جامعة الجلالة
GALALA UNIVERSITY

Artificial Intelligence Science Program

Chapter 3: Solving Problems by Searching

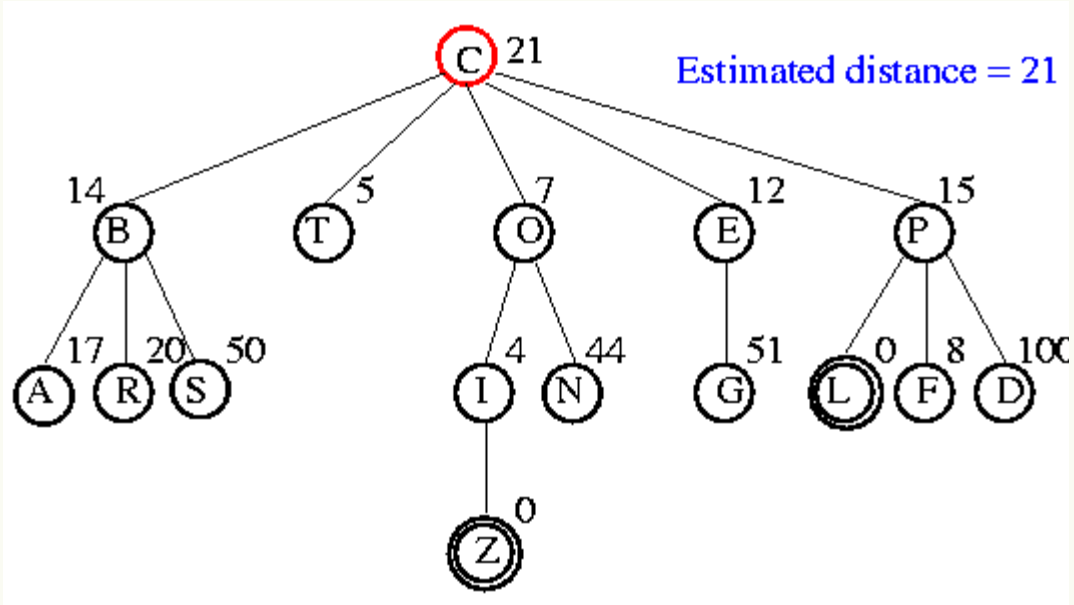
Informed (Heuristic) Search Strategies

- Greedy best-first search
- A* search

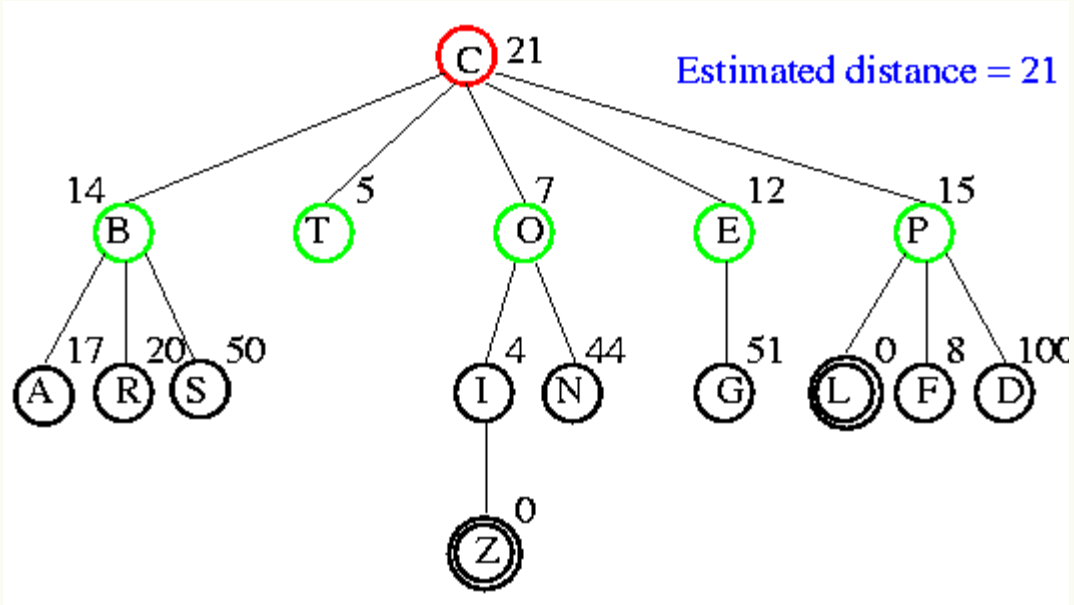
Greedy best-first search

- A heuristic function h(n) = estimated cost of the cheapest path from the state at node n to a goal state.
- At each step, best-first search sorts the queue according to a heuristic function.
- evaluation function $f(n) = h(n)$

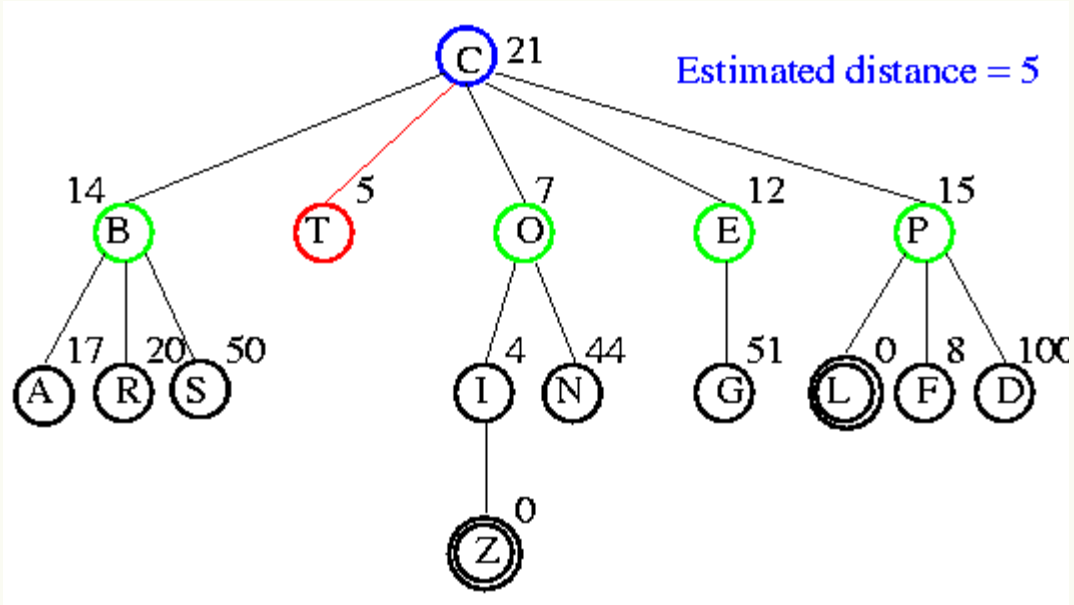
Example


C
21
Estimated distance = 21
14
B
5
T
7
O
12
E
15
P
17
A
20
R
50
S
4
I
44
N
51
G
0
L
8
F
100
D
0
Z

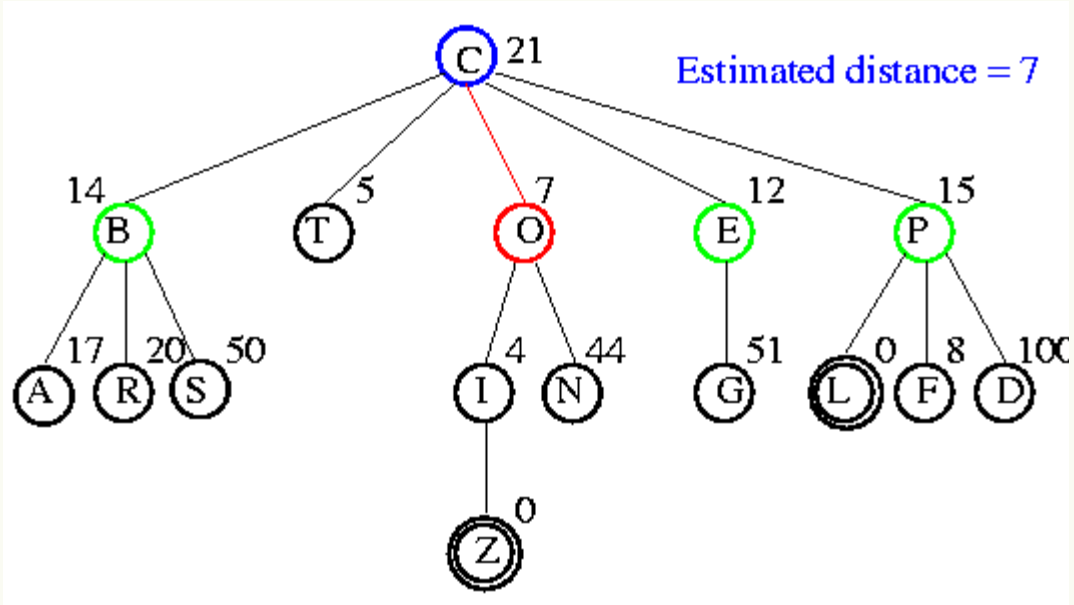
Example


C
21
Estimated distance = 21
14
B
5
T
7
O
12
E
15
P
17
A
20
R
50
S
4
I
44
N
51
G
0
L
8
F
100
D
0
Z

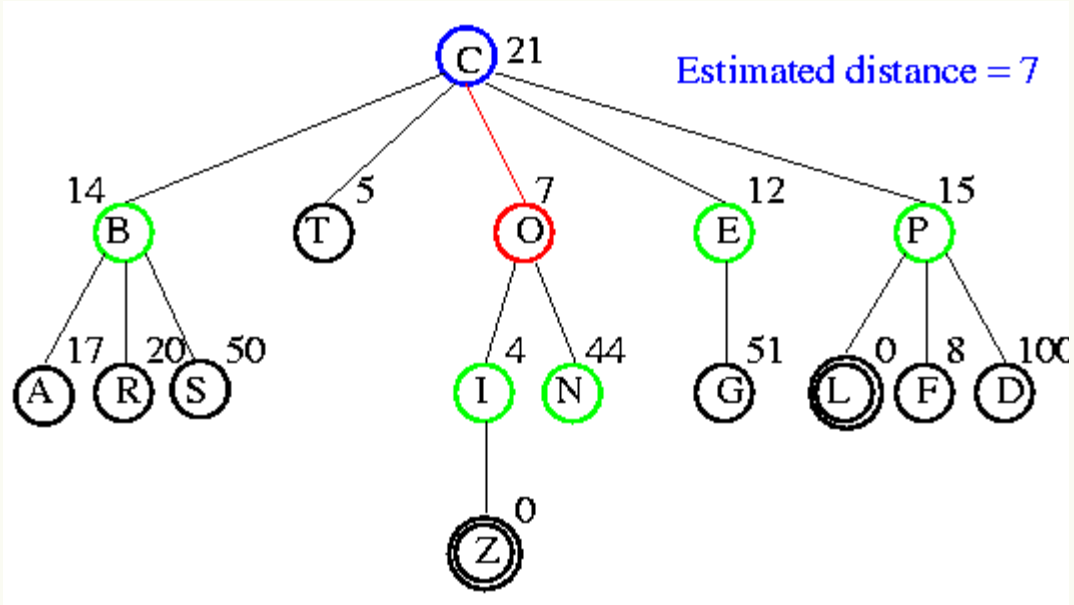
Example


C
21
Estimated distance = 5
14
B
5
T
7
O
12
E
15
P
17
A
20
R
50
S
4
I
44
N
51
G
0
L
8
F
100
D
0
Z

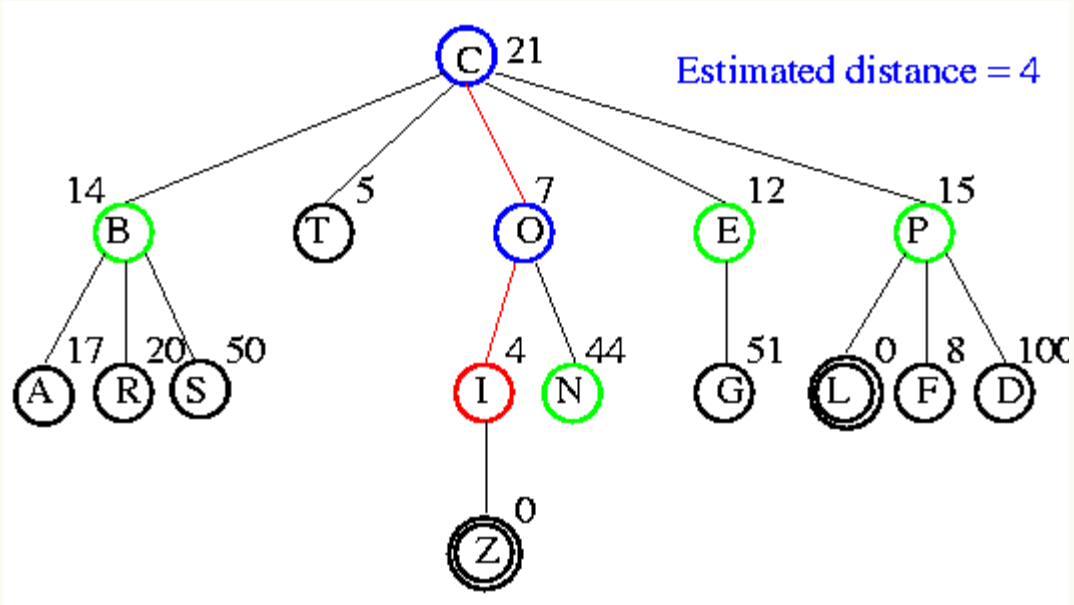
Example 2


C
21
Estimated distance = 7
14
B
5
T
7
O
12
E
15
P
17
A
20
R
50
S
4
I
44
N
51
G
0
L
8
F
100
D
0
Z

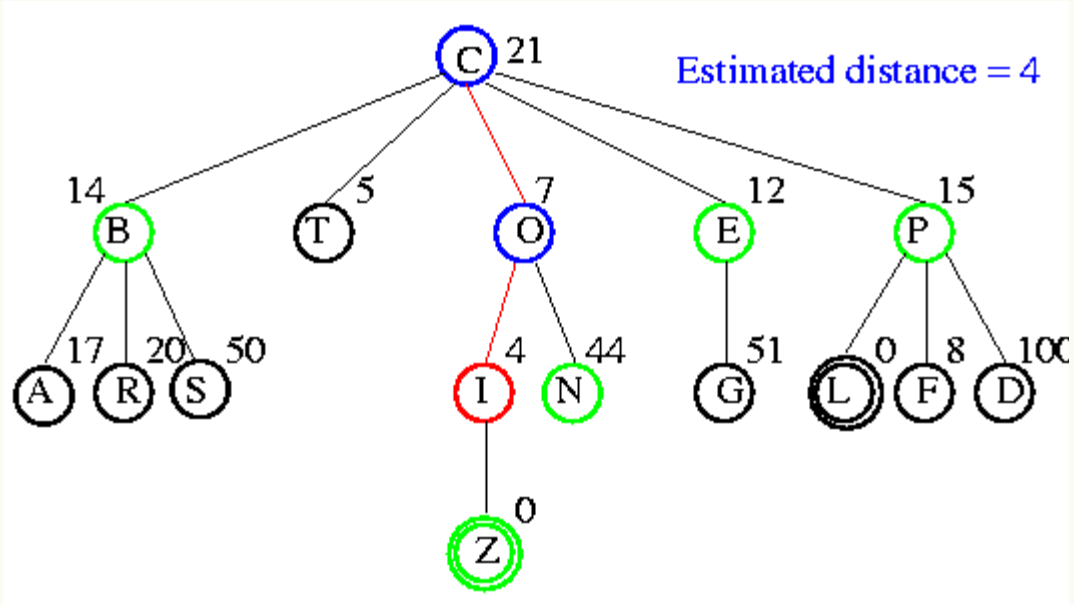
Example


C
21
Estimated distance = 7
14
B
5
T
7
O
12
E
15
P
17
A
20
R
50
S
4
I
44
N
51
G
0
L
8
F
100
D
0
Z

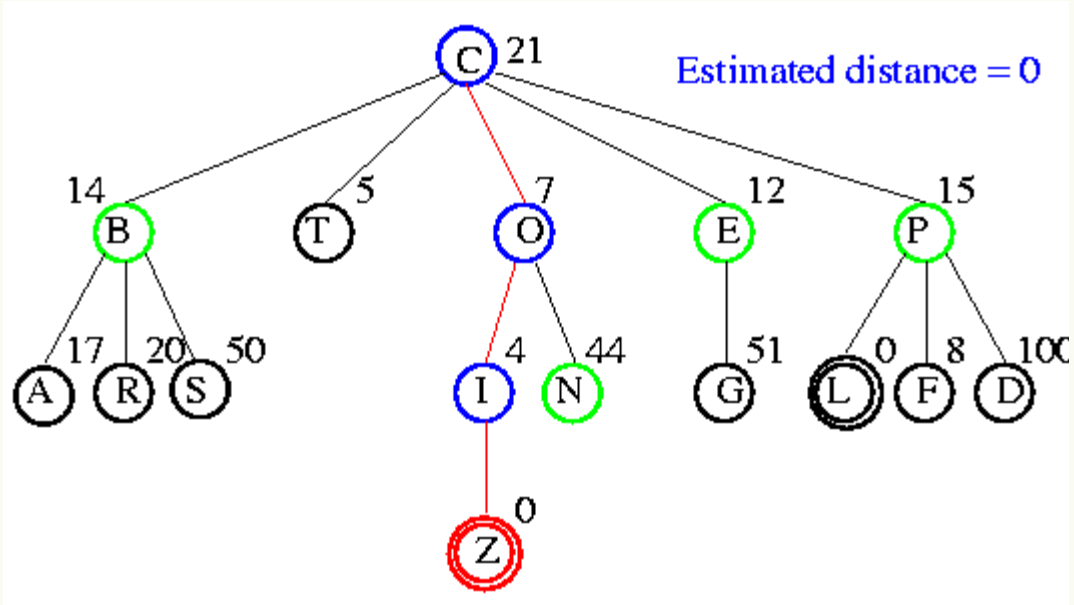
Example 2


C
21
Estimated distance = 4
14
B
5
T
7
O
12
E
15
P
17
A
20
R
50
S
4
I
44
N
51
G
0
L
8
F
100
D
0
Z

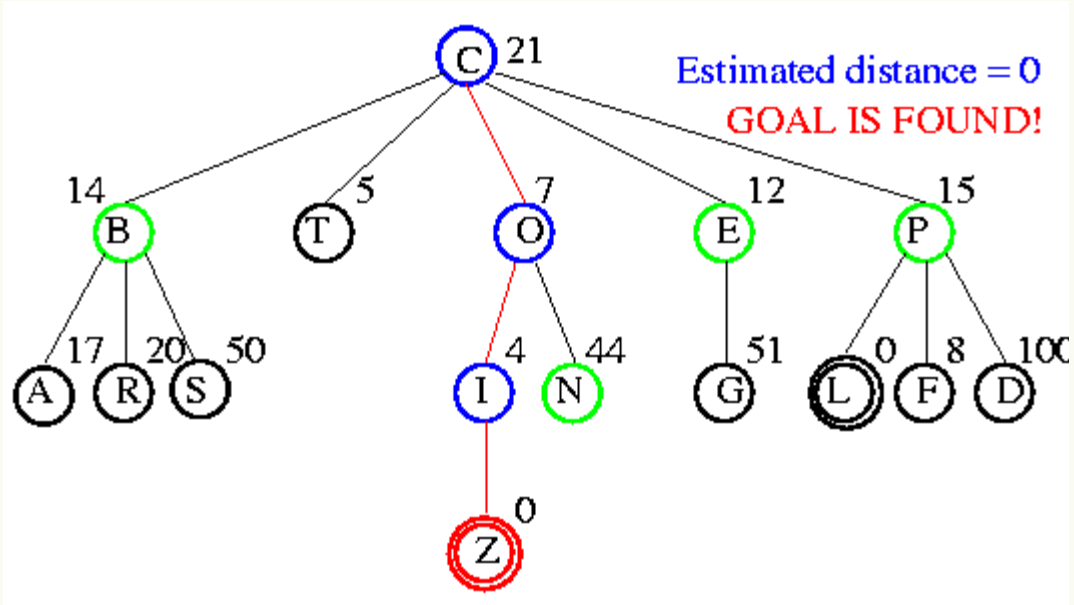
Example


C
21
Estimated distance = 4
14
B
5
T
7
O
12
E
15
P
17
A
20
R
50
S
4
I
44
N
51
G
0
L
8
F
100
D
0
Z

Example


C
21
Estimated distance = 0
14
B
5
T
7
O
12
E
15
P
17
A
20
R
50
S
4
I
44
N
51
G
0
L
8
F
100
D
0
Z

Example 2


C
21
Estimated distance = 0
GOAL IS FOUND!
14
B
5
T
7
O
12
E
15
P
17
A
20
R
50
S
4
I
44
N
51
G
0
L
8
F
100
D
0
Z

A* search

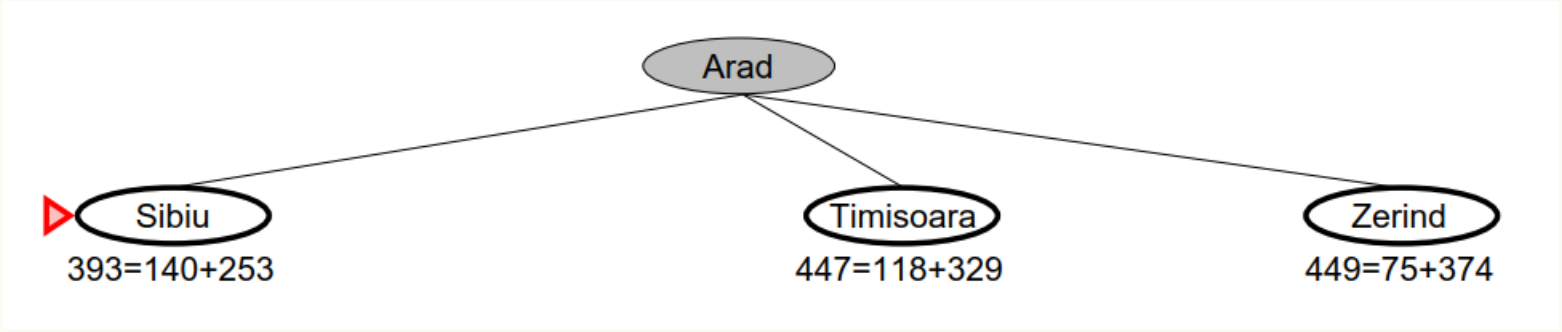
- best-first search that uses the evaluation function

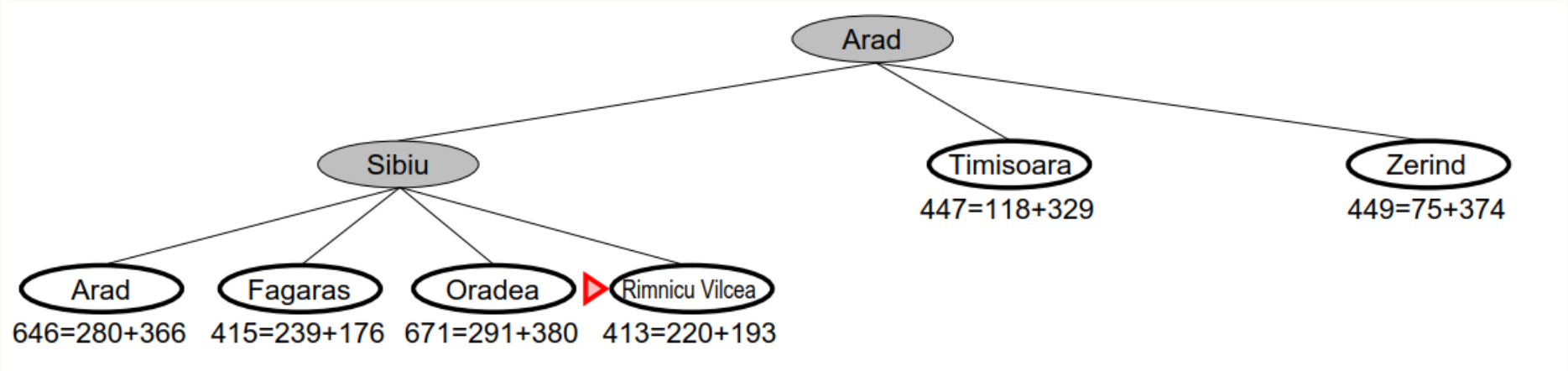
$$f(n) = g(n) + h(n)$$

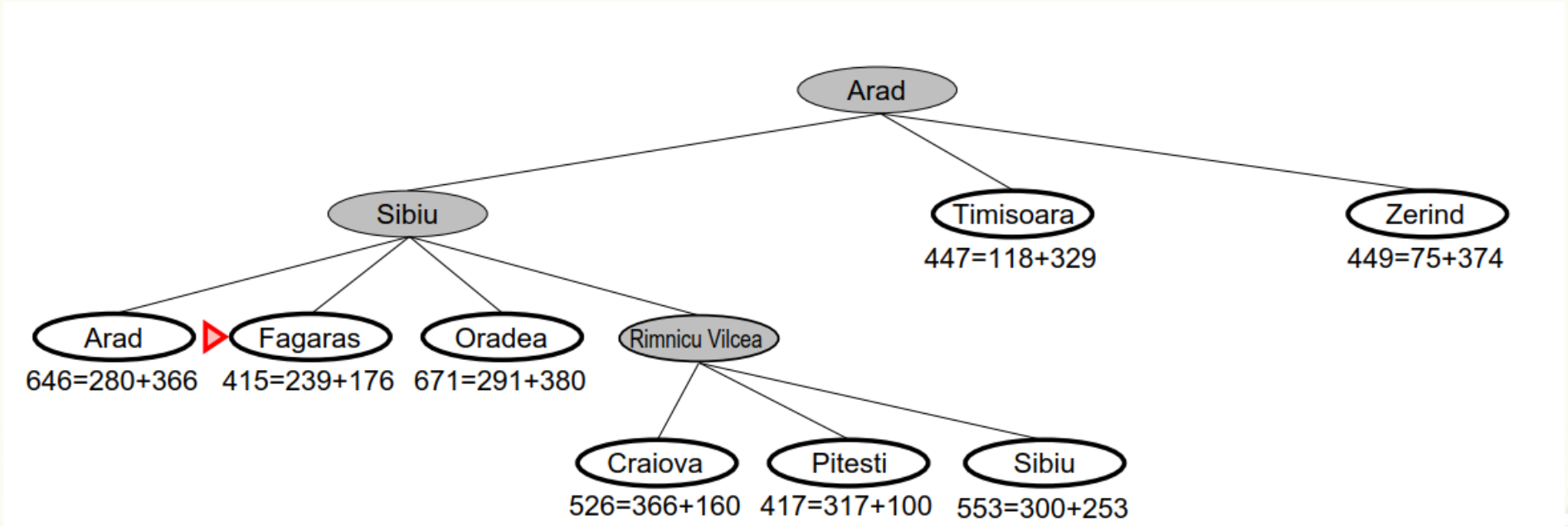
where $g(n)$ is the path cost from the initial state to node n and $h(n)$ is the estimated cost of the shortest path from n to a goal state, so we have

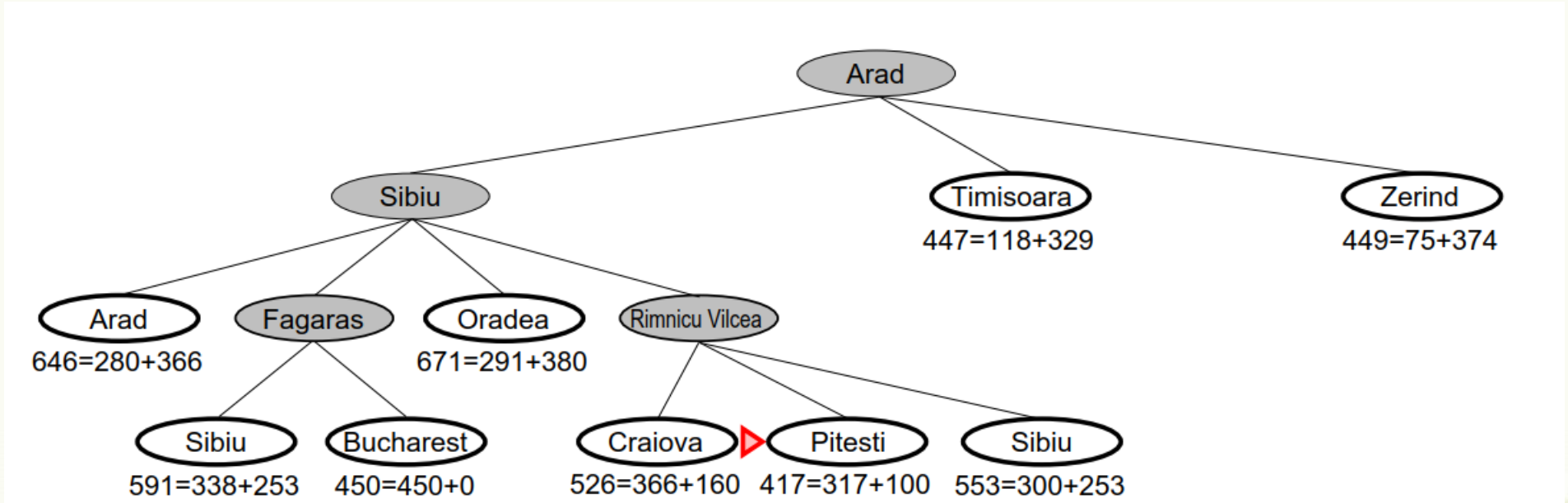
- UCS keeps solution cost low
- Best-first helps find solution quickly
- A* combines these approaches

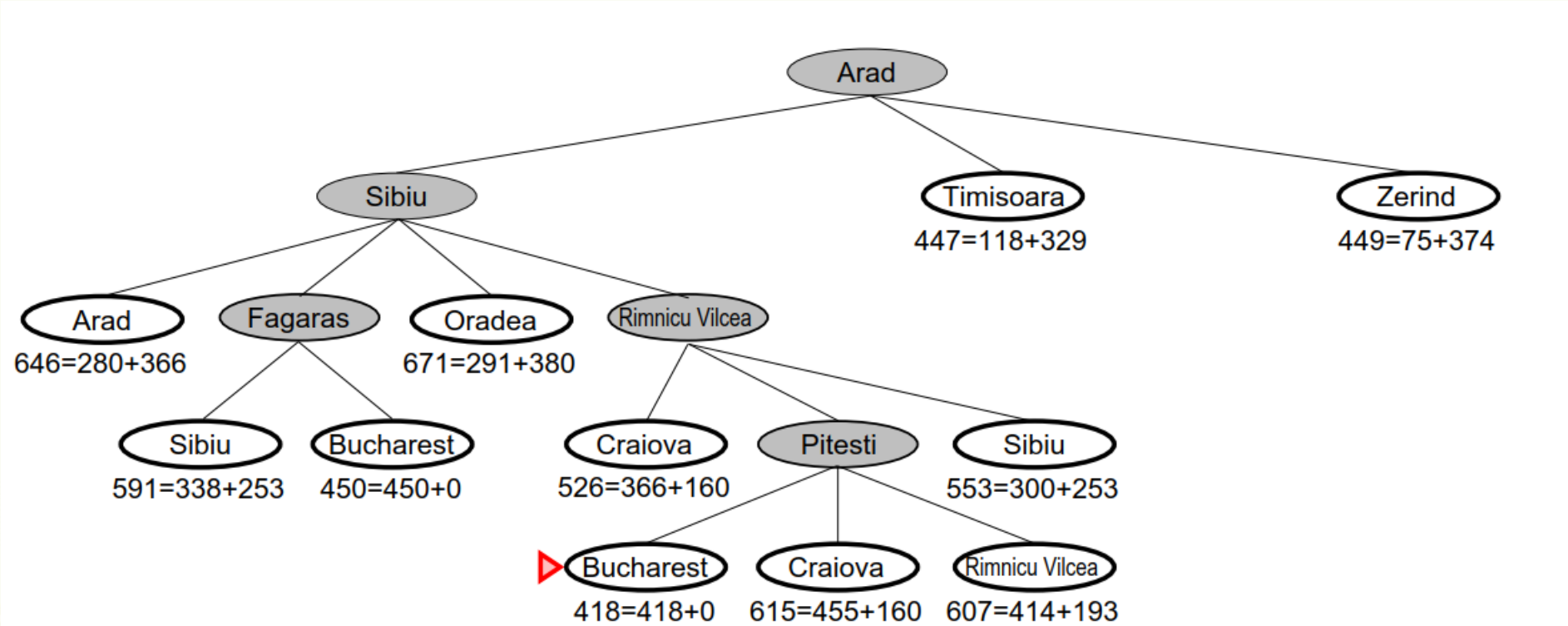

Arad
366=0+366


Arad
Sibiu
393=140+253
Timisoara
447=118+329
Zerind
449=75+374


Arad
Sibiu
Timisoara
447=118+329
Zerind
449=75+374
Arad
646=280+366
Fagaras
415=239+176
Oradea
671=291+380
Rimnicu Vilcea
413=220+193


Arad
Sibiu
Timisoara
447=118+329
Zerind
449=75+374
Arad
646=280+366
Fagaras
415=239+176
Oradea
671=291+380
Rimnicu Vilcea
Craiova
526=366+160
Pitesti
417=317+100
Sibiu
553=300+253


Arad
Sibiu
Timisoara
447=118+329
Zerind
449=75+374
Arad
646=280+366
Fagaras
Oradea
671=291+380
Rimnicu Vilcea
Sibiu
591=338+253
Bucharest
450=450+0
Craiova
526=366+160
Pitesti
417=317+100
Sibiu
553=300+253


Arad
Sibiu
Timisoara
447=118+329
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449=75+374
Arad
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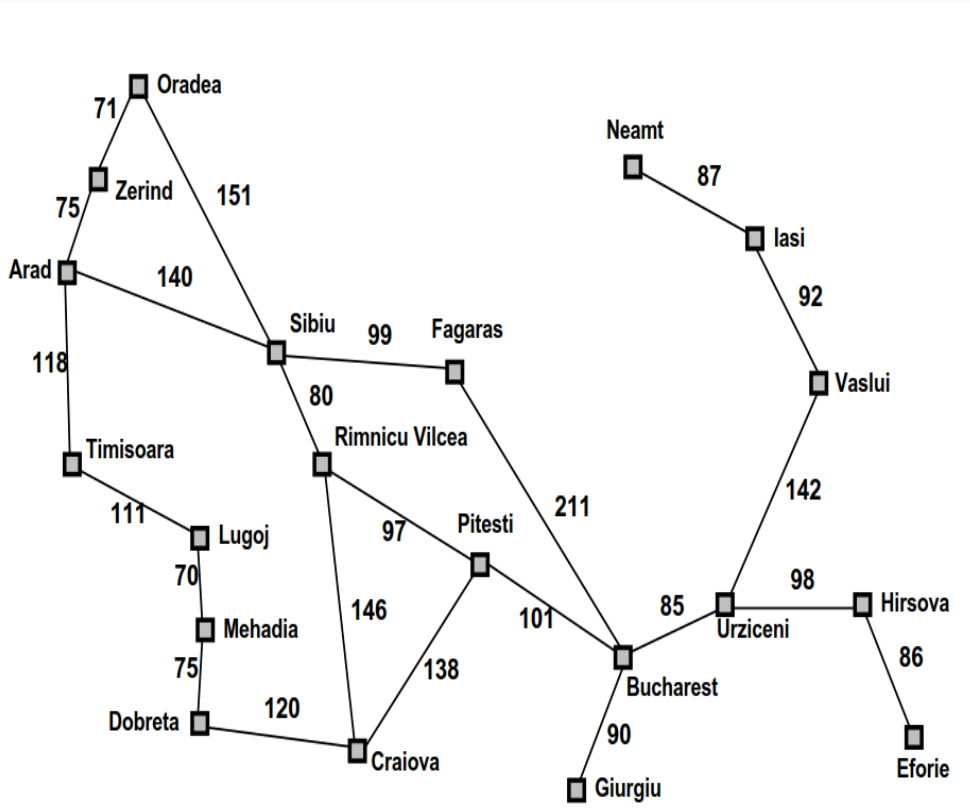
Fagaras
Oradea
671=291+380
Rimnicu Vilcea
Sibiu
591=338+253
Bucharest
450=450+0
Craiova
526=366+160
Pitesti
Sibiu
553=300+253
Bucharest
418=418+0
Craiova
615=455+160
Rimnicu Vilcea
607=414+193

Optimality of A*

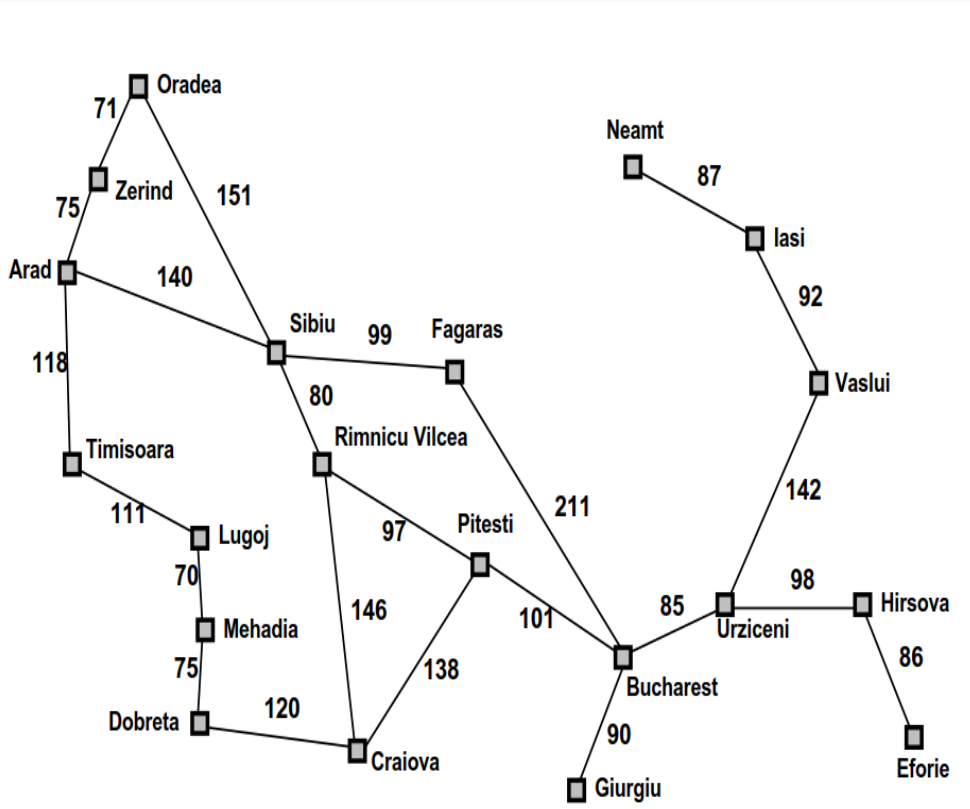
- If h is admissible, then f(n) never overestimates the actual cost of the best solution through n.
- Admissible h(n)<= G(n,n’)
- Where n’ is the successor of n



Straight−line distance to Bucharest	
Arad	366
Bucharest	0
Craiova	160
Dobreta	242
Eforie	161
Fagaras	178
Giurgiu	77
Hirsova	151
Iasi	226
Lugoj	244
Mehadia	241
Neamt	234
Oradea	380
Pitesti	98
Rimnicu Vilcea	193
Sibiu	253
Timisoara	329
Urziceni	80
Vaslui	199
Zerind	374

Optimality of A*

- A heuristic h(n) is consistent if, for every node n and every successor n’ of n generated by an action a, we have:
- h(n)<=g(n,n’)+h(n’)



Straight−line distance to Bucharest	
Arad	366
Bucharest	0
Craiova	160
Dobreta	242
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