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1. Explain 4 general steps in problem solving.

Problem solving is the process by which an intelligent agent makes decisions to achieve a specific goal by finding a sequence of actions from an initial state to a desired goal state.

1. The 4 genral steps in problem solving are:
2. Goal formulation:

A goal is a desired state of the world that the agent aims to reach. Goal formulation is the 1st step of problem-solving that organizes the steps/sequence required to formulate one goal out of multiple as well as actions to achieve that goal.It is based on the current situation and the agent's performance measure. The quality of the solution depends on how well the goal is defined. Example: In a navigation system, the goal could be "reach destination B from location A".

1. Problem formulation:
2. Problem formulation is the most important step of problem-solving which decides what actions should be taken to achieve the formulated goal.
3. There are following five components involved in problem formulation:
4. **Initial State:** It is the starting state or initial step of the agent towards its goal.
5. **Actions:** It is the description of the possible actions available to the agent.
6. **Transition Model:** It describes what each action does.
7. **Goal Test:** It determines if the given state is a goal state.
8. **Path cost:** It assigns a numeric cost to each path that follows the goal. The problem-solving agent selects a cost function, which reflects its performance measure. An optimal solution has the lowest path cost among all the solutions.
9. Example: Representing a chess game where states are board positions and actions are legal moves.
10. Search Method :
11. Search method explores the state space using a search algorithm to determine the possible sequence of actions that finds a path from the initial state to the goal state. Then, the best sequence of actions is chosen. Its types are: uninformed(eg BFS,DFS), informed (eg A\*,Greedy)
12. Execute:

After finding the solution (sequence of actions), the agent executes the plan in the real or simulated environment. This step may include monitoring environment changes, handling unexpected events and adjusting the plan if needed (in dynamic environments)

1. What is search? Explain in brief about:

**The process of looking for a sequence of actions that reaches the goal is called search.** A search algorithm takes a problem as input and returns a **solution** in the form of an action sequence. Once a solution is found, the actions it recommends can be carried out.

* 1. State space:

A state-space is defined as a set of all possible states of a problem. A state-space representation allows for the formal definition of a problem that makes the move from the initial state to the goal state.

State-space of a problem is a set of all states which can be reached from the initial state followed by any sequence of actions. The state-space forms a directed map or graph where nodes are the states, links between the nodes are actions, and the path is a sequence of states connected by the sequence of actions.

State space search process is used in the field of computer science, including artificial intelligence (AI), in which successive configurations or states of an instance are considered, with the goal of finding a goal state with a desired property.

In, state space search, a state space is formally represented as a tuple S

S: [S, A, Action(s), Result (s, a), Cost (s, a)]

in which:

S: is the set of all possible states;

A: is the set of possible actions, not related to a particular state but regarding all the state space;

Action(s): is the function that establish which action is possible to perform in a certain state;

Result(s,a): is the function that returns the state reached performing action ‘a’ in state ‘s’

Cost(s,a) is the cost of performing an action ‘a’ in state ‘s’.

* 1. Problem formulation:

Problem formulation means choosing a relevant set of states to consider and a feasible set of operators for moving from one state to another. So given a problem we want to formulate the problem in terms of a set of states and a set of operators on actions.

**A problem can be defined formally or formulated by five components:**

**1) initial state: -**

The **initial state** is the agent starts in. It is a description of starting configuration of the agent. For example, the initial state for our agent in Romania might be described as In(Arad).

**2) Actions: -**

Action signifies the description of the possible **actions** available to the agent. An action takes an agent from one state to another state. By taking an action the agent moves from a current state to its successor state.

For example, from the state In(Arad), the applicable actions are {Go(Sibiu), Go(Timisoara), Go(Zerind)}.

**3) Transition Model**

Transition Model signifies the description of what each action does; the formal name for this is the **transition model**, specified by a function RESULT (s, a) that returns the state that results from doing action (a) in state (s). For example, we have

RESULT(In(Arad),Go(Zerind)) = In(Zerind) .

**4) Goal test**

The **goal test**, which determines whether a given state is a goal state or not. Sometimes there is an explicit set of possible goal states, and the test simply checks whether the given state is one of them. The agent’s goal in Romania is the singleton set {In(Bucharest )}.

**5) path cost**

A **path** cost function assigns a numeric cost to each path. The problem-solving agent chooses a cost function that reflects its own performance measure. For the agent trying to reach Bucharest, time is of the essence, so the cost of a path might be its length in kilometres. The **step cost** of taking action (a) in state (s) to reach state (z) is denoted by **c (s, a, z).**

Problem formulation involves deciding what actions and states to consider, given the goal.

* 1. Well defined problem:

The well-defined problems have specific goals, clearly defined solution paths, and clear expected solutions. Similarly, the ill-defined problems are those that do not have clear goals, solution paths, or expected solution.

In the study of problem solving, any problem in which the initial state or starting position, the allowable operations, and the goal state are clearly specified, and a unique solution can be shown to exist then it is considered as well-defined problems.

A well-defined problem can be described by:

 **Initial state**

 **Operator or successor function** - for any state x returns s(x), the set of states reachable from x with one action

 **State space** - all states reachable from initial by any sequence of actions

 **Path** - sequence through state space

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 **Path cost** - function that assigns a cost to a path. Cost of a path is the sum of costs of individual actions along the path

**Goal test** - test to determine if at goal state

Some problems which are simple and well-defined are called well-structured problems and include a set number of possible solutions - solutions are either 100% right or 100% wrong. An example of a well-structured problem is a typical mathematical (2 + 2 = 4) question.

1. Search strategies:

A problem determines the graph and the goal but not which path to select from the frontier. This is the job of a search strategy. A search strategy specifies which paths are selected from the frontier. Different strategies are obtained by modifying how the selection of paths in the frontier is implemented. We have different types of search strategies like inform, uninform etc… we will see in detail later on…

Search strategies evaluate in terms of four criteria:

 **Completeness:** is the strategy guaranteed to find a solution when there is one?

 **Time complexity:** how long does it take to find a solution?

 **Space Complexity:** how much memory is required to perform the search?

 **Optimality:** does the search strategy find the highest quality solution when there are multiple solutions?



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