RESEARCH REVIEW - AIND PLANNING

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What is AI Planning and Searching?

AI Planning is a branch of artificial intelligence that concerns the realization of strategies or action sequences, typically for execution by intelligent agents, autonomous robots and unmanned vehicles.

Given a description of the possible

1. Initial states of the world
2. A set of goals
3. A set of possible actions

the planning problem is to synthesise a plan that is guaranteed to generate a state which contains the desired goals.

Why is it critical to AI?

Planning is a key ability for intelligent systems, increasing their autonomy and flexibility through the construction of sequences of actions to achieve their goals. It has been an area of research in artificial intelligence for over three decades. Planning techniques have been applied in a variety of tasks including robotics, process planning, web-based information gathering, autonomous agents and spacecraft mission control.

Historical developments in AI Planning

The most important developments in AI planning that we have learned in this course are as follows.

Stanford Research Institute Problem Solver(STRIPS)

STRIPS is an automated planning technique that works by executing a domain and problem to find a goal. With STRIPS, you first describe the world. You do this by providing objects, actions, preconditions, and effects. These are all the types of things you can do in the game world.

Once the world is described, you then provide a problem set. A problem consists of an initial state and a goal condition. STRIPS can then search all possible states, starting from the initial one, executing various actions, until it reaches the goal.

Planning Domain Definition Language (PDDL)

A common language for writing STRIPS domain and problem sets is the Planning Domain Definition Language (PDDL). PDDL lets you write most of the code with English words, so that it can be clearly read and (hopefully) well understood. It's a relatively easy approach to writing simple AI planning problems.

Example: Air Cargo Problem in PDDL

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Air Cargo Action Schema

Action(Load(c, p, a),
          PRECOND: At(c, a) ∧ At(p, a) ∧ Cargo(c) ∧ Plane(p) ∧ Airport(a)
          EFFECT: ¬ At(c, a) ∧ In(c, p))
Action(Unload(c, p, a),
          PRECOND: In(c, p) ∧ At(p, a) ∧ Cargo(c) ∧ Plane(p) ∧ Airport(a)
          EFFECT: At(c, a) ∧ ¬ In(c, p))
Action(Fly(p, from, to),
          PRECOND: At(p, from) ∧ Plane(p) ∧ Airport(from) ∧ Airport(to)
          EFFECT: ¬ At(p, from) ∧ At(p, to))

Problem initial state and goal
Init(At(C1, SFO) ∧ At(C2, JFK)
          ∧ At(P1, SFO) ∧ At(P2, JFK)
          ∧ Cargo(C1) ∧ Cargo(C2)
          ∧ Plane(P1) ∧ Plane(P2)
          ∧ Airport(JFK) ∧ Airport(SFO))
Goal(At(C1, JFK) ∧ At(C2, SFO))
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Planning Graphs

Planning graph is a powerful data structure that encodes information about which states may be reachable. *Planning Graph* is polynomial in size and can be efficiently constructed for some challenging problems. It is a layered graph with alternate set of State and Action layers. Each layer is either a set of States or a set of Actions and its edges are only permitted to connect vertices between successive layers.

$$PG = (S0, A0, S1, A1, S2, A2\ldots\ldots Sn)$$

The edges are defined as follows.

- To each action $a \in A(i)$, a directed edge is made from each state $s \in S(i)$ that is a precondition of action a.
- To each state $s \in Si$, a directed edge is made from each action $a \in A(i)$ that has state s as an effect.

The planning graph is constructed layer by layer, starting from S0 where

$$S(0) = initial\ state$$

Every positive literal s is placed in the layer *S(0)* along with negation of every positive literal not in s. The set *A(i)* is a set of all actions for which their preconditions are subset of *S(i)*. The set *S(i+1)* is the union of the effects of all operators in *A(i)*.

The iterations continue until the graph stabilizes i.e.,

$$S(i+1) = S(i) \text{ and } A(i+1) = A(i)$$

References

AIMA book by Peter Norvig

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