Research Review – AI Planning

The planning problem in Artificial Intelligence is about the decision making performed by intelligent creatures like robots, humans, or computer programs when trying to achieve some goal. This document discusses some different strategies in AI planning field.

STRIP

The simplest language used for formalizing actions is the STRIPS language. In STRIPS, the state variables have the domain {0,1} (equivalently {FALSE, TRUE}), and an action consists of three sets of state variables, the PRECONDITION, the ADD={a1,a2,...,an} list, and the DELETE={d1,d2,...,dm} list (it is assumed that ADD and DELETE don't intersect.)

PDDL

PDDL is a generalization of STRIPS, describes the initial and goal states as conjunctions of literals, and actions in terms of their preconditions and effects.

Search algorithms

There are several types of search algorithms that are routinely applied in planning.

- well-known uninformed search algorithms like depth-first search, breadth-first search
- systematic heuristic search algorithms with optimality guarantees, for example A* and its variants like IDA*, WA*
- systematic heuristic search algorithms without optimality guarantees, for example the standard "best-first" search algorithm which is like A* but ignores the cost-so-far component of the valuation function
- incomplete unsystematic search algorithms, most notably stochastic search algorithms

Symmetry reduction

Symmetry reduction methods try to decrease the effective search space by recognizing symmetries in the state-space graph. In planning, symmetries are typically caused by the interchangeability of objects. If there is a plan that involves

some interchangable objects A and B, there is a symmetric plan with the roles of A and B interchanged.

Partial-order reduction

Partial-order reduction methods try to decrease the number of search steps by recognizing different forms of independence of actions/transitions. The basic idea is that if actions/transitions A and B are independent in the sense that they can be taken in either order A;B or B;A, one only needs to consider one of these orderings.

[1] Artificial Intelligence: A Modern Approach, 3/e
[2] A brief overview of AI planning https://users.aalto.fi/~rintanj1/planning.html