Planning and Learning

● The planning problem

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 Planning.

Representation of Planning problems is often done using following:

- A set of states
- A set of goals
- A set of actions

Artificial intelligence (AI) has fundamentally changed several industries and has become a part of daily life. Planning, which entails putting together a series of actions to accomplish a particular objective, is one of the fundamental elements of AI. In this Artificial Intelligence tutorial, we will explore planning in AI, involving applying algorithms and approaches to create the best plans possible, which can improve the efficacy and efficiency of AI systems.

Planning in AI is the process of coming up with a series of actions or procedures to accomplish a particular goal. It entails assessing the existing situation, identifying the intended outcome, and developing a strategy that specifies the steps to take to get there. It is not confined to a particular industry; it may also be used in robots, video games, logistics, as well as healthcare.

A planning system in AI is made up of many crucial parts that cooperate to produce successful plans. These components of planning system in ai consist of:

Representation: The component that describes how the planning problem is represented is called representation. The state space, actions, objectives, and limitations must all be defined.

Search: To locate a series of steps that will get you where you want to go, the search component searches the state space. To locate the best plans, a variety of search techniques, including depth-first search & A* search, can be used.

Heuristics: Heuristics are used to direct search efforts and gauge the expense or benefit of certain actions. They aid in locating prospective routes and enhancing the effectiveness of the planning process.

Benefits of AI Planning

Numerous advantages of AI planning contribute to the efficacy and efficiency of artificial intelligence systems. Some key benefits include:

Resource Allocation: With the help of AI planning, resources can be distributed in the best way possible, ensuring that they are used effectively to accomplish the desired objectives.

Better Decision-Making: AI planning aids in making knowledgeable judgments by taking a variety of aspects and restrictions into account. It helps AI systems to weigh several possibilities and decide on the best course of action.

Automation of Complex Tasks: AI planning automates complicated tasks that would otherwise need a lot of human work. It makes it possible for AI systems to manage complex procedures and optimize them for better results.

Applications of AI Planning

AI planning is used in many different fields, demonstrating its adaptability and efficiency. A few significant applications are:

Robotics: To enable autonomous robots to properly navigate their surroundings, carry out activities, and achieve goals, planning is crucial.

Gaming: AI planning is essential to the gaming industry because it enables game characters to make thoughtful choices and design difficult and interesting gameplay scenarios.

Logistics: To optimize routes, timetables, and resource allocation and achieve effective supply chain management, AI planning is widely utilized in logistics.

Healthcare: AI planning is used in the industry to better the quality and effectiveness of healthcare services by scheduling patients, allocating resources, and planning treatments.

Challenges in AI Planning

While AI planning has many advantages, many issues need to be resolved. Typical challenges include:

Complexity: Due to the wide state space, multiple possible actions, and interdependencies between them, planning in complicated domains can be difficult.

Uncertainty: One of the biggest challenges in AI planning is overcoming uncertainty. Actions' results might not always be anticipated, thus the planning system needs to be able to deal with such ambiguous situations.

Scalability: Scalability becomes a significant barrier as the complexity and scale of planning problems rise. Large-scale issues must be effectively handled via planning systems.

Several important aspects are incorporated into best practices for AI planning:

Formulation of the issue clearly: Clearly state your goals, restrictions, and desired results.

Optimal representation: Construct an appropriate representation of the planning domain.

Algorithm selection: Choose planning algorithms that strike a compromise between complexity and optimality.

Iterative improvement: Keep the planning process under constant review and improvement.

Management of uncertainty: Include methods, such as probabilistic modeling, to deal with uncertainty.

Utilizing human expertise: Ask for and use feedback from others to make sure your aims are in line with theirs.

Benchmarking and evaluation: Continually assess performance and evaluate against pertinent indicators.

Collaboration: Encourage cooperative planning by incorporating pertinent parties.

Scalability: Design planning systems with scalability in mind to effectively tackle big problems.

Real-time responsiveness: Create systems that can instantly adjust and replan in response to shifting circumstances.

Ethical considerations: Address AI ethical issues, promote justice, and ensure accountability in the planning procedures..

Documentation: Keep thorough records of the planning process for future reference.

● Partial order planning

In partial ordered planning (POP), ordering of the actions is partial. Also partial ordered planning doesn't specify which action will come first out of the two actions which are placed.

With partial ordered planning, problems can be decomposed, so it can work well in case the environment is non-cooperative.

It combines two action sequence:

i. First branch covers the left sock and left shoe.

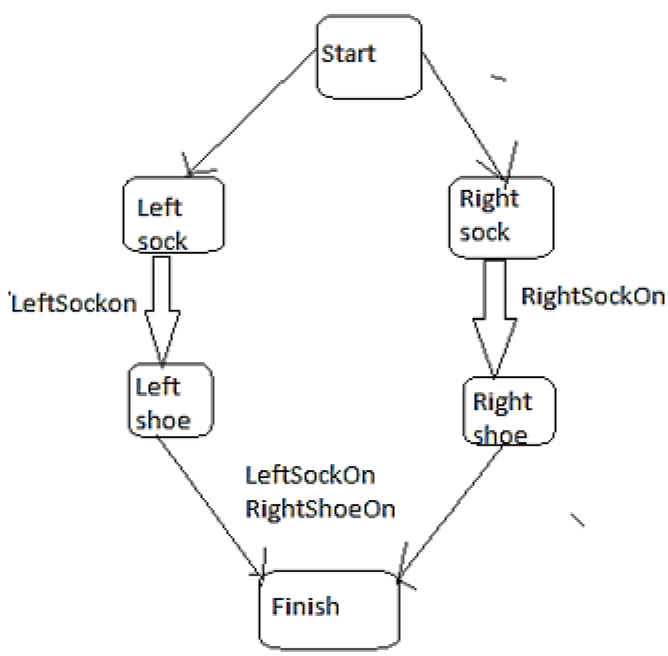
ii. In case, to wear a left shoe, wearing a left sock is preconditioned, similarly.

iii. Second branch covers the right shock and right shoe.

iv. Here, wearing a right shock is a precondition for wearing the right shoe.

Once these actions are taken we achieve our goal and reach the finish state.

E.g. Partial order planning of Wearing Shoe



Pop as search problem:

Set of actions:

These are the steps of the plan.

For e.g.: Set of Actions = {Start, Rightsock, Rightshoe ,Leftsock, Leftshoe, Finish}

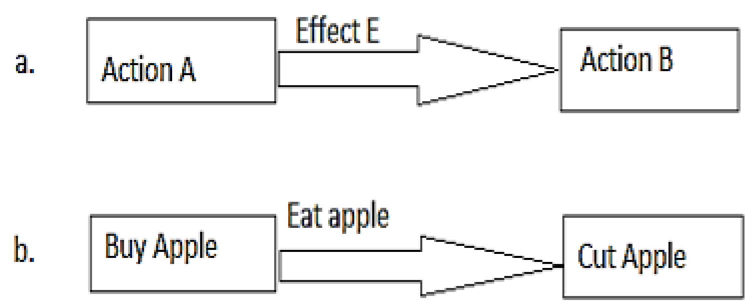
Set of ordering constraints/preconditions:

i. Preconditions are considered as ordering constraints.(i.e. without performing action “x” we cannot perform action “y”)

ii. For e.g.: Set of ordering = {Right-sock <right-shoe; left-sock<left-shoe}="" that="" is="" in="" order="" to="" wear="" shoe,="" first="" we="" should="" wear="" a="" sock.<="" p="">

Set of causal links:

Action A achieves effect “E” for action B



i. You can understand that if you buy an apple its effect can be eating an apple and the precondition of eating an apple is cutting the apple.

ii. For e.g. Set of Causal Links = {Right-sock-> Right-sock-on

Set of open preconditions:

i. Preconditions are called open if it cannot be achieved by some actions in the plan.

ii. Consistent Plan is a Solution for POP Problem

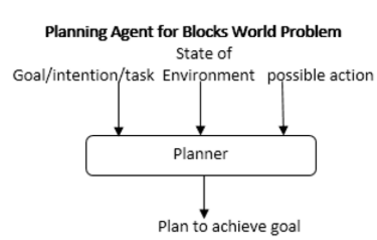
iii. A consistent Plan doesn’t have cycles of constraints; it doesn’t have conflicts in the causal links and doesn’t have open preconditions so it can provide a solution for the POP problem.

- **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.

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



Designing the Agent

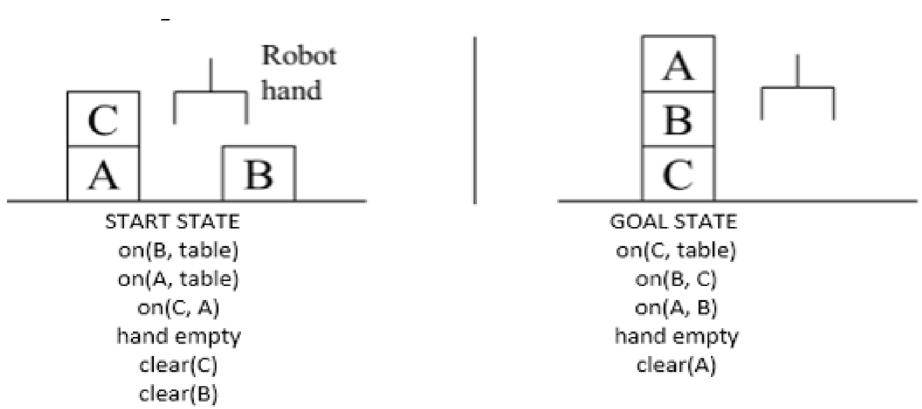
Idea is to give an agent:

- 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.

Assume start & goal states as below:



a. STRIPS : A planning system – Has rules with precondition deletion list and addition list

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

Rules:

k. R1 : pickup(x)

- Precondition & Deletion List : hand empty, on(x,table), clear(x)
- Add List : holding(x)

l. R2 : putdown(x)

- Precondition & Deletion List : holding(x)
- Add List : hand empty, on(x,table), clear(x)

m. R3 : stack(x,y)

- Precondition & Deletion List :holding(x), clear(y)
- Add List : on(x,y), clear(x)

n. R4 : unstack(x,y)

- Precondition & Deletion List : on(x,y), clear(x)
- Add List : holding(x), clear(y)

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)