- **Q: What is planning in AI?**

- Planning in AI can be defined as a problem that needs decision making by intelligent system to accomplish the given target.
- OS uses scheduling algorithms like First-in-First out & prints prioritize tasks assigned to it.
- Intelligent system can be robot or computer program.
- **For ex:** Ola driver in sharing ride needs planning to pickup customers from different points.
- Planning is about deciding sequence of actions to accomplish target.
- **Agent Knows:**
- A. Initial state
- B. Goal state
- C. Finite state
- Agent needs to plan sequence of actions for optimal solution.
- **Simple Planning Agent:**
- Consider an example of three users who assigned three different tasks to a single robot & tasks like coffee making, printing & mailing.
- Robot takes i/p from sensor & decide sequence of actions which will be performed by actuators.

- **Q. Partial Order Planning:**

- In partial ordered planning, ordering of the action is partial.

- Problem can be break down and is suitable for non-co-operative environment.

- Example of wearing shoe.

- Here, we formed two branches.

- First branch cover left-sock and left-shoe.

- Precondition-First wear a left sock then left shoe.

- Second branch covers right-sock and right-shoe.

- Pre-condition first wear right sock then right shoe.

- **Pop as a Search Problem:**
- Four main component of planning are:
- **Set of Actions:**
- List of actions which can take agent to goal state.
- Set of Actions:
- { start, Right sock, Right shoe, Left sock ,Left shoe, finish}
- **Preconditions:**
- First wear left sock then left shoe, or wear right sock first then right shoe.
- **Set of Casual Links:**
- Casual links means if you by an apple you need to cut apple (pre-condition) in order to it apple.
- **For Example:**
- Set of casual links: {Right-sock→ Right-sock-on→ Right-shoe, left sock→ Left sock→ Left sock→ Left shoe Right shoe→ Right shoe on→ Finish Left shoe→ Left shoe on→ Finish.

- **Set of Open Preconditions:**
- Open pre-condition means pre-conditions i.e not followed while performing an action.
- Consistent plan is a solution for POP problem.
- Consistent plan do not have.
- Cycle of constraint
- Conflict in casual links.
- Open pre-conditions.
- If open per-condition can't be achieved, then back track the step and try solving with POP.
- Advantage can sole huge state space plan in lesser step.

- **Q. The Internet Shopping World:**
- Internet is used as a medium by all commercial websites.

- Online commerce or e-commerce website boom very rapidly and made huge amount of economy.
- On internet, shopping agent helps a buyer to find products online
- User enters his desire in form of keywords and in return he gets a list of web pages
- If we compare online shopping with Artificial intelligence i/p will be product description provided by user in form of query & o/p will be list of web pages
- **Environment** :world wide web
- **Percept :** list of web pages which will direct towards information
- **front-end** : browsers
- **Back-end**: html of web page
- **Example:**
- Internet shopping World
- Select products:
- Mobile
- Car
- Techmax books
- Grocery
- Shoes
- **<h1>Internet Shopping World</h1>**
  Select products:
  <ul>
  <li>Mobile

  <li>car

<li>Tech-max books

<li>Grocery
<li>Shoes
**
**

- Internet agent can be simple or complex because web pages varies from static to dynamic having content like audio ,video, movies, flash, cookies etc

- **For ex:**

- If agent wants to buy cell phone, agent need to collect review of latest cell phone & then we can visit selling portal where agent have to select product and add to shopping cart payment selection depend upon user.

- **Q. Total order planning**
- Progression & regression planner imposed total ordering of action at all stages of planning process
- Sequence of action is created on basis of pre-condition which can have multiple combinations of required actions
- Precondition :wear left socks then left shoe& right socks then right shoe
- Disadvantages:
- Not suitable for non-cooperative environment
- Total order planning fails if there is a cycle of constraints.

Start →Left Sock →Left Shoe →Right Sock →Right Shoe →Finish

Start →Right Sock →Right shoe →Left Sock →Left Shoe →Finish

Start →Left Sock →Right Sock →Left Shoe →Right Shoe →Finish

Start →Left Sock →Right Sock →Right Shoe →Left Shoe →Finish

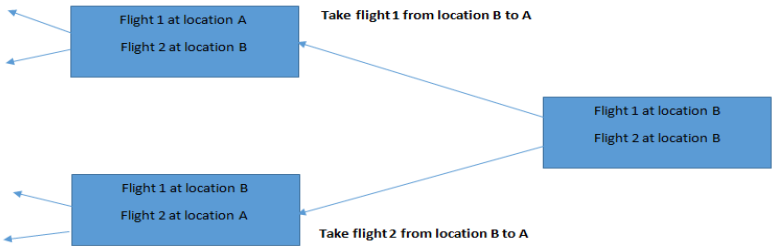
Start →Right Sock →Left Sock →Left Shoe →Right Shoe →finish

Start →Right Sock →Left Sock →Right Shoe →left shoe →Finish

- **Q: Planning Problem:**

- To achieve any goal an agent has to answer few questions like “what will be effects of its action & how it will affect upcoming actions.
- Consider an example of tic-tac-toe game
- Agent while making a current move checks opponent last move, effectors of his move & future move by opponent.
- A classical planning has following assumptions about task environment:
- **Fully observable:**
- Agent can observe current state of environment
- **Deterministic**:
- Agent can determine effect of his actions
- **Finite:**
- Set of actions possible in a particular state
- **Static:**
- External events are ignored which can’t be handled by an agent
- **Discrete**:
- Event varies from start to end
- Goal is a union of sub-goals
- Take an example of tennis game which is divided in to 3 or 5 sets
- Sub-goals can be to win 2 out of 3 or 3 out of 5 sets in order to win a game.
- **Problem solving & planning:**
- Planning is a combination of problem solving + logical representation
- Planning agent has parameters like states, goals & operations which are decomposed in to sentences
- Planning complexity can be reduced by setting sub-goals
- Agent have information like past actions, present action and effect of actions etc.

- **Q. Regression planner:**



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- It is also called as backward state-space search.

- Processing will go from goal state to initial state.

- In backward state-space search we need information about predecessor of the current state.

- This approach is not suitable because we are unable to find actual pre-decessor who leads to goal state when there is more than one goal state.

- In given ex. We have two goals state i.e. flight at location B & flight 2 at location B.

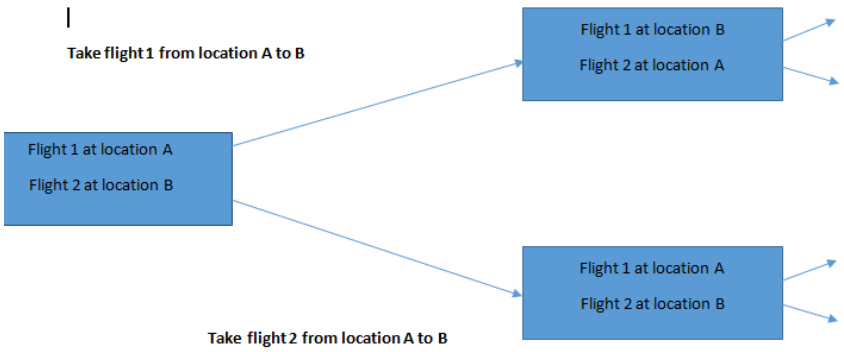
- If we iteration in backward, there are two predecessor states.

- First one is flight at location A & flight 2 at location B.

- Second one is flight at location B & flight 2 at location A.

- **Regression Algorithm:**
- To determine pre-decessor:
  a. Pre-decessor is found out by applying actions.
  b. One action is chosen to achieve goal state.
  c. Pre-condition need to be satisfied for relevant action.
  d. Sub-goals are checked only.
     Advantages: Relevant actions are considered.

- **Q. Progression Planner:**



- It is also called as forward state-space search.
- It is processing from initial state to goal state.
- The probability of actions needs to be considered while going from initial to goal state.
- Progression planner should know:
  (1) Initial state
  (2) Set of actions
  (3) Goal state.

    - Actions have pre-condition & effects.
    - Initially both flight A and B are at location A.
    - After taking flight 1 from A to B then flight 1 at location B flight 2 at location A.
    - After second action, flight 2 at location B while 1 at location A.

- Initial state of planning problem has a set of positive, the literals which don't appear are considered as false.
- If preconditions are satisfied then the actions are favoured i.e. if the preconditions are satisfied then positive effect literals are added for that action else the negative effect literals are deleted for that action.
- Perform goal testing by checking if the state will satisfy the goal.
- Lastly keep the step cost for each action as 1.

- **Q. Multi-Agent Planning:**

- Whatever planning we have discussed so far, belongs to single user environment. Agent acts alone in a single user environment.

- When the environment consist of agent to, then the way a single agent plan its action get changed.

- We have a glimpse of environment where multiple agents have to take actions based on current state. The environment could be co-operative or competitive. In both the cases agent's action influences each other.

- Few of the multi agent planning strategies are listed below:

- **Co-operative:**

- In co-operative strategy agents have joint goals and plans. Goals can be divided into sub-goals but ultimately combined to achieve ultimate goal.

- **Multi-body Planning:**

- Multi body planning is the strategy of implementing correct joint plan.

- **Co-ordination mechanisms:**

- These strategies specify the co-ordination between co-operating agent. Co-ordination mechanism is used in co-operating planning.

- **Competition:**

- Competition strategies are used when agents are not co-operating but competing with each other. Every agent wants to achieve the goal first.

- **Q. Conditional planning:**

- Conditional planning has to work regardless of the outcome of an action.

- Conditional planning can take place in fully observable environments (FOE) where the current state of the agent is known environment is fully observable. The outcome of action cannot be determined so the environment is said to be nondeterministic.

- In conditional planning we can check what is happening in the environment at predetermined points of the plan to deal with ambiguous actions.

- It can be observed from vacuum world example, Conditional planning needs to take some actions at every state and must be able to handle every outcome for the action it takes. A state node is represented with a square and chance node is represented with a circles.

- For a state node we have an option of choosing some actions. For a chance node agent has to handle every outcome.

- Conditional planning can also take place in the partially observable environments (POE) where, we cannot keep a track on every state. Actions can be uncertain because of the imperfect sensor.

- In vacuum agent example if the dirt is at right and agent knows about right, but not about left. Then, in such cases dirt might be left behind when the agent, leaves a clean square. Initial state is also called as a state set or a belief state.

- Sensor play important role in conditional planning for partially observable environments. Automatic sensing can be useful; with automatic sensing an agent gets all the available percept at every step. Another method is active sensing, with which percept are obtained only by executing specific sensory actions.