CSD 3102 ARTIFICIAL INTELLIGENCE TECHNIQUES
MODULE IV

PLANNING

Topic: Means Ends Analysis

MODULE IV PLANNING 9

Planning Problem – Simple Planning agent –Blocks world - Goal Stack Planning- **Means Ends Analysis-** Planning as a Statespace Search - Partial Order Planning- Planning Graphs-Hierarchical Planning - Non- linear Planning -Conditional Planning- Reactive Planning - Knowledge based Planning-Using Temporal Logic – Execution Monitoring and Re-planning- Continuous Planning-Multi-agent Planning-Job shop Scheduling Problem.

Means Ends Analysis

- The planning strategies can reason either in forward or backward, but a mixture of the two directions is appropriate for solving a complex and large problem.
- Such a mixed strategy, make it possible that first to solve the major part of a problem and then go back and solve the small problems arise during combining the big parts of the problem.
- Such a technique is called Means-Ends Analysis. Means-Ends Analysis is problem-solving techniques used in Artificial intelligence for limiting search in AI programs.
- It is a mixture of Backward and forward search technique. The MEA technique was first introduced in 1961 by Allen Newell, and Herbert A. Simon in their problem solving computer program, which was named as General Problem Solver (GPS).
- The MEA analysis process centered on the evaluation of the difference between the current state and goal state.

How means-ends analysis Works ?

- The means-ends analysis process can be applied recursively for a problem. It is a strategy to control search in problem-solving.
- Following are the main steps which describes the working of MEA technique for solving a problem.
  - First, evaluate the difference between Initial State and final State.
  - Select the various operators which can be applied for each difference.
  - Apply the operator at each difference, which reduces the difference between the current state and goal state.

Operator Subgoaling

- In the MEA process, we detect the differences between the current state and goal state.
- Once these differences occur, then we can apply an operator to reduce the differences. But sometimes it is possible that an operator cannot be applied to the current state.
- So we create the sub problem of the current state, in which operator can be applied, such type of backward chaining in which operators are selected, and then sub goals are set up to establish the preconditions of the operator is called Operator Subgoaling.

Algorithm for Means-Ends Analysis:

Let's take Current state as CURRENT and Goal State as GOAL, then the steps for the MEA algorithm are following.

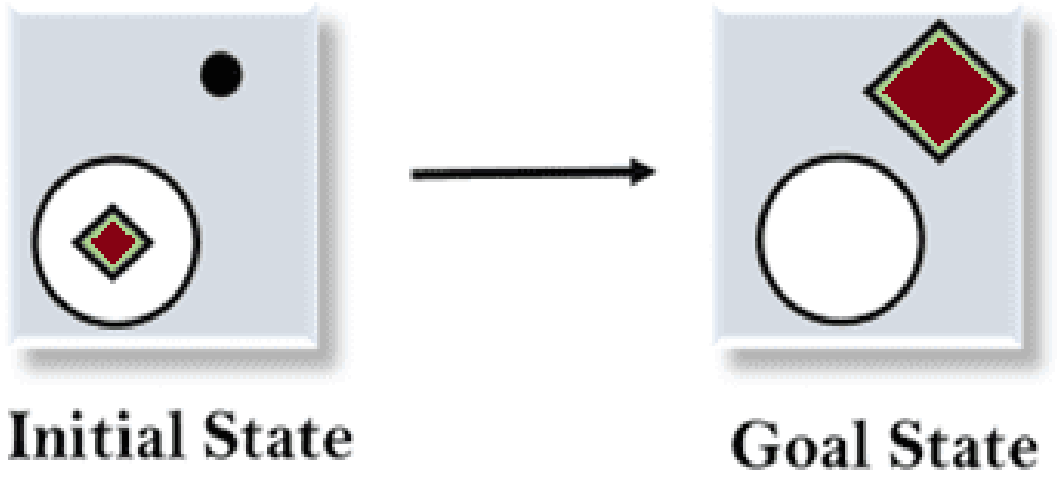
Step 1: Compare CURRENT and GOAL, and if there are no discrepancies, return Success and Exit.

Step 2: If not, choose the most significant difference and lessen it by following the steps below until success or failure is achieved.

- Choose a new operator O that applies to the current difference, and if no such operator exists, signal failure.
- Try to apply operator O to CURRENT. Make description of two states.
  - O-Start, a state in which O?s preconditions are satisfied.
  - O-Result, the state that would result if O were applied In O-start.
- If
  (First-Part <------ MEA (CURRENT, O-START)
  And
  (LAST-Part <----- MEA (O-Result, GOAL), are successful, then signal Success and return the result of combination of FIRST-PART, O, and LAST-PART.

- **Example of Mean-Ends Analysis:**

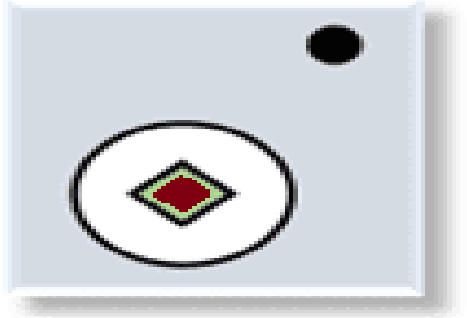
Let's look at an example where we know the starting state and the desired state. In this issue, we must detect differences between the beginning state and the goal state and apply operators to obtain the goal state.



Solution:

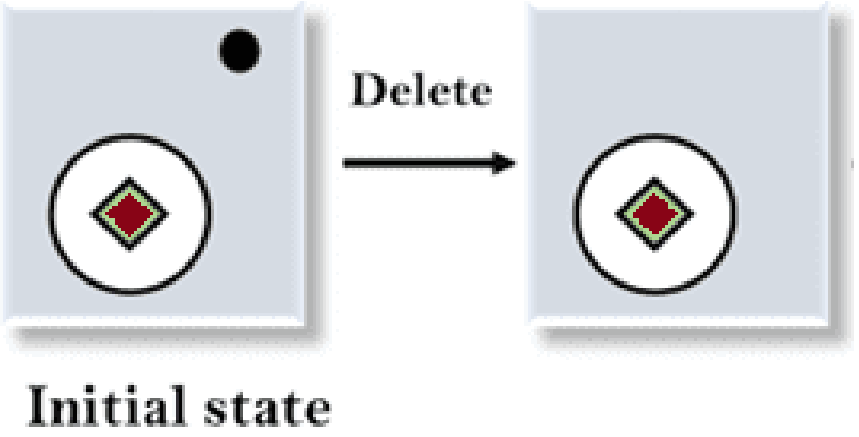
- To solve the problem, we will first identify the differences between starting and goal states, then construct a new state and apply the operators to each difference. For this problem, we have the following operators:
  - Move
  - Delete
  - Expand

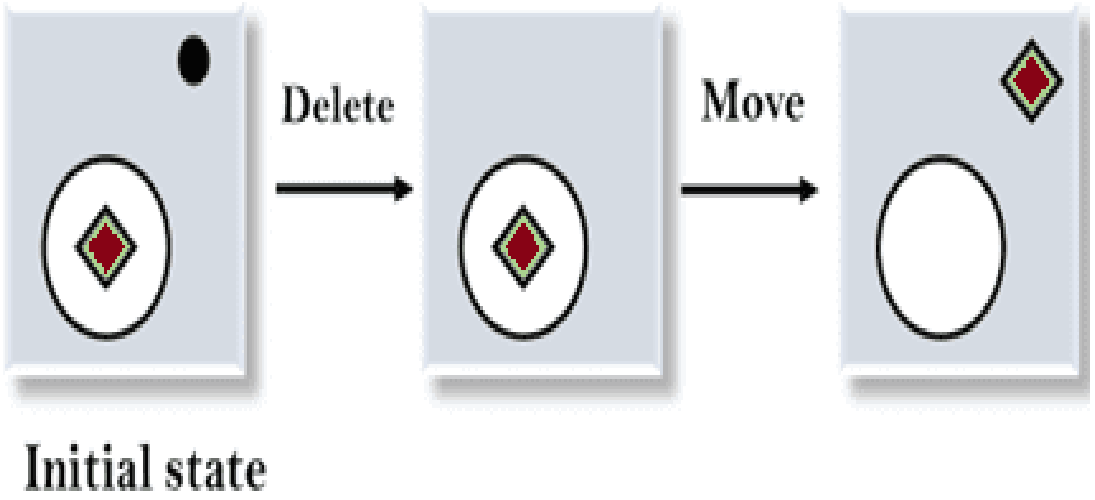
1. Evaluating the initial state: In the first step, we'll evaluate the initial state and compare it to the Goal state to see what the differences Evaluating the initial state: In the first step, we'll evaluate the initial state and compare it to the Goal state to see what the differences are.



Initial state

2. Applying the Delete operator: As you can see, the first difference is that there's no dot symbol in the Goal state, whereas there is in the initial state, so we'll use the Delete operator to remove it.





3. Applying the Move Operator: After using the Delete operator, a new state appears, which we will compare to the objective state again. After comparing these states, we notice that the square is outside the circle, so we'll use the Move Operator to fix it.

4. Applying the Expand Operator: In the third phase, a new state is created, and we will compare it to the desired state. There is still one difference between the states, which is the size of the square, so we will use the Expand operator to construct the desired state.