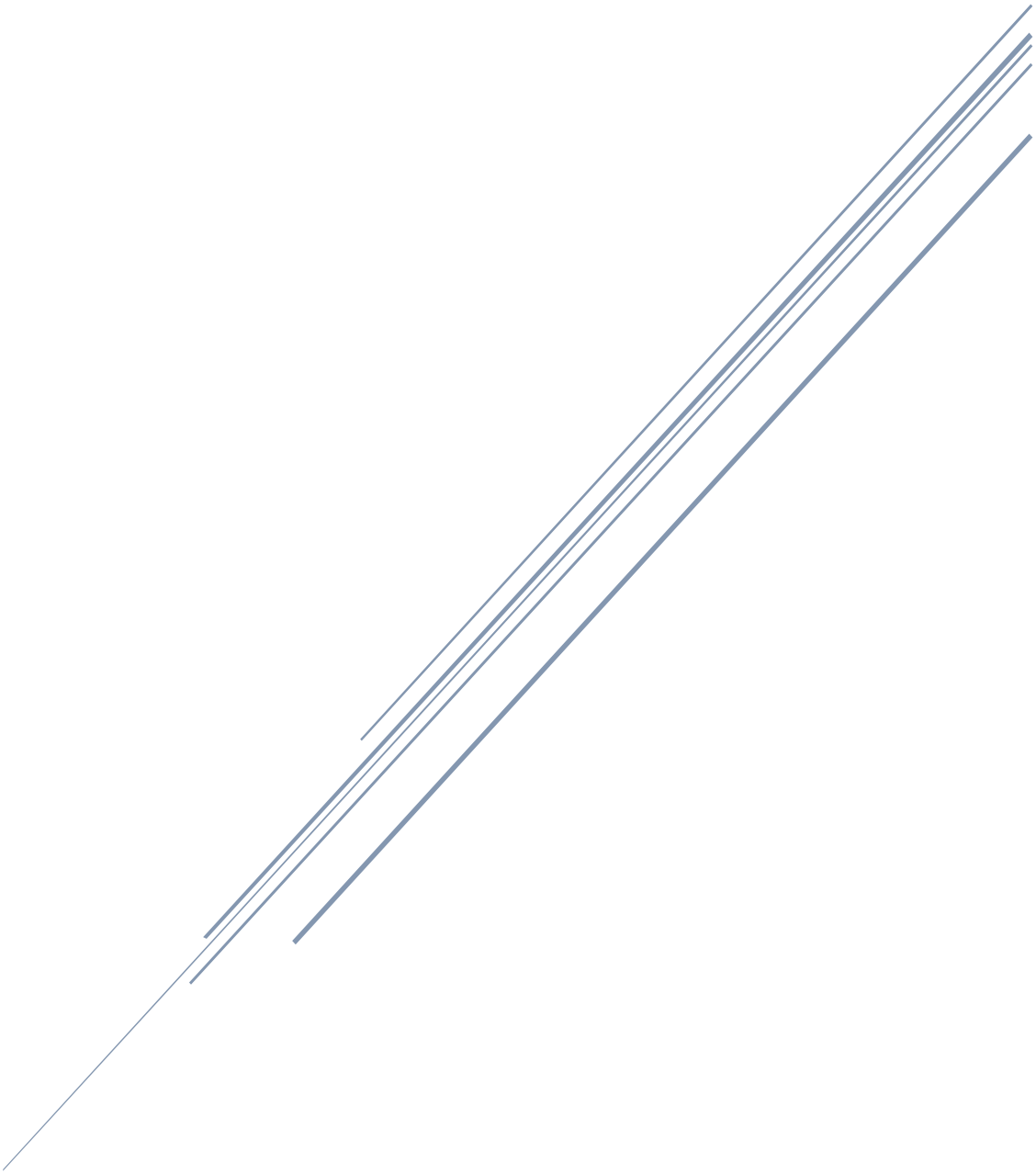
CHAPTER 1

Solving Problems by Searching



Exercise 1: Water jugs problem

Given two water jugs with capacities of 5 and 2 liters. Initially, the 5-liter jug is completely full, and the 2-liter jug is completely empty. The jugs don't have markings to allow measuring smaller quantities. We want to keep only 1 liter in the 2-liter jug and 4 liters in the 5-liter jug. We can use a third jug of unknown capacity but greater than 5 liters (see Figure 1.37). Propose an ideal formulation for this problem and solve it using the BFS algorithm.

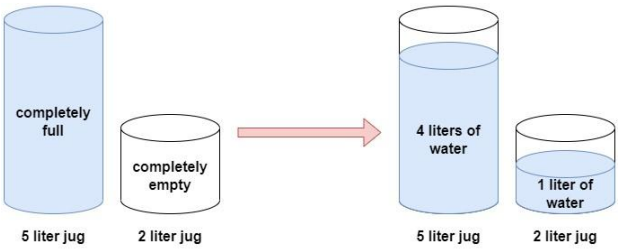


Figure 1.1 Water jugs problem

Exercise 2: Grammar problem

We are given the sequence *ABBEACC*. We can transform this sequence using the following rules:

1. $AC \rightarrow E$
2. $AB \rightarrow BC$
3. $BB \rightarrow E$
4. $Ex \rightarrow x$ for any $x \in \{A, B, C, E\}$

Our objective is to produce the sequence *E*.

Propose a formulation for this problem and solve it using the Breadth-First Search (BFS) algorithm.

Exercise 3: Maze Problem

Consider a robot placed in a maze (a matrix with walls) as shown in Figure 1.39. This robot has to reach the destination marked as the *Goal* position. Find the possible path and its cost that the robot can take from the source to the destination using DFS and A* algorithms.

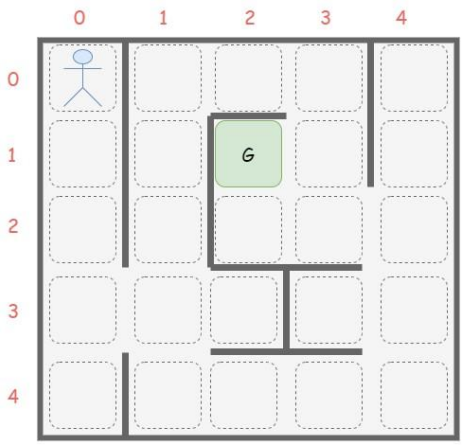


Figure 1.2 Maze problem

Exercise 4: Battlefield Problem

1. In a strategy game, a unit needs to navigate a battlefield represented as a 2D grid, where each cell has a terrain type that influences the movement cost. The objective is to move the unit from its starting position (0, 0) to a target position (4, 4) with the minimum total cost, while avoiding enemy zones and impassable terrain. The terrain types are:

- P (Plain): Normal cost of 1.
- F (Forest): Higher cost (cost of 3).
- M (Mountain): Impassable terrain.
- E (Enemy Zone): Avoid if possible, extremely high cost (cost of 10).

Solve this game using the A* algorithm, ensuring that the path avoids enemy zones and impassable terrain.

	0	1	2	3	4
0	P	P	F	P	P
1	P	F	E	P	P
2	P	P	F	P	P
3	M	M	F	P	P
4	P	P	P	P	P

Exercise 5: 8-puzzle problem

Given an initial state of an 8-puzzle problem and the goal state to be reached in Figure 1.42. Find the most cost-effective path to reach the goal state from the initial state using A* algorithm.

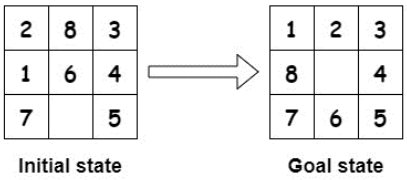


Figure 1. 3 8-puzzle problem