

# Informed Search

## Heuristics function

- Heuristic is a function which is used in Informed Search, and it finds the most promising path.
- It takes the current state of the agent as its input and produces the estimation of how close agent is from the goal.
- The heuristic method, however, might not always give the best solution, but it guaranteed to find a good solution in reasonable time.
- Heuristic function estimates how close a state is to the goal.
- It is represented by  $h(n)$ , and it calculates the cost of an optimal path between the pair of states.
- The value of the heuristic function is always positive.

# Informed Search

- It expands nodes based on their heuristic value  $h(n)$ .
- It maintains two lists, OPEN and CLOSED list.
- In the CLOSED list, it places those nodes which have already expanded and in the OPEN list, it places nodes which have yet not been expanded.
- On each iteration, each node  $n$  with the lowest heuristic value is expanded and generates all its successors and node  $n$  is placed to the closed list. The algorithm continues until a goal state is found.
- In the informed search two main algorithms are given below:
  - **Best First Search Algorithm(Greedy search)**
  - **A\* Search Algorithm**

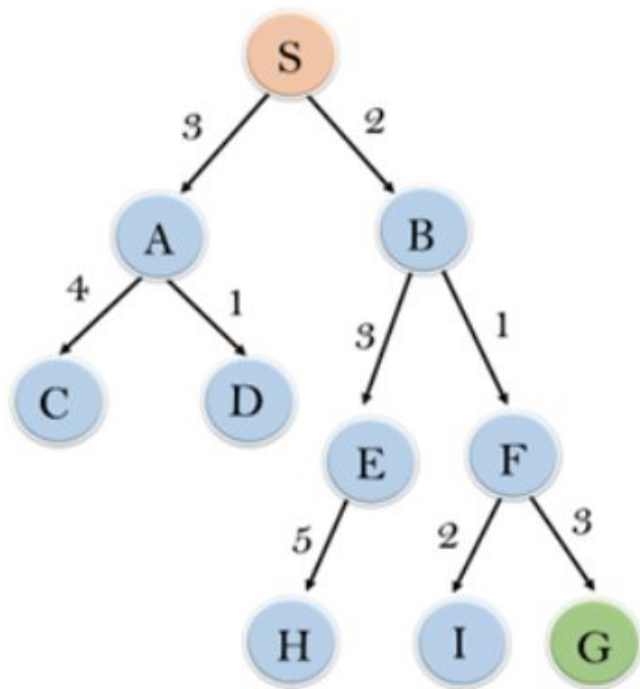
# Best First Search (Greedy Search)

- With the help of best-first search, at each step, we can choose the most promising node.
- In the best first search algorithm, we expand the node which is closest to the goal node and the closest cost is estimated by heuristic function, i.e.
  - $f(n) = h(n)$

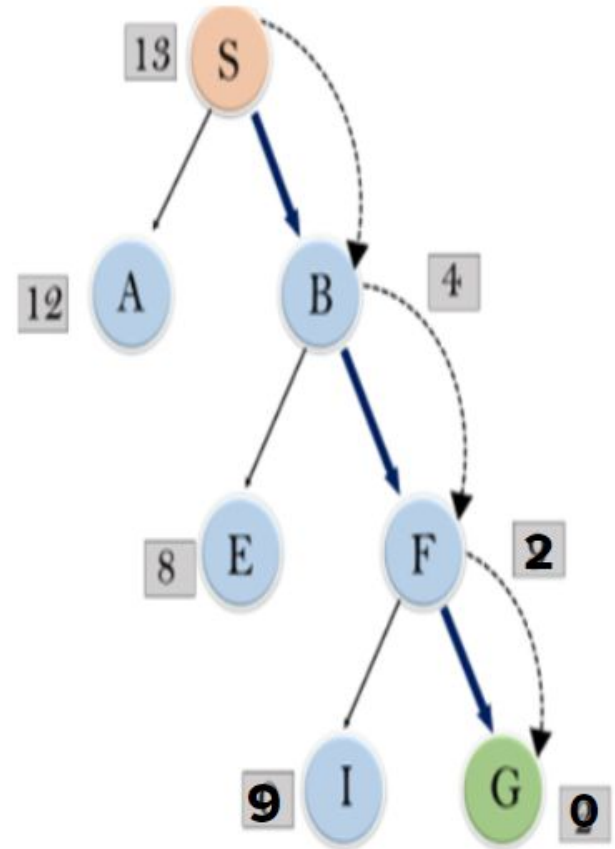
Where,  $h(n)$  = estimated cost from node  $n$  to the goal.

- The worst-case time complexity for greedy search is  $O(b^m)$ , where  $m$  is the maximum depth of the search space.
- space complexity is the same as its time complexity.
- **Complete:** Greedy best-first search is also incomplete, even if the given state space is finite.
- **Optimal:** Greedy best first search algorithm is not optimal.

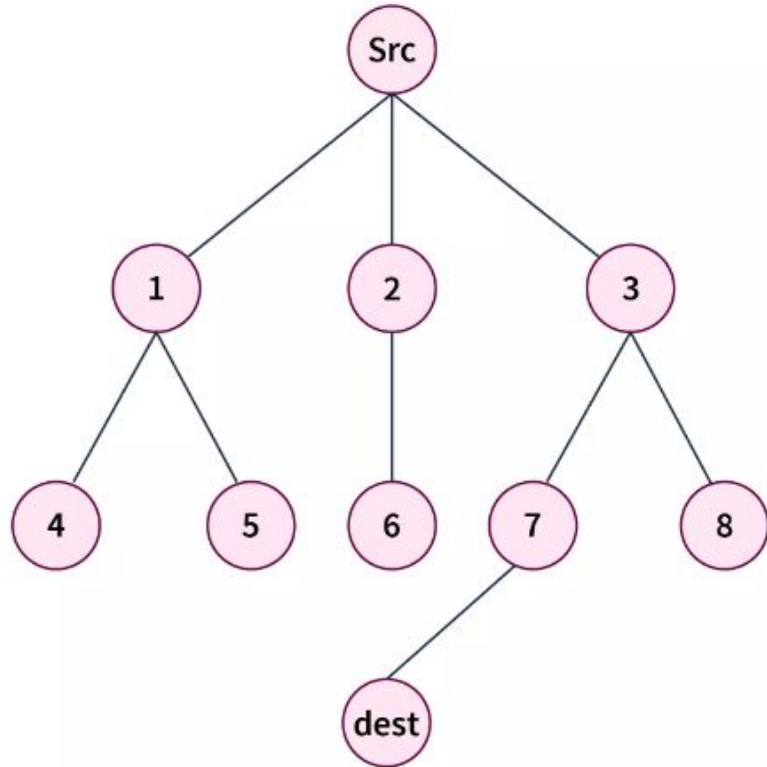
# Best First Search



node	H (n)
A	12
B	4
C	7
D	3
E	8
F	2
H	4
I	9
S	13
G	0



# Best First Search



Src	20
1	22
2	21
3	10
4	25
5	24
6	30
7	5
8	12
dest	0

# Best First Search

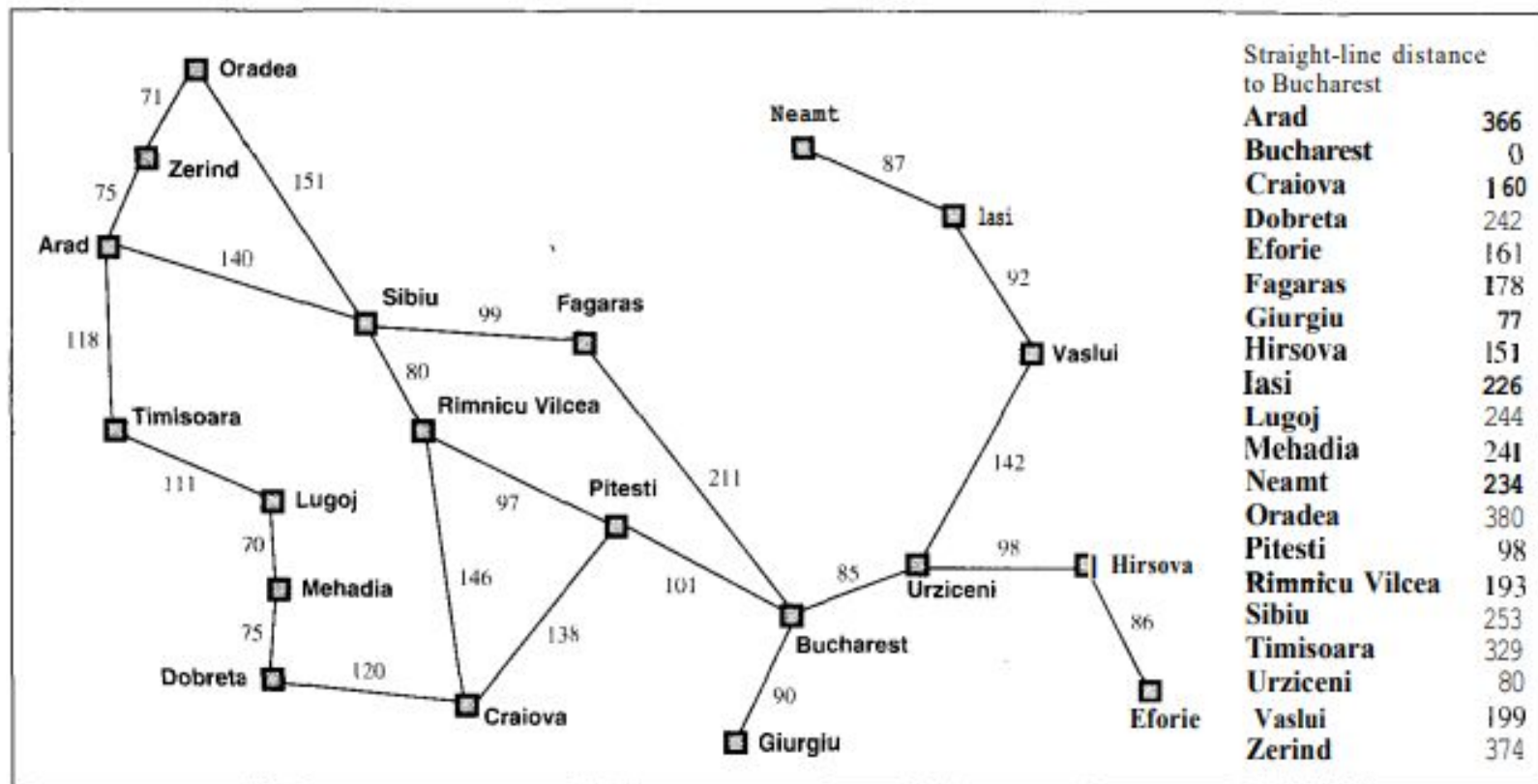
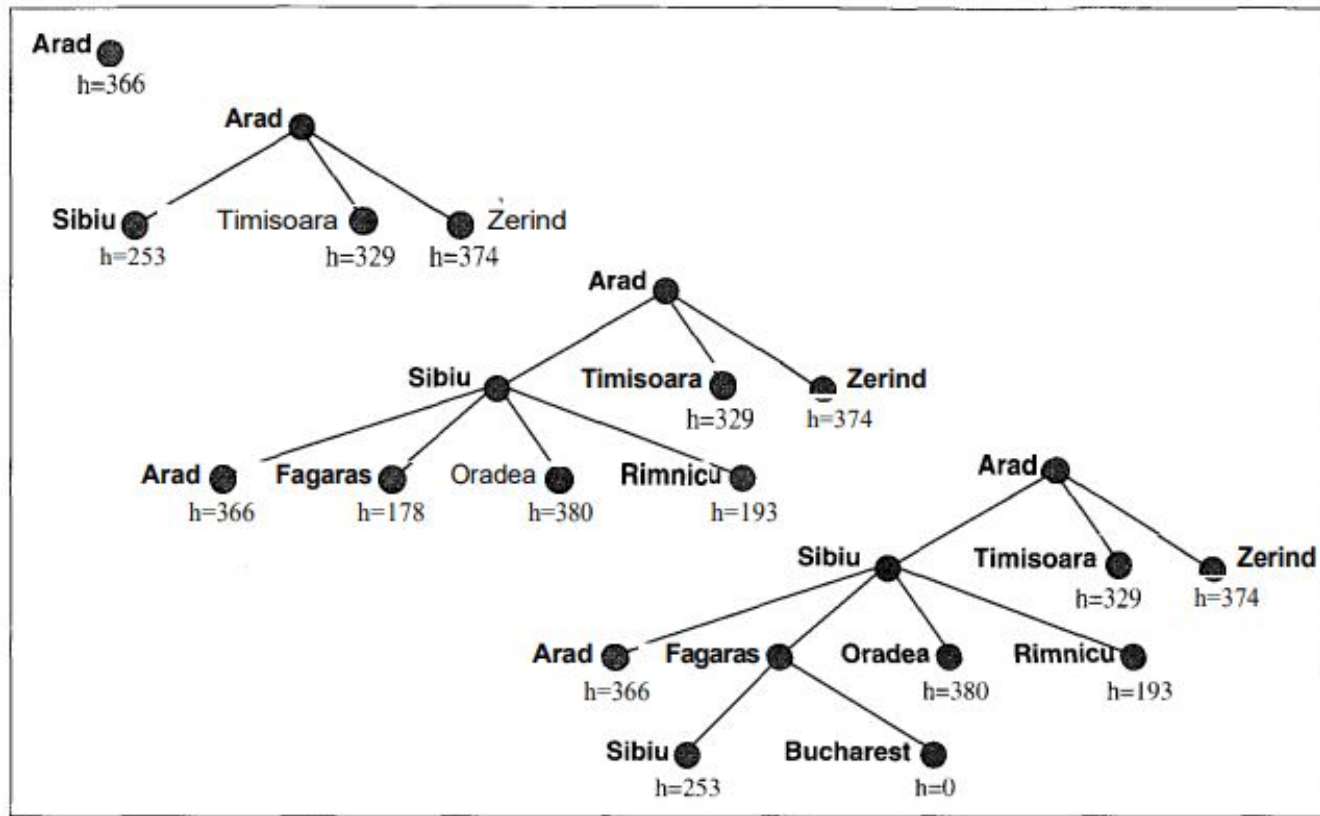


Figure 4.2 Map of Romania with road distances in km, and straight-line distances to Bucharest.

# Best First Search



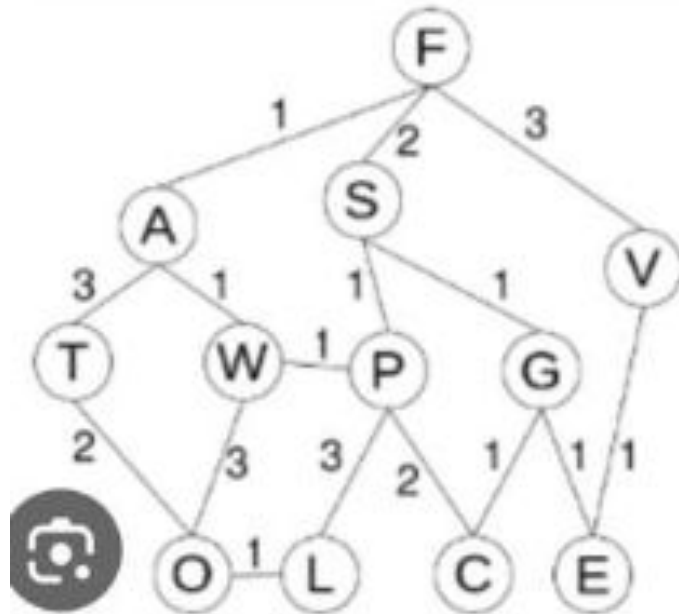
**Figure 4.3** Stages in a greedy search for Bucharest, using the straight-line distance to Bucharest as the heuristic function  $h_{SLD}$ . Nodes are labelled with their  $h$ -values.

# Best First Search

The numbers represent actual distances between nodes

Heuristic values from each node to the Goal

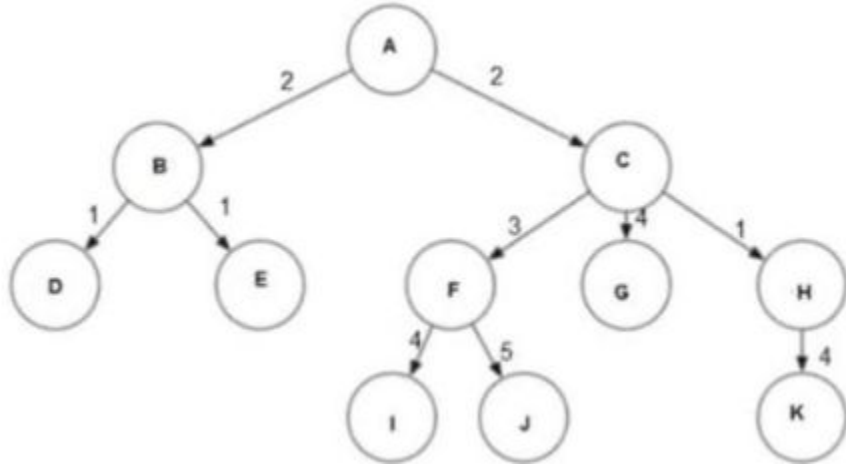
Initial State: F  
Goal State: C



F: 4  
A: 3  
S: 2  
T: 3  
W: 2  
P: 1  
G: 1  
V: 1  
O: 2  
L: 1  
C: 0  
E: 1



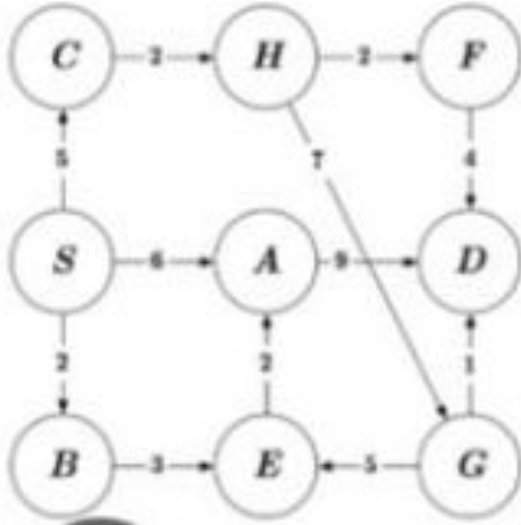
# Best First Search



**Initial State: A**  
**Goal State: G**

Nodes	$h(n)$
A	5
B	3
C	3
D	2
E	1
F	4
G	5
H	2
I	7
J	8
K	1

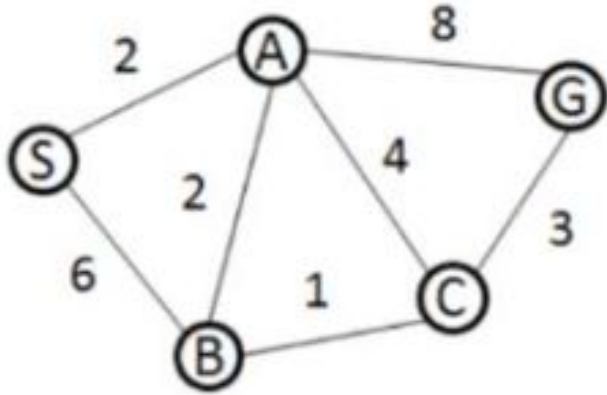
# Best First Search



**A:** 5  
**B:** 1  
**C:** 3  
**D:** 9  
**E:** 4  
**F:** 0  
**G:** 0  
**H:** 7

**Initial State: S**  
**Goal State: G**

# Best First Search



State	$h(x)$
S	7
A	6
B	2
C	1
G	0

**Initial State: S**  
**Goal State: G**

# Best First Search

2	8	3
1	6	4
7		5

**Initial State**

1	2	3
8		4
7	6	5

**Final State**