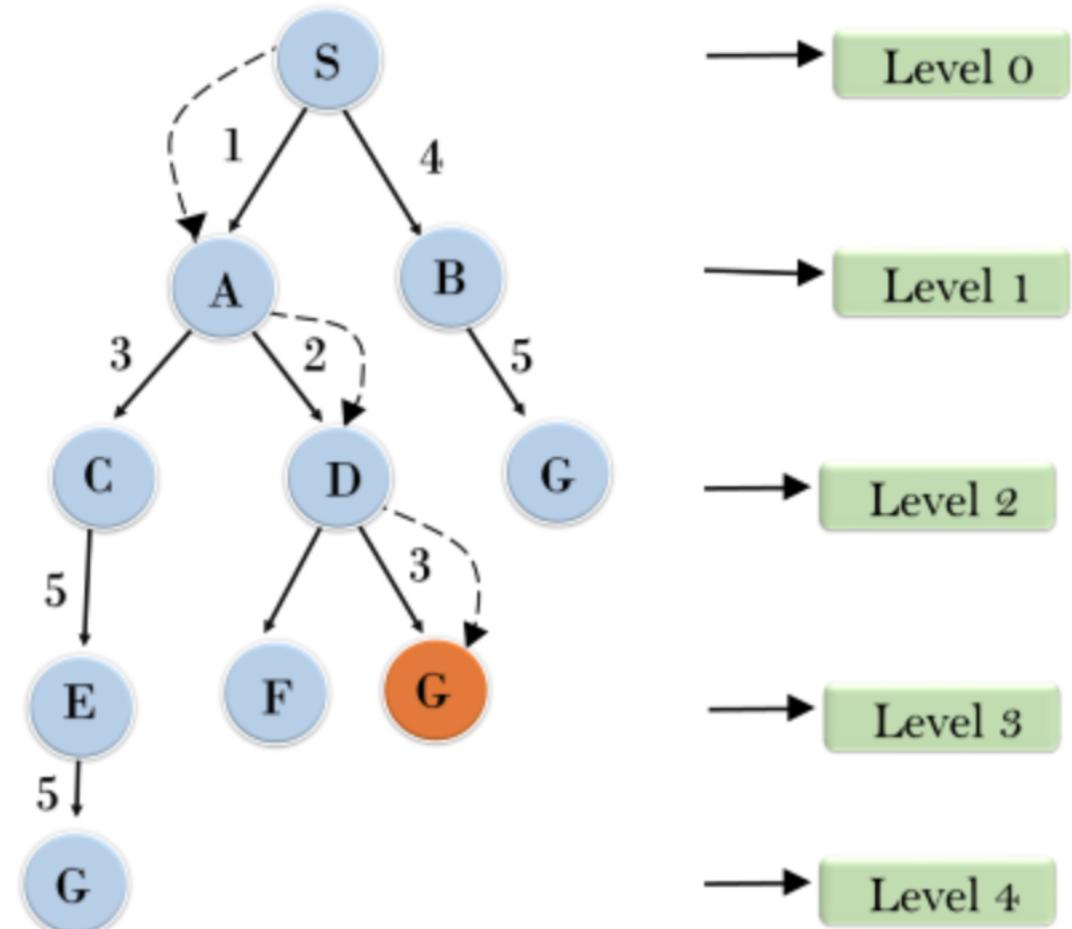


CSCI 3202: Intro to Artificial Intelligence

Lecture 6: Uniform Cost Search (UCS)

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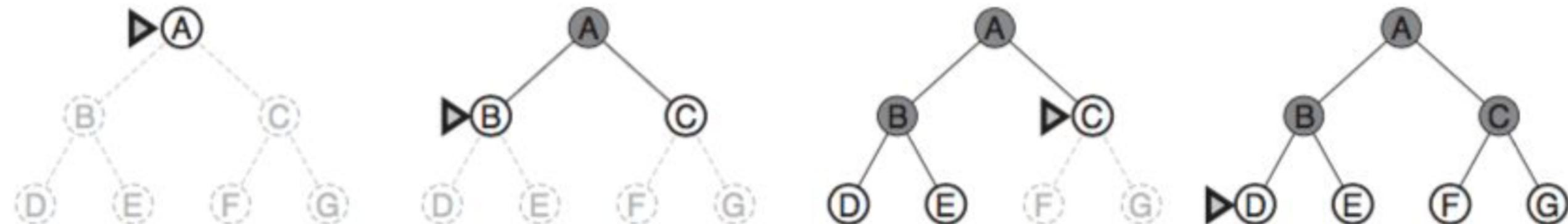
Uniform Cost Search



Review: Breadth-first Search (BFS)

- Expand all nodes at a given depth before proceeding to the next layer (FIFO)

- ***Apply goal test to each node as it is generated.***
- Optimal if all step costs are equal (because expanding the shallowest node is equivalent to expanding the cheapest node)



Uniform-cost Search (UCS)

- Expand cheapest node first (lowest path cost)
- In addition to the stacks/queues (BFS, DFS), UCS must track path cost to reach each state on the frontier

→ Priority queue



Uniform-cost Search (UCS)

- *Goal test occurs when node is selected for expansion*

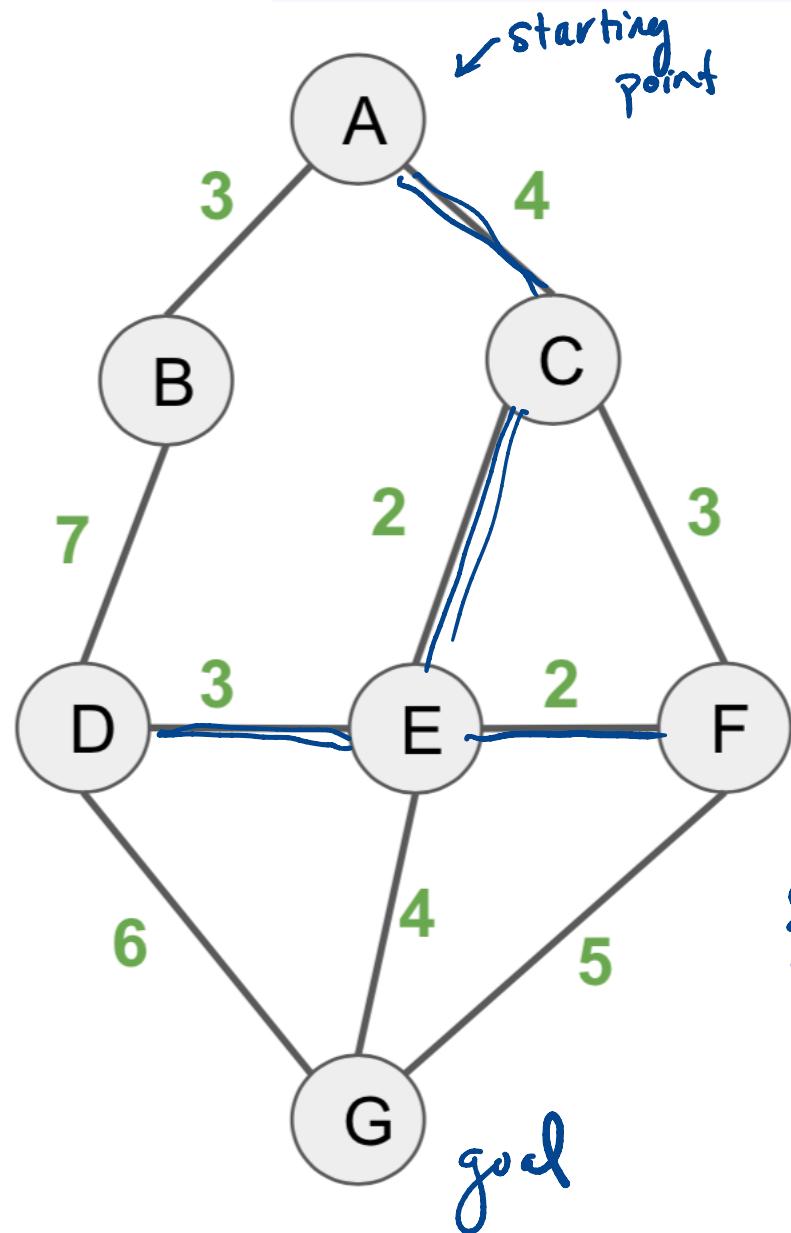
- Because we know we've taken the cheapest path to get there, UCS is **optimal**
- It is also **complete** because it's a more general form of BFS (which is complete)

UCS would
expand Buffalo next

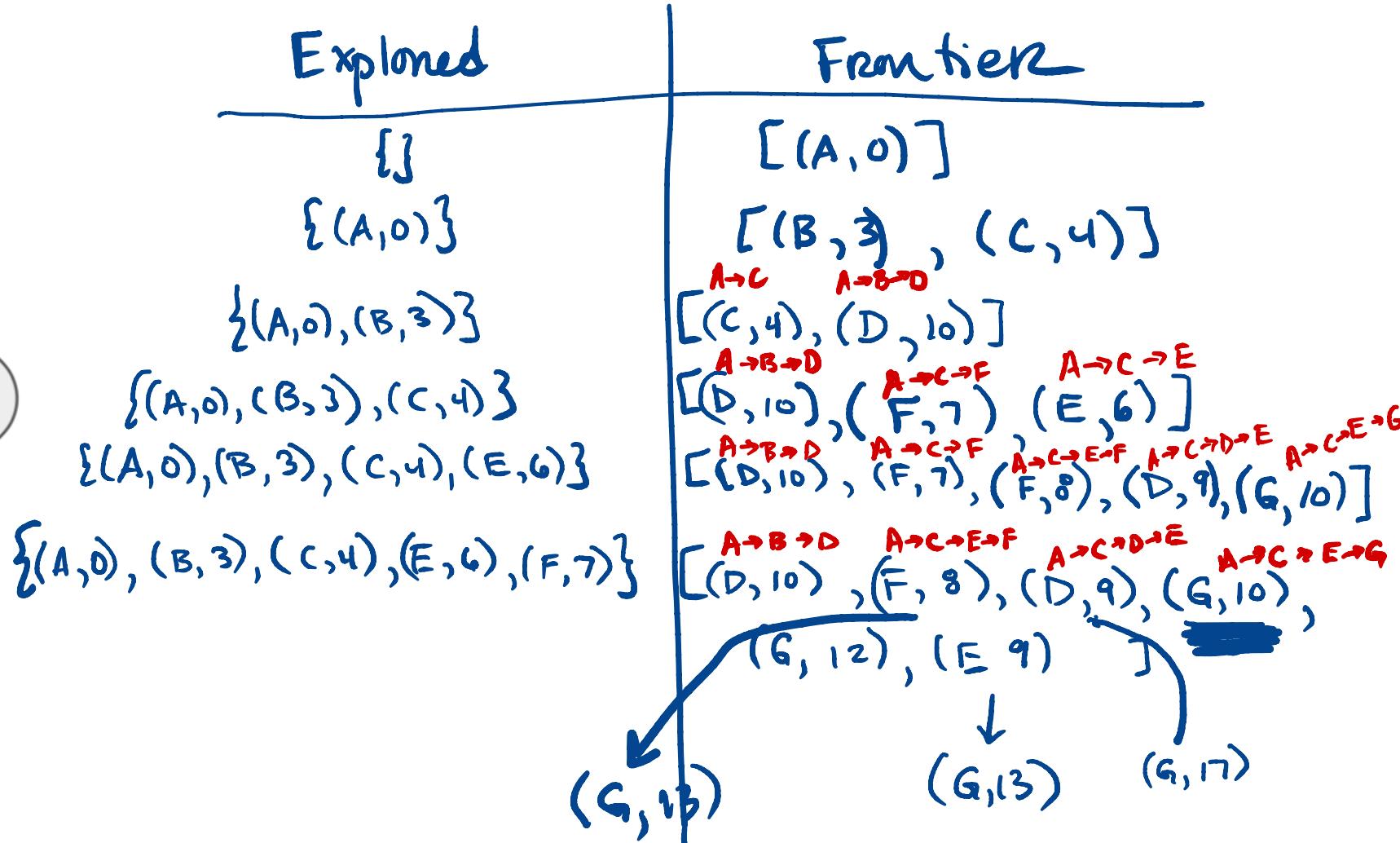


Uniform-cost Search (UCS)

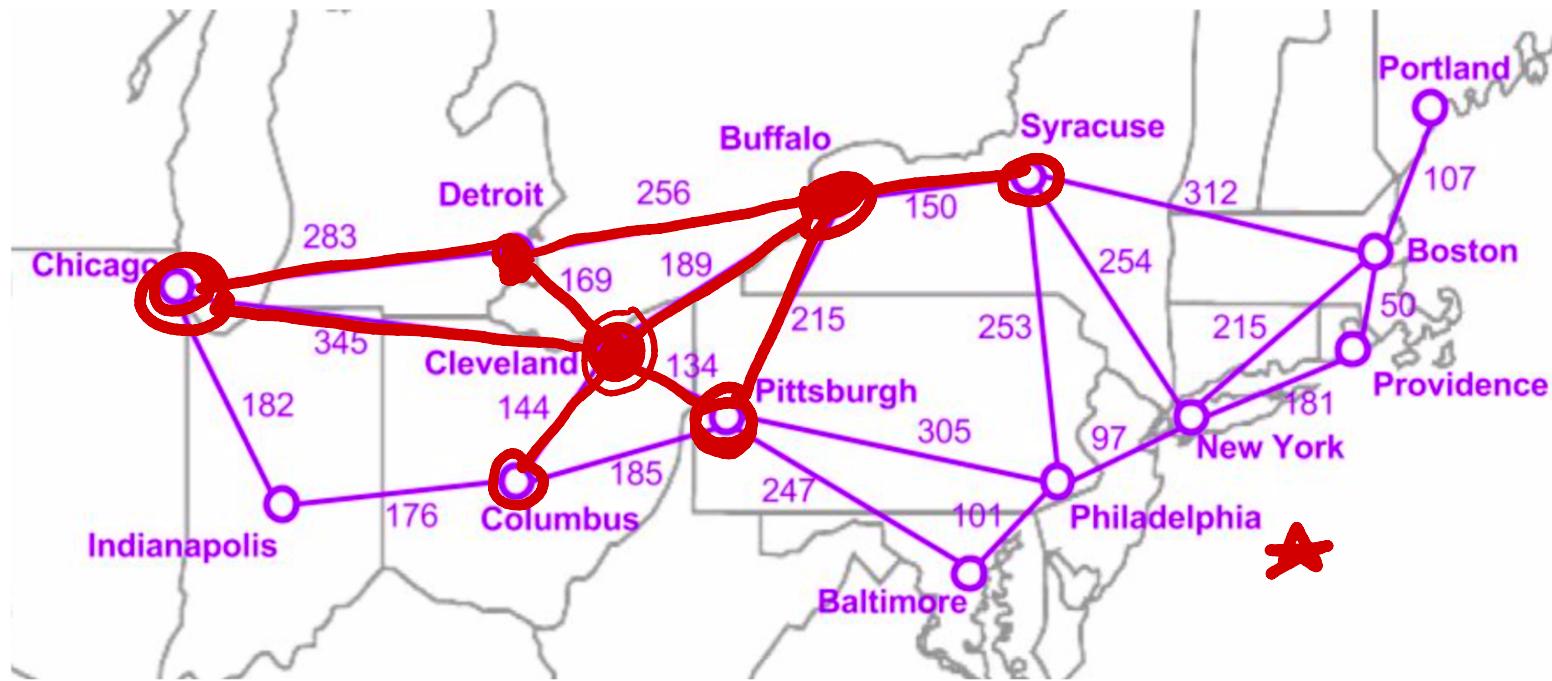
Solution: $A \rightarrow C \rightarrow E \rightarrow G$



Example: Perform a UCS on the graph below. A is the starting point; G is the goal.



Uniform-cost Search (UCS)



Example: Use UCS to find a route from Detroit to Philadelphia.

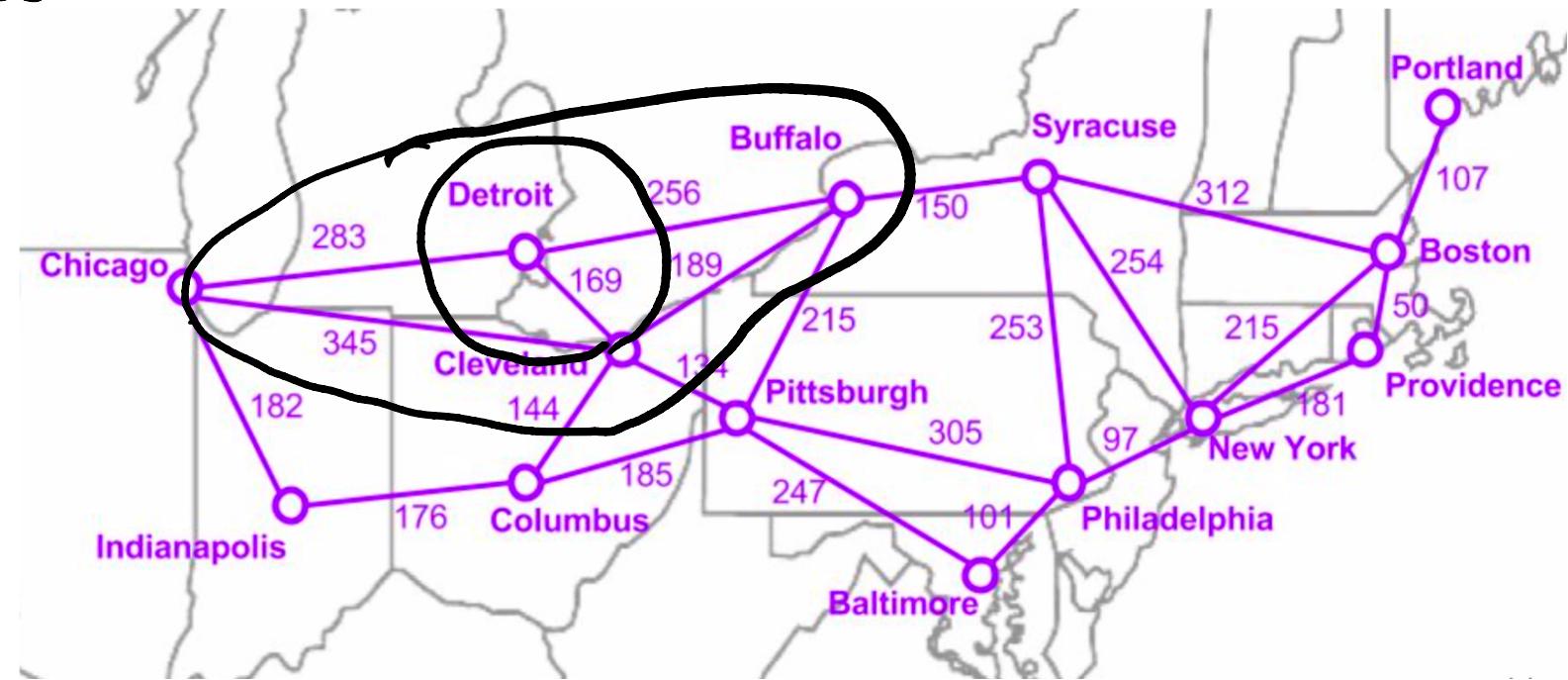
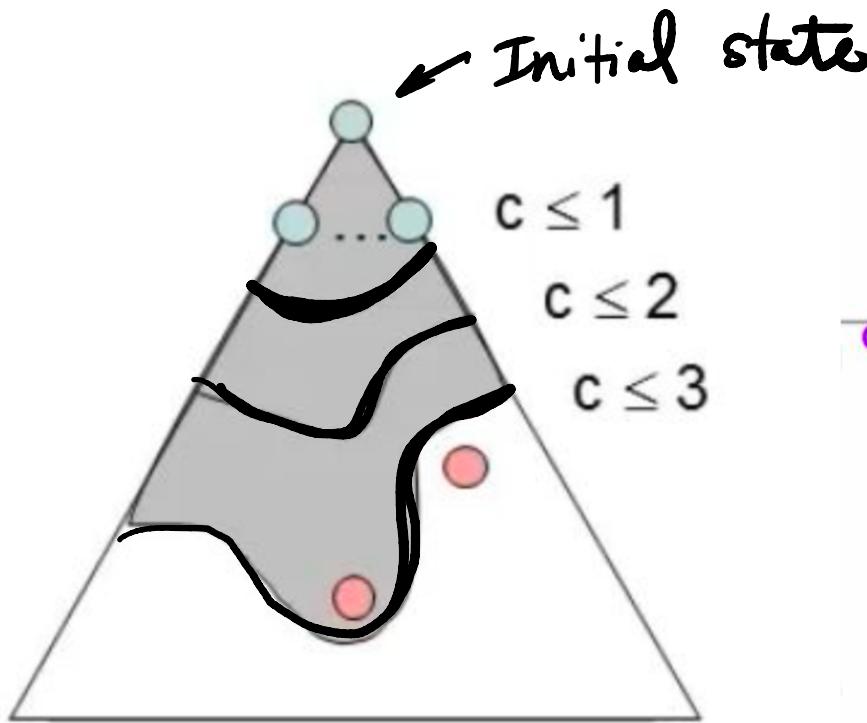
Uniform-cost Search (UCS)

- Can get stuck if there are sequences of no-cost actions.
- Worst-case in time and space complexity: $O(b^{1+\lfloor C^*/\epsilon \rfloor})$
 - C^* is cost of optimal solution
 - ϵ is minimal action cost
- Similar to BFS
- Potential inefficiency: Explores in every “direction”

$$\frac{C^*}{\epsilon} \approx d \quad b^{d+1}$$

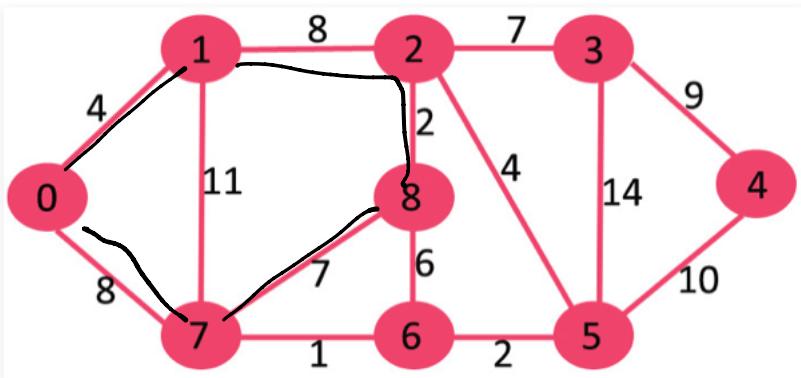
is an estimate of the depth of the search

Uniform-cost Search (UCS)



Dijkstra's Shortest Path Algorithm

- ❖ Uniform Cost Search is a variant of Dijkstra's shortest path algorithm.



Example: Use Dijkstra's algorithm to find the shortest path from 0 to all other nodes (Shortest Path Tree)

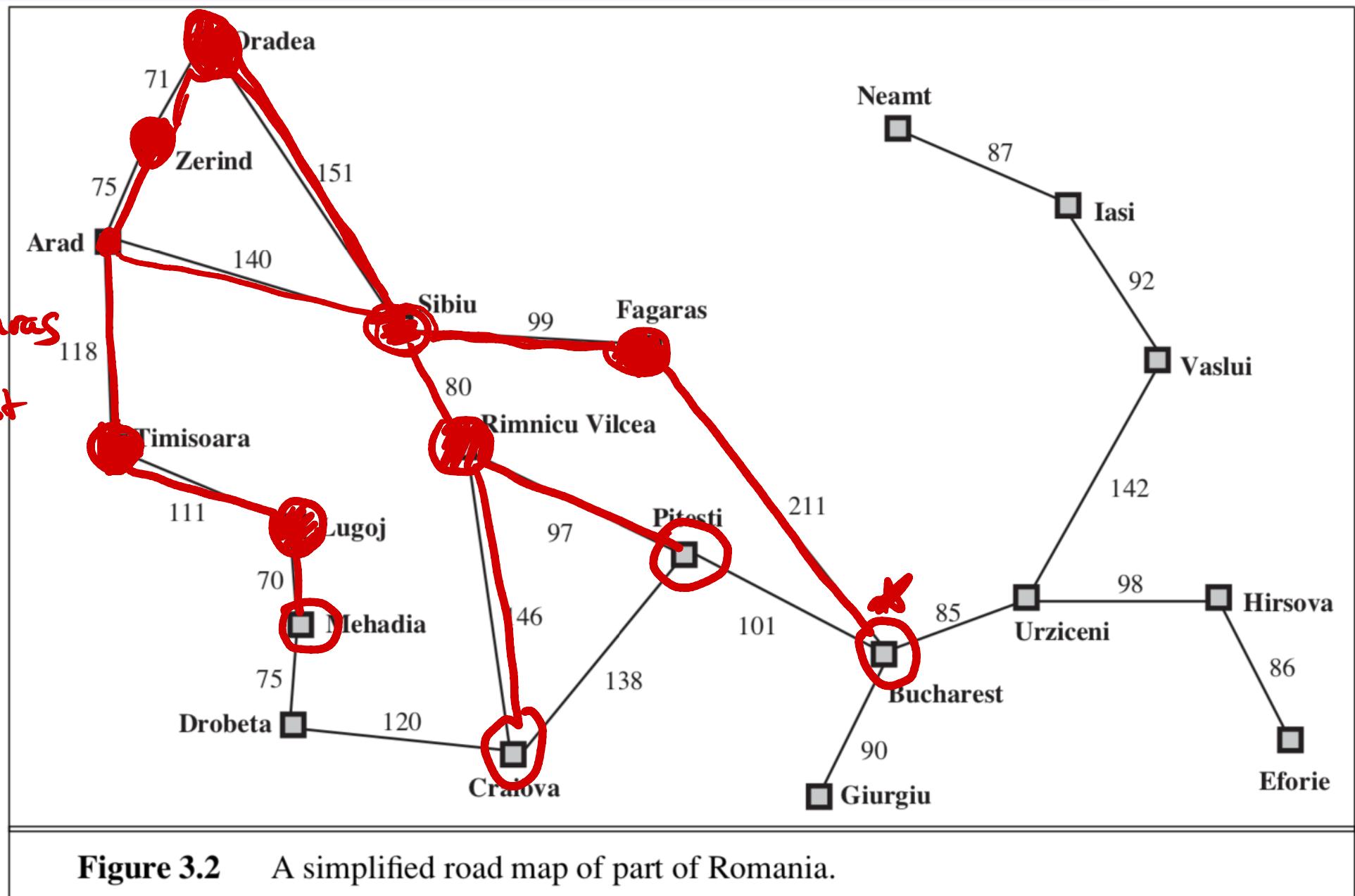
vertex	shortest distance from 0	previous
0	0	None
1	4	0
2	12	1
3	19	2
4	21	5
5	11	6
6	9	7
7	8	0
8	14	2

Recap

Breadth-First Search

Arad → Bucharest

*Arad → Sibiu → Fagaras
→ Bucharest*



Recap

Depth-First Search

Arad → Bucharest

Arad → Timisoara

→ Lugoj

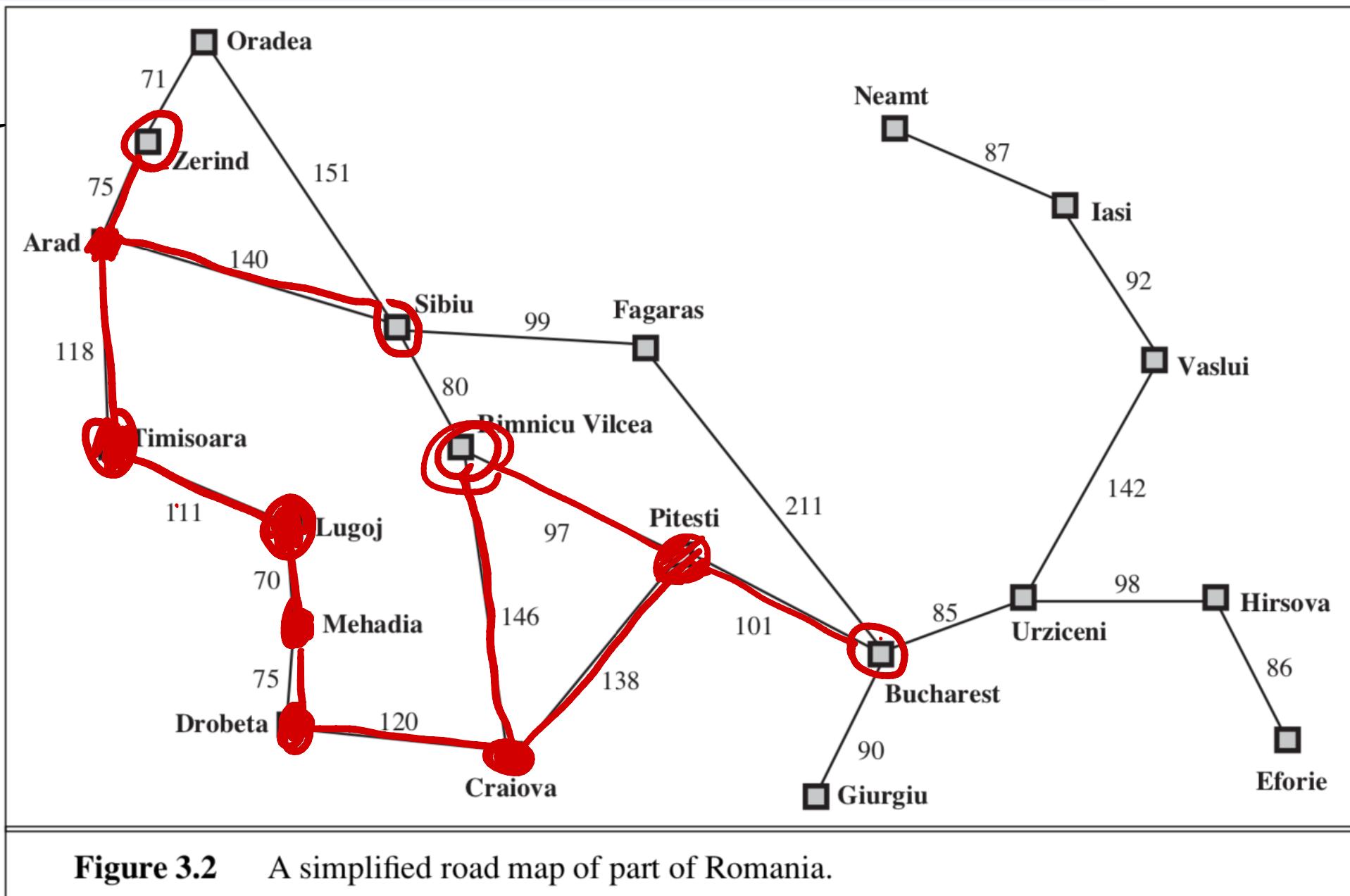
→ Mehadia

→ Drobeta

→ Craiova

→ Pitesti

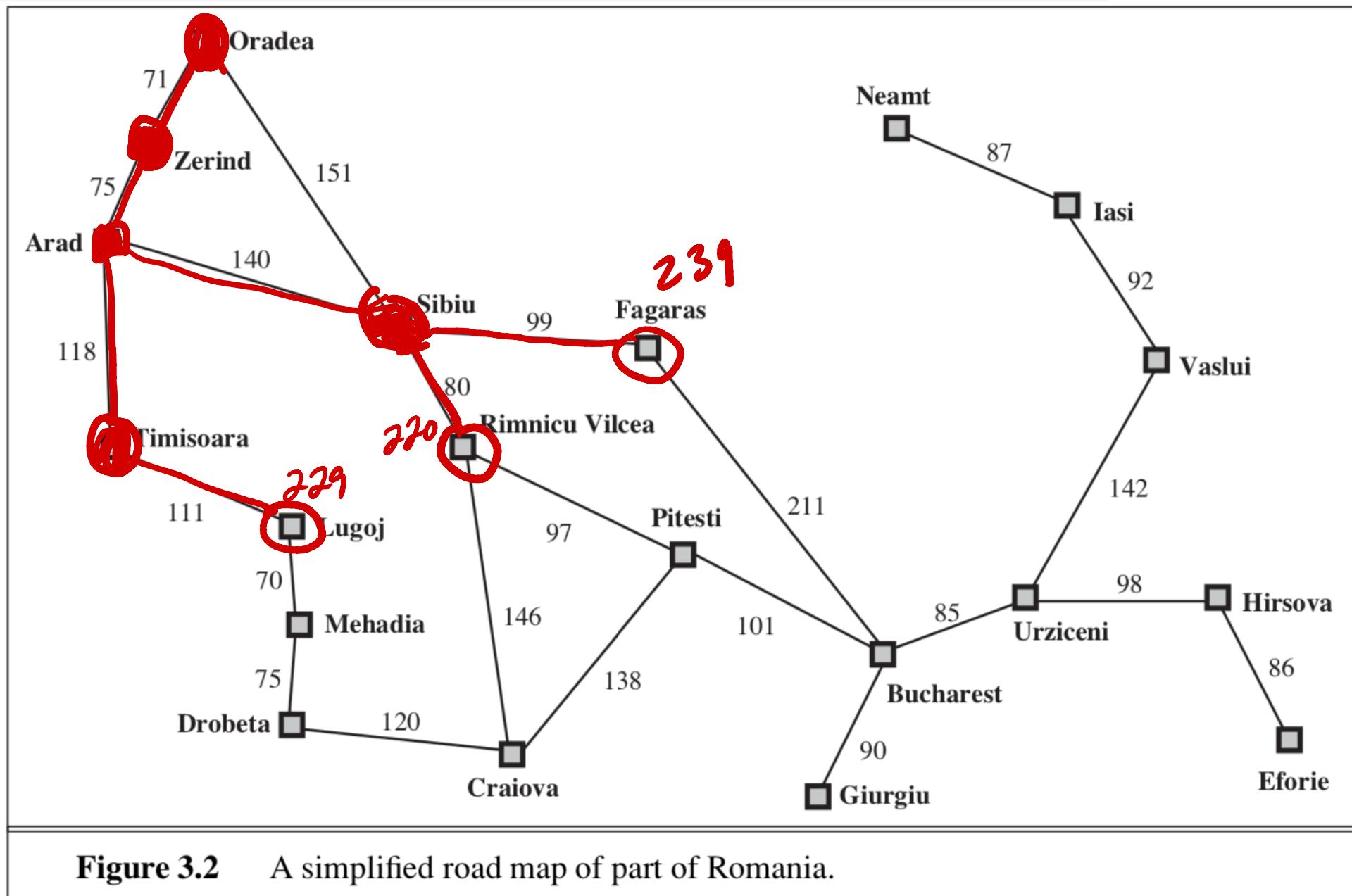
→ Bucharest



Recap

146

Uniform Cost Search



Next Time

A* Search