UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Workbook:
Depth-first search (graph search)

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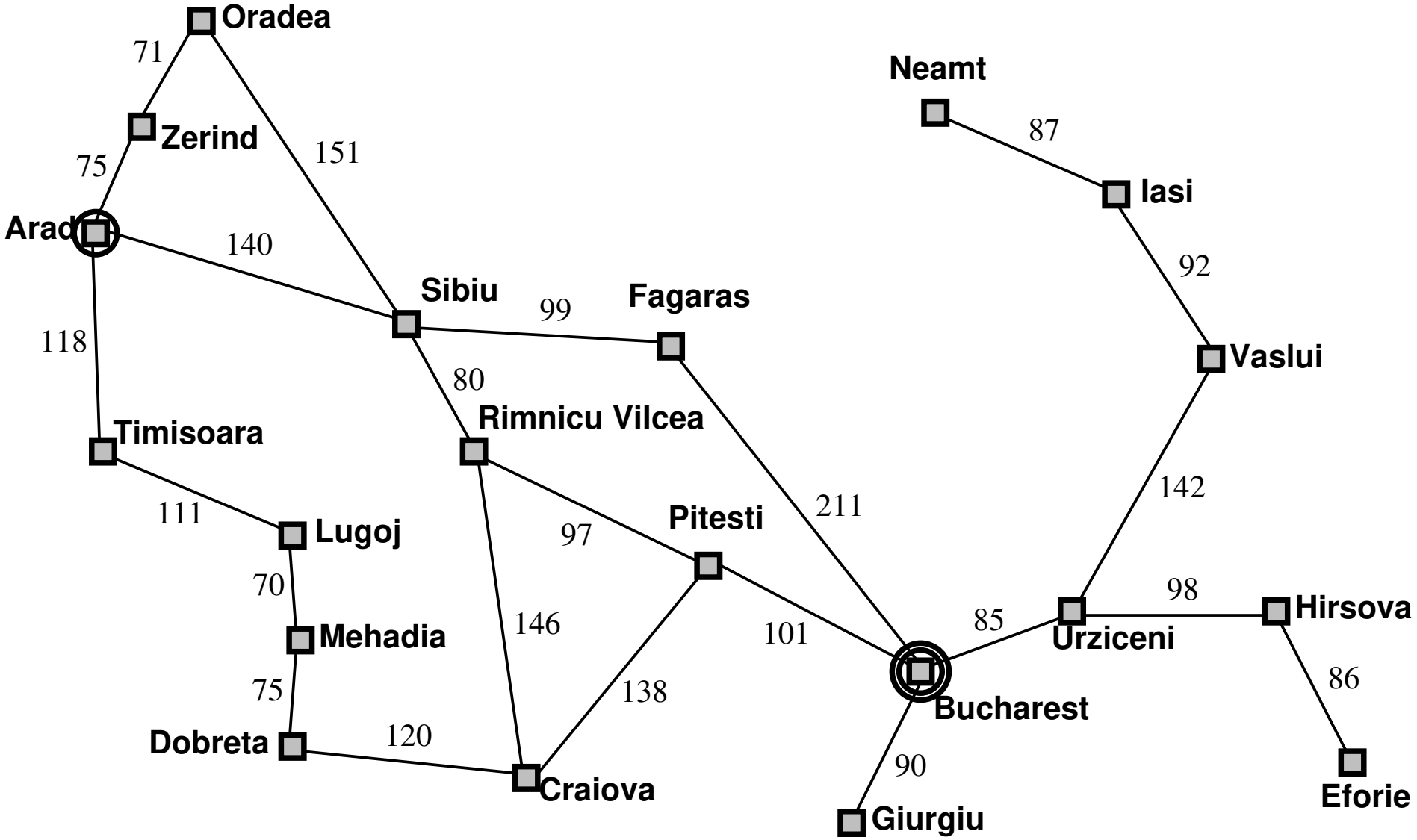
Learning objectives

- To describe depth-first search (graph search).
- To draw the tree of depth-first search.
- To apply depth-first search (graph search) to a well-known problem
- To analyze the quality of depth-first search (graph search).

Problem: Shortest path between two points

Shortest path from Arad to Bucarest [1]:



Actions(Arad) = {Move(Sibiu), Move(Timisoara), Move(Zerind)}.

Depth-first search (graph search) [1, 2]

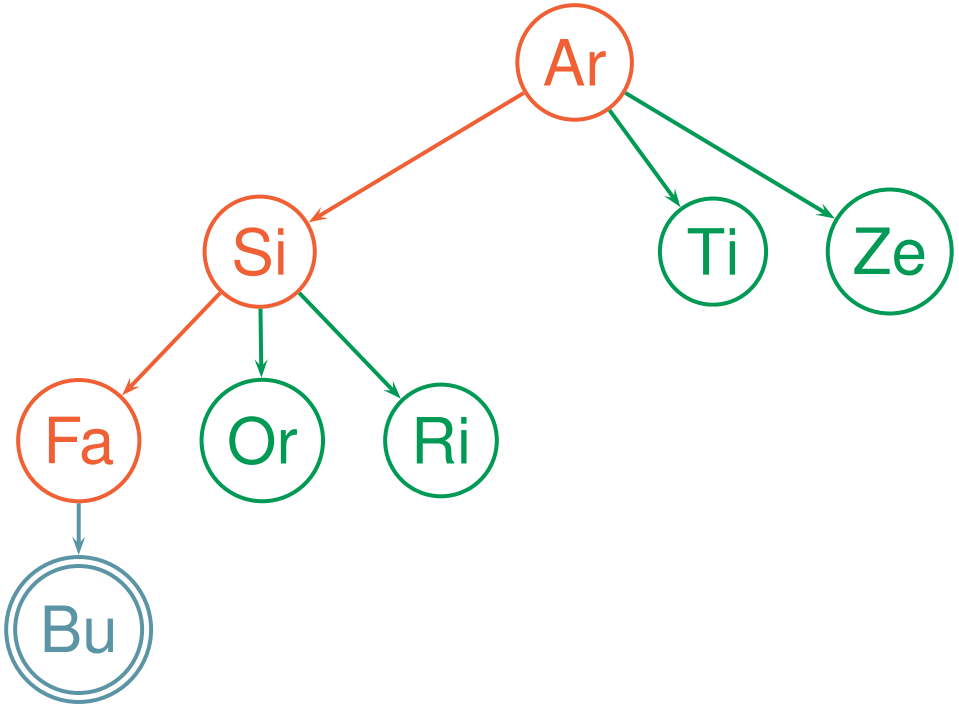
Graph search: keeps track of explored nodes in a set C.

```
DFS(G, s')          // Depth-first search; G graph and s initial node
  O = IniStack(s')                  // Open: search frontier-stack
  C = ∅                             // Closed: set of explored nodes
  while not EmptyStack(O):
    s = Pop(O)                      // selection LIFO (Last in, first out)
    if Goal(s) return n             // solucion found!
    C = C ∪ {s}                     // s already explored
    forall (s, n) ∈ Adjacents(G, s): // generacion: n child of s
      if n ∉ C ∪ O:                 // n not found unit now
        Push(O, n)                  // n is added to the stack
  return NULL                       // no solution found
```

- ***Question 1***: Write a trace of the ***DFS*** algorithm (graph search) applied to the problem of finding the shortest path from Arad to Bucarest.

O	C	s
{Arad}		–
{Sibiu, Timisoara, Zerind}	{Arad}	Arad
{Fagaras, Oradea, Rimnicu, Timisoara, Zerind}	{Arad, Sibiu}	Sibiu
{Bucharest, Oradea, Rimnicu, Timisoara, Zerind}	{Arad, Sibiu, Fagaras}	Fagaras
{Oradea, Rimnicu, Timisoara, Zerind}	{Arad, Sibiu, Fagaras}	Bucharest

- ***Question 2***: Draw the search tree as a result of applying the ***DFS*** algorithm (graph search) to the problem of finding the shortest path from Arad to Bucarest.



- ***Question 3***: Does the DFS algorithm (graph search) find a solution? ***Yes***

- ***Question 4***: If the answer is "Yes":
  - What is the solution found? ***The solution path is: Arad, Sibiu, Fagaras, Bucharest***
  - What is the cost of this solution? ***450***
  - Is this the solution of minimum cost? ***No, because there is an alternative solution with lower cost of 418: Arad, Sibiu, Rimnicu, Pitesti, Bucharest***
  - What type of solution is found by the DFS algorithm (graph search)? ***Search for solutions exploring first the deepest paths avoiding repeated nodes***

References

[1] S. Russell and P. Norvig. *Artificial Intelligence: A Modern Approach*. Pearson, third edition, 2010.

[2] Bernhard Korte and Jens Vygen. *Combinatorial Optimization: Theory and Algorithms*. Springer, 2018.