STATE SPACE SEARCH

Dr. Krishnendu Guha

Assistant Professor (On Contract)

National Institute of Technology (NIT), Jamshedpur

Email: krishnendu.ca@nitjsr.ac.in

INTRODUCTION

To build a system that can solve a particular problem, we need to do four things:

- Define the problem (specifically the initial and final states)
- Analyze the problem
- Isolate and represent the task knowledge that is necessary to solve the problem
- Choose the best problem solving technique and apply it

STATE SPACE REPRESENTATION

- The state space representation forms the basis of most AI methods
- It allows for a formal definition of a problem as the need to convert some given situation into some desired situation using a set of permissible operations
- It permits us to define the process of solving a particular problem as a combination of known techniques (which are defined as rules) and search
- Search involves exploring the space to try to find some path from the current state to a goal state

EXAMPLE: WATER JUG PROBLEM

- Given two jugs: (i) 4 gallon (ii) 3 gallon
- Neither has any measuring markers on it
- There is a pump that can be used to fill the jugs with water
- How can you get exactly 2 gallons of water into the 4 gallon jug?

STATE SPACE FOR WATER JUG PROBLEM

- This can be described as the set of ordered pairs of integers (x,y)
- Where x represents the number of gallons of water in the 4 gallon jug, i.e. x={0,1,2,3,4}
- Where y represents the number of gallons of water in the 3 gallon jug, i.e. y={0,1,2,3}
- Start State: (0,0), i.e. both are empty
- Goal State: (2,n), i.e. the 4 gallon jug must contain 2 gallons of water and the 3 gallon jug can contain any amount of water

OPERATORS OR RULES

Sl. No.	State	Action	Description
1	(x,y) if x<4	(4, y)	Fill the 4 gallon jug
2	(x,y) if y<3	(x, 3)	Fill the 3 gallon jug
3	(x,y) if x>0	(x-d, y)	Pour some water out of 4 gallon
4	(x,y) if y>0	(x, y-d)	Pour some water out of 3 gallon jug
5	(x,y) if x>0	(0, y)	Empty the 4 gallon jug on ground
6	(x,y) if y>0	(x, 0)	Empty the 3 gallon jug on ground
7	(x,y) if x+y>=4 and y>0	(4, y-(4-x))	Pour water from 3 gallon jug to 4 gallon jug till full
8	(x,y) if x+y>=3 and x>0	(x-(3-y), 3)	Pour water from 4 gallon jug to 3 gallon jug till full
9	(x,y) if x+y<=4 and y>0	(x+y, 0)	Pour all water from 3 gallon to 4 gallon jug
10	(x,y) if x+y<=3 and x>0	(0, x+y)	Pour all water from 4 gallon to 3 gallon jug
11	(0,2)	(2, 0)	Pour 2 gallons from 3 gallon to 4 gallon jug
12	(2,y)	(0, y)	Empty2 gallons in the 4 gallon jug on ground

POSSIBLE SOLUTION TO WATER JUG PROBLEM

	Gallons of water in 4 gallon jug	Gallons of water in 3 gallon jug	Rule Applied
Initial State	0	0	
Step 1	0	3	2
Step 2	3	0	9
Step 3	3	3	2
Step 4	4	2	7
Step 5	0	2	5
Step 6	2	0	9 or 11

STATE SPACE AS GRAPH

- Thus, we can think of the problem space as a graph, where
- Nodes= Problem states
- Arcs= Steps in a Solution Process
- One node corresponds to an initial state
- One node corresponds to a final state

- **Solution Path:** Solution path is an ordered sequence of nodes from the initial state to the goal state

SEARCH ALGORITHM

- Now we need to find a solution path through a state space and for that we need a search algorithm
- Search can proceed from
  - Data to Goal (FORWARD CHAINING)
  - Goal to Data (BACKWARD CHAINING)
- Either could result in a successful search path, but one or the other may require examining more nodes depending on the circumstances

NEXT DAY

- Discuss different types of search techniques like
- Breadth first search
- Depth first search
- Etc etc


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