean as output [5]. A Boolean function can be represented as rooted, directed, acyclic graph, which consists of several decision nodes and terminal nodes.

First step is to generate Universal Plans. Second step generates plans which are guaranteed to achieve the goal despite non-determinism, if such plan exists. In third step, the implementation of the planner is based on symbolic model checking techniques which have been designed to explore efficiently large state spaces.

References

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