Planning and Learning

Content

- The planning problem,
- Partial order planning,
- Total order planning.
- Learning in AI, Learning Agent,
- Concepts of Supervised, Unsupervised, Semi-Supervised Learning,
- Reinforcement Learning, Ensemble Learning.
- Expert Systems, Components of Expert System: Knowledge base, Inference engine, user interface, working memory, Development of Expert Systems

The Planning

- In AI, the agent starts from the initial state and performs a series of actions in order to reach the goal state.
- For instance, a vacuum cleaner agent will perform actions of moving right and left, and sucking in dirt to reach the goal of successfully cleaning the environment.
- This activity of coming up with a sequence of actions in order to accomplish the target or goal is called as Planning.

The Planning

- Representation of Planning problems is often done using following:
  - *A set of states*
  - *A set of goals*
  - *A set of actions*

Partial Order Planning

- It works on problem decomposition.
- It will divide the problem into parts and achieve these sub goals independently.
- It solves the sub problems with sub plans and then combines these sub plans and reorders them based on requirements.
- In POP, ordering of the actions is partial.
- It does not specify which action will come first out of the two actions which are placed in the plan.

Partial Order Planning

The problem of wearing shoes can be performed through total order or partial order planning.

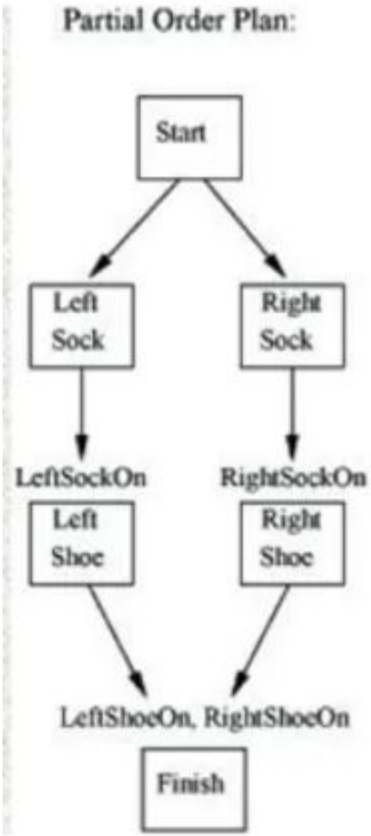
Init: Barefoot

Goal: RightShoeOn ^ LeftShoeOn

Action: 1. RightShoeOn

Precondition: RightSockOn

Effect: RightShoeOn



Partial Order Planning

2. LeftShoeOn

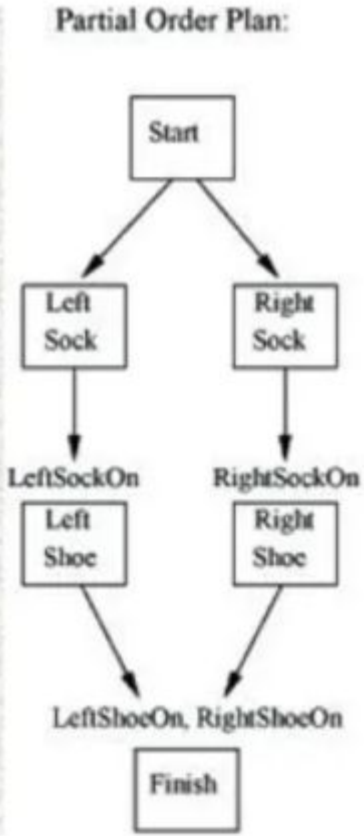
Precondition: LeftSockOn

Effect: LeftShoeOn

3. LeftSockOn

Precondition: Barefoot

Effect: LeftSockOn

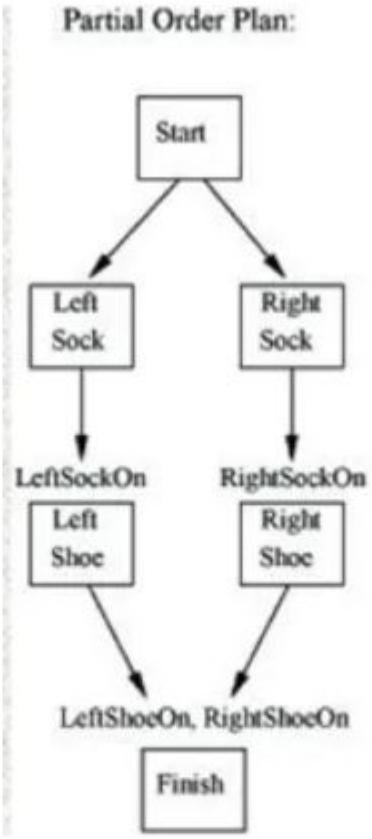


Partial Order Planning

4. RightSockOn

Precondition: Barefoot

Effect: RightSockOn



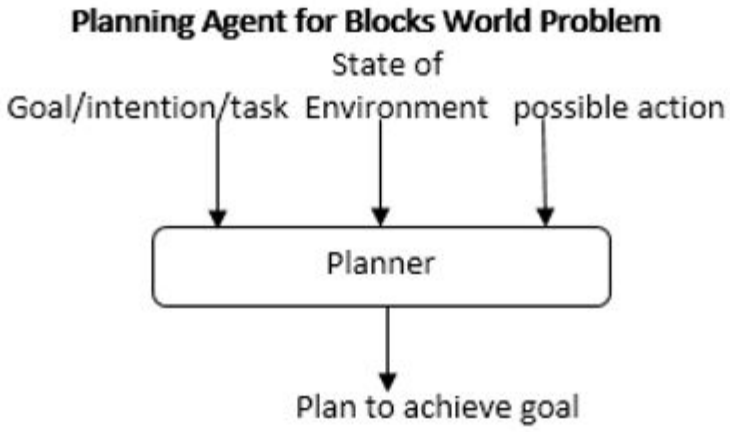
Total Order Planning

- They only explore linear sequences of actions from start to goal state
- They cannot take advantage of problem decomposition, i.e. splitting the problem into smaller sub-problems and solving them individually.

Compare and Contrast Problem Solving Agent and Planning Agent

- Planning and problem solving (Search) are considered **as different approaches** even though they can often be applied to the same problem.
- Basic problem solving searches a state-space of possible actions, starting from an initial state and following **any path that it believes will lead it the goal state.**
- Planning is distinct from this in three key ways:
  1. **Planning "opens up" the representation of states, goals and actions** so that the planner can deduce direct connections between states and actions.
  2. The **planner does not have to solve the problem** in order (from initial to goal state) it can suggest actions to solve any sub-goals at anytime.
  3. Planners assume that most parts of the world **are independent** so they can be stripped apart and solved individually.

Design a planning agent for a Blocks World problem. Assume suitable initial state and final state for the problem.



Designing the Agent

Idea is to give an agent:

- Representation of goal/intention to achieve
- Representation of actions it can perform; and
- Representation of the environment;
- Then have the agent generate a plan to achieve the goal.
- The plan is generated entirely by the planning system, without human intervention.

Design a planning agent for a Blocks World problem. Assume suitable initial state and final state for the problem.

Assume start & goal states as below:

START STATE
on(B, table)
on(A, table)
on(C, A)
hand empty
clear(C)
clear(B)

GOAL STATE
on(C, table)
on(B, C)
on(A, B)
hand empty
clear(A)

Design a planning agent for a Blocks World problem. Assume suitable initial state and final state for the problem.

a. STRIPS(The Stanford Research Institute Problem Solver) : (An Automate Planner) A planning system – Has rules with precondition

Sequence of actions :

b. Grab C

c. Pickup C

d. Place on table C

e. Grab B

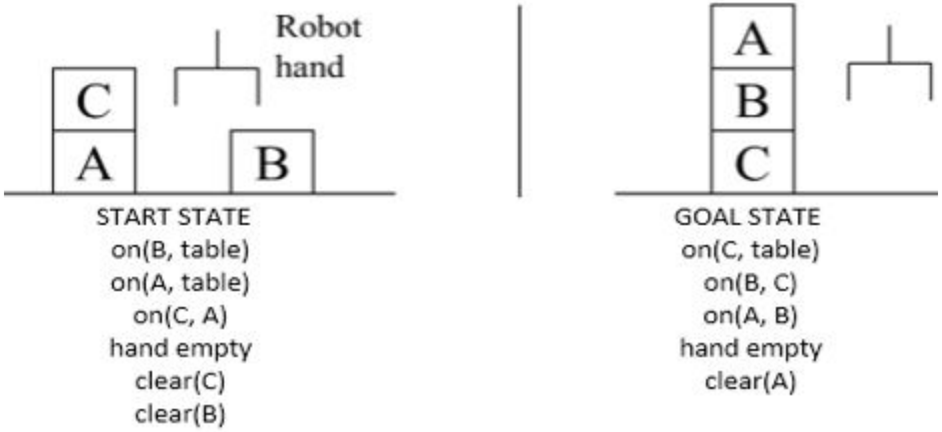
f. Pickup B

g. Stack B on C

h. Grab A

i. Pickup A

j. Stack A on B



Design a planning agent for a Blocks World problem. Assume suitable initial state and final state for the problem.

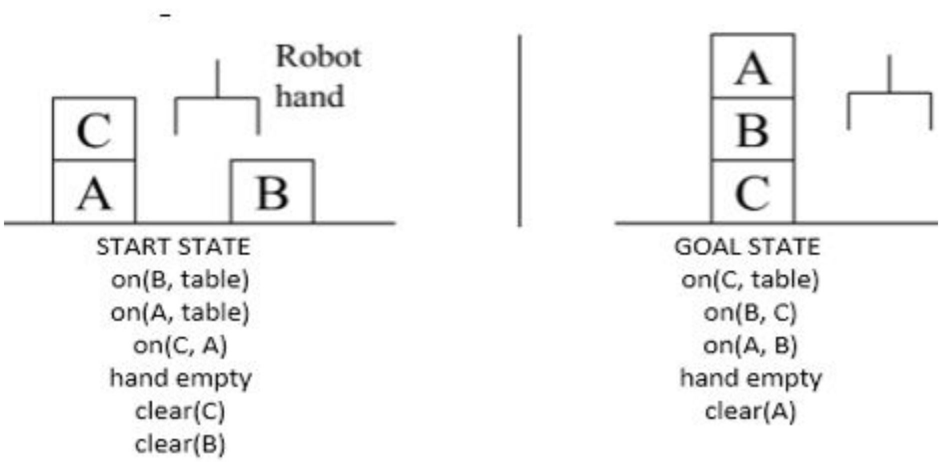
Rules:

R1 : pickup(x)

R2 : putdown(x)

R3 : stack(x,y)

R4 : unstack(x,y)

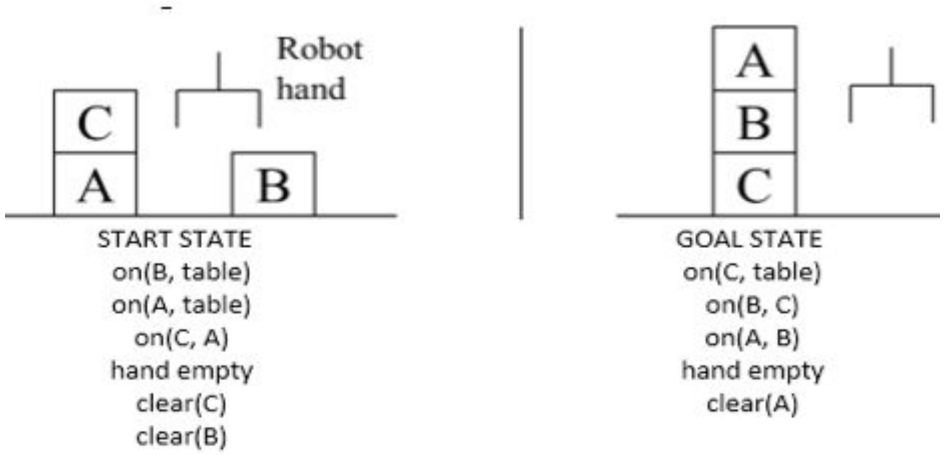


Design a planning agent for a Blocks World problem. Assume suitable initial state and final state for the problem.

Plan for the assumed blocks world problem

For the given problem, Start → Goal can be achieved by the following sequence:

1. Unstack(C,A)
2. Putdown(C)
3. Pickup(B)
4. Stack(B,C)
5. Pickup(A)
6. Stack(A,B)



Design a classical planner for air cargo transportation problem using STRIPS. The problem involves loading, unloading cargo and flying it from place to place. Define three actions: Load, Unload and Fly. The actions affect two predicates: In(c, p) means that cargo c inside plane p, and At(x, a) means that object x (either plane or cargo) is at airport a. [10]

- predicates In(·, ·),At(·, ·)
- type predicates: Cargo(·), Plane(·),Airport(·)
- Start
  - 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)
- Actions
  - Load(c, p, a)
  - Unload(c, p, a)
  - Fly(p, from, to)

- Actions
  - Load(c, p, a)
    - PRE: At(c, a) ^ At(p, a) ^ Cargo(c) ^ Plane(p) ^ Airport(a)
    - EFF: ¬At(c, a) ^ In(c, p)
  - Unload(c, p, a)
    - PRE: In(c, p) ^ At(p, a) ^ Cargo(c) ^ Plane(p) ^ Airport(a)
    - EFF: At(c, a) ^ ¬In(c, p)
  - Fly(p, from, to)
    - PRE: At(p, from) ^ Plane(p) ^ Airport(from) ^ Airport(to)
    - EFF: ¬At(p, from) ^ At(p, to)

- a solution is
  - Load(C1, P1, SFO),
  - Fly(P1, SFO, JFK),
  - Unload(C1, P1, JFK),
  - Load(C2, P2, JFK),
  - Fly(P2, JFK, SFO),
  - Unload(C2, P2, SFO)

(b) Explain planning problem in AI. What are different types of planning? Consider problem of changing a flat tire. The goal is to have a good spare tire properly mounted on to the car's axle, where the initial state has a flat tire on the axle and a good spare tire in the trunk. **[10]**