PRACTICE 3

INFORMED SEARCH

0. Uninformed search vs. Informed search

- Uninformed search uses ONLY information in problem definition.
- Informed search uses **problem-specific knowledge**, so the search process is more efficient.

Informed search includes these implementations:
- **Best-first search**: Using an evaluation function f(n) for every node in search tree to check their suitability to expand.
- **Local search**: Defining a state space (set of different configurations) & moving between states to improve based on a particular criterion
- **Adversarial search**: Involving two agents with opposing goals (e.g. in a game)

1. Which of the following statements are true? Explain.

1. Depth-first search always expands at least as many nodes as A∗ search with an admissible heuristic.
2. h(n) = 0 is an admissible heuristic for the 8-puzzle. Suppose the cost function is the Manhattan distance between the current state and the desired state.
3. A∗ is of no use in robotics because percepts, states, and actions are continuous.
4. Breadth-first search is complete even if negative step costs are allowed.
5. Assume that a rook can move on a chessboard any number of squares in a straight line, vertically or horizontally, but cannot jump over other pieces. Manhattan distance is an admissible heuristic for the problem of moving the rook from square A to square B in the smallest number of moves.

2. Answer the following questions.

Suppose two friends live in different cities on a map, such as the Romania map shown in Figure 3.2. On every turn, we can **simultaneously move each friend to a neighboring city** on the map. The amount of time needed to move from city i to neighbor j is equal to the road distance **d(i, j)** between the cities, but on each turn the friend that arrives first must wait until the other one arrives before the next turn can begin. We want the two friends to meet **as quickly as possible**.

a. Write a detailed formulation for this search problem.
b. Let D(x, y) be the straight-line distance between cities x and y. Which of the following heuristic functions are admissible?
    (i) D(x, y)
    (ii) 2 · D(x, y)
    (iii) D(x, y) / 2.

3. Perform the algorithms to search for a path from Lugoj to Bucharest.

1. Greedy best-first search (GBFS)
2. A* search

Given the straight-line distance to Bucharest heuristic h(n)

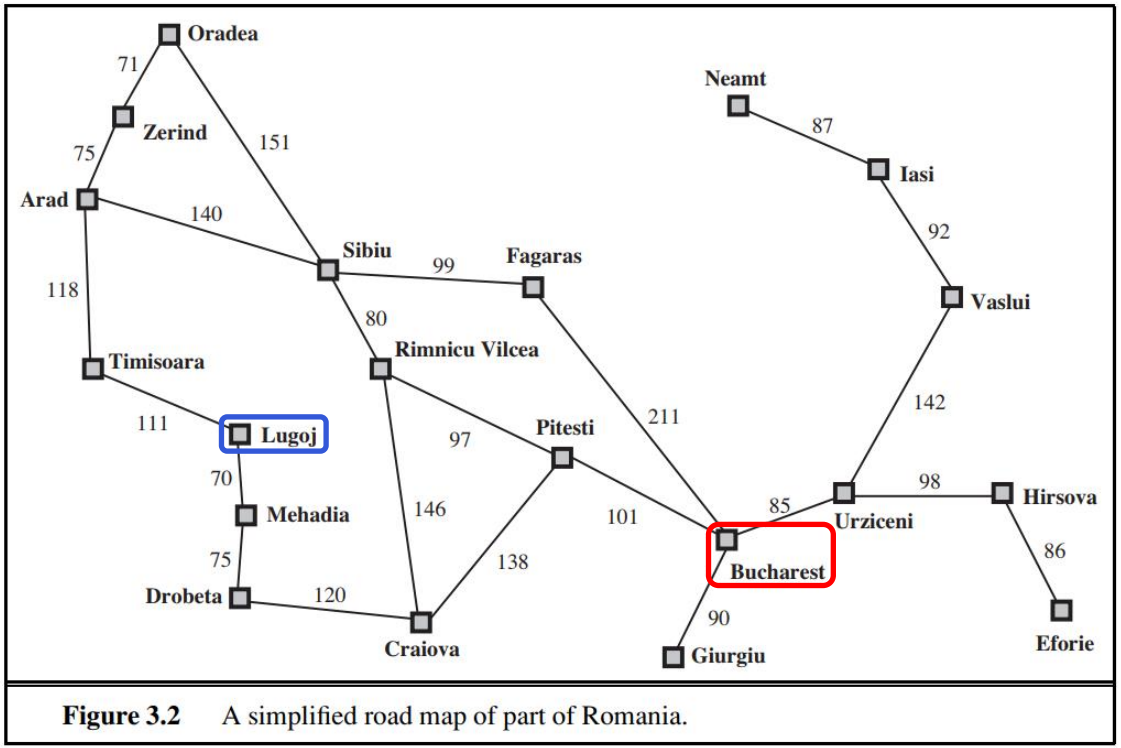
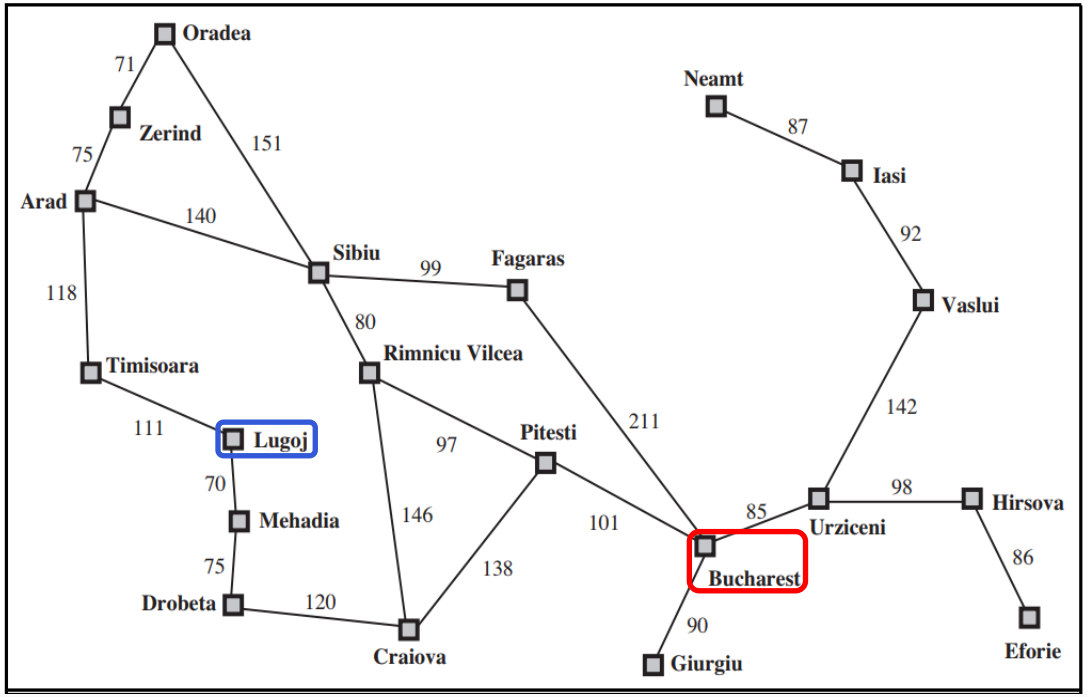
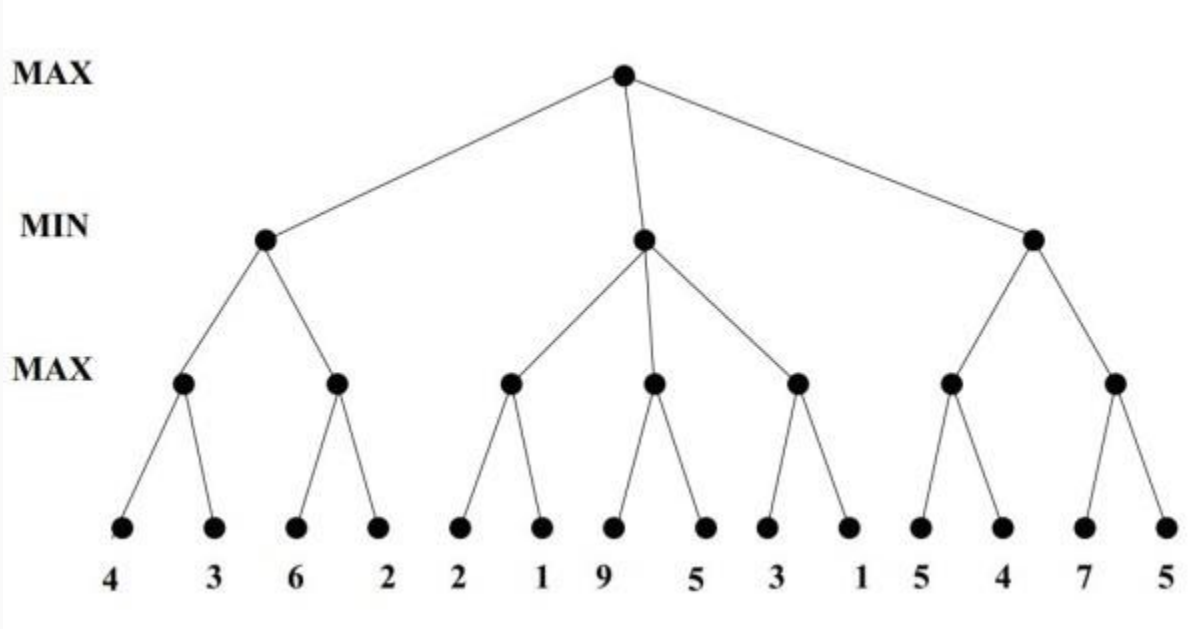


Figure 3.2 A simplified road map of part of Romania.



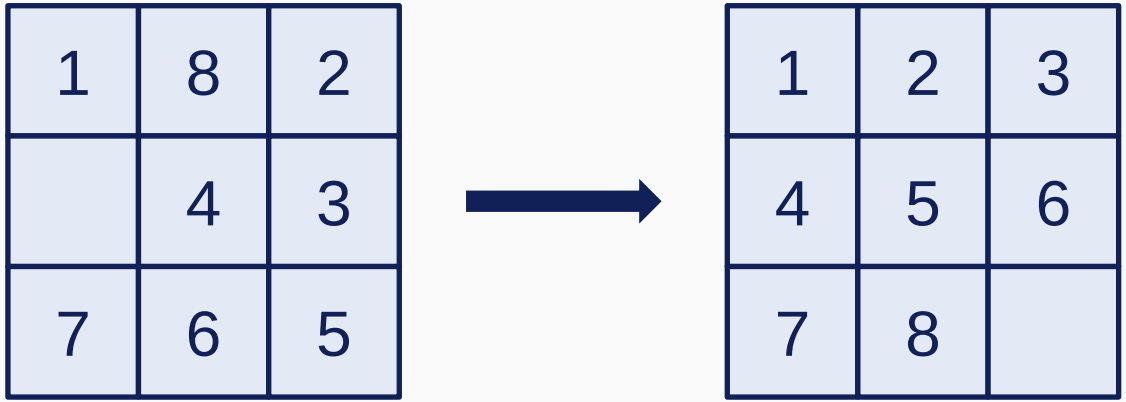
n	Arad	Bucharest	Craiova	Drobeta	Eforie	Fagaras	Giurgiu	Hirsova	Iasi	Lugoj
h(n)	366	0	160	242	161	176	77	151	226	244
n	Mehadia	Neamt	Oradea	Pitesti	Rimnicu Vilcea	Sibiu	Timisoara	Urziceni	Vaslui	Zerind
h(n)	241	234	380	10	193	253	329	80	199	374

4. Given the following search tree, assume a depth-first traversal from left to right. (a) Apply the minimax algorithm and compute the value at the root node. (b) Apply alpha-beta pruning and show the branches that need not to be traversed



5. Implement these heuristics in code to solve the 8-puzzle, using a variety of informed search algorithms. Which one often performs better?

1. Manhanttan distance heuristic
2. Misplaced tiles heuristic



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1. **Manhanttan distance heuristic**
2. Misplaced tiles heuristic

1	8	2
	4	3
7	6	5

Sum of the **Manhattan distances** between a numbered tile and their goal position.

In the left configuration:
- 1: distance from goal position = 0
- 2: _____ = 1
- 3: _____ = 1
- ...

→ **The overall heuristic value = 9**

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1. Manhanttan distance heuristic
2. **Misplaced tiles heuristic**

1	8	2
	4	3
7	6	5

Total number of **misplaced (not in goal position)** numbered tiles

In the left configuration:
- 1: correct position
- 2: incorrect _____
- 3: incorrect _____
- ...

→ **The overall heuristic value = 6**