UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Workbook: Breadth-first search

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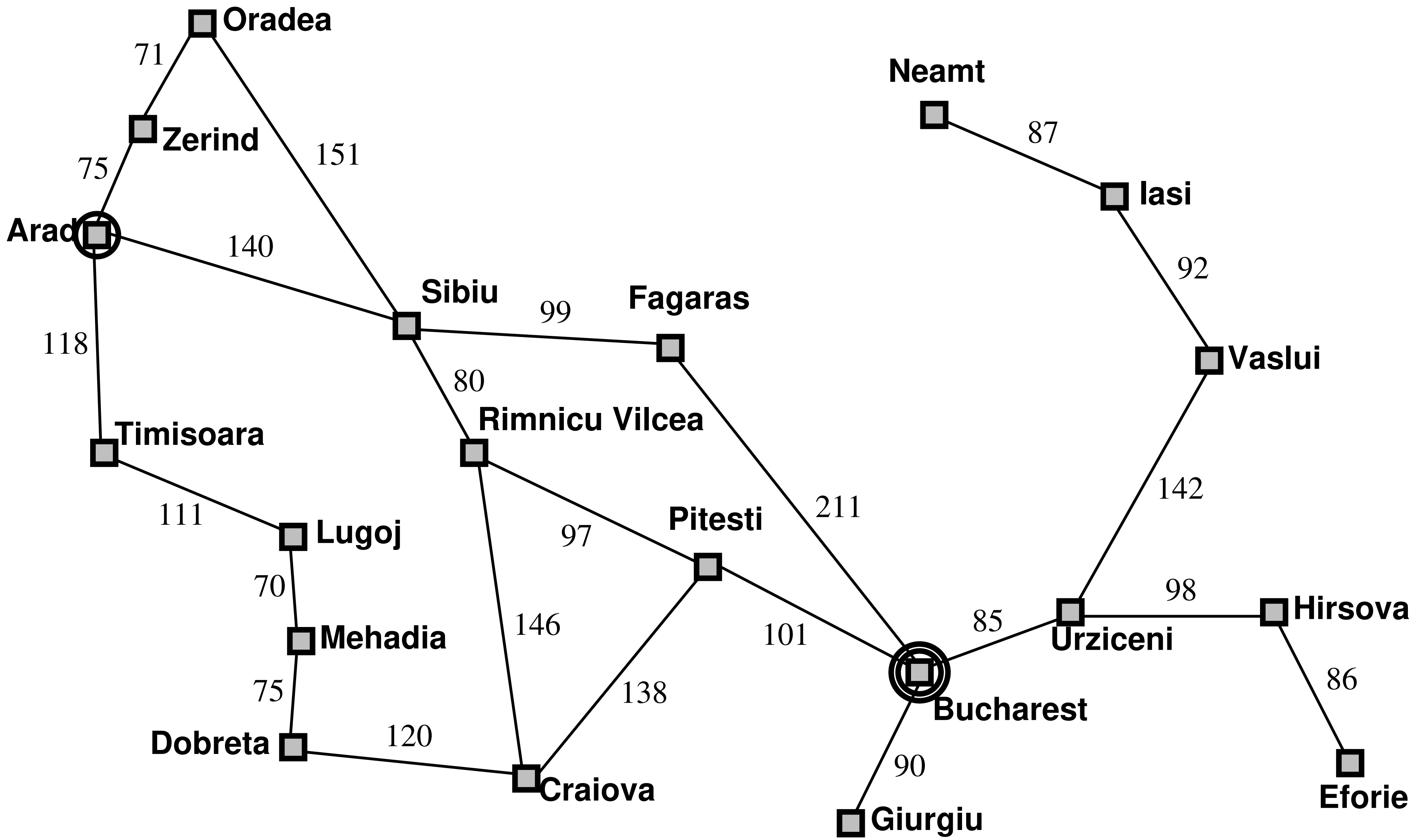
Learning objectives

- To describe breadth-first search.
- To draw the tree of breadth-first search.
- To apply breadth-first search to a well-known problem.
- To analyze the quality of breadth-first search.

Problem: Shortest path between two points

Shortest path from Arad to Bucarest [1]:



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

Breadth-first search [1, 2, 3, 4]

BFS(G, s') // ***Breadth-first search***; G graph and s' initial node
  $O = InitQueue(s')$ // ***Open: search frontier-queue***
  $C = \emptyset$ // ***Closed:*** set of explored nodes
  while not $EmptyQueue(O)$:
    $s = Unqueue(O)$ // ***FIFO (First in, first out) selection***
    $C = C \cup \{s\}$ // s is now explored
    forall $(s, n) \in Adjacents(G, s)$: // generation: n child of s
      if $n \notin C \cup O$: // n not discovered until now
        if $Goal(n)$ **return** n // solution found!
        $Append(O, n)$ // n added to the queue
  return NULL // no solution found

- ***Question 1***: Write a trace of the ***BFS*** algorithm applied to the problem of finding the shortest path from Arad to Bucarest.
- ***Question 2***: Draw the search tree as a result of applying the ***BFS*** algorithm to the problem of finding the shortest path from Arad to Bucarest.
- ***Question 3***: Does the BFS algorithm find a solution?
- ***Question 4***: If the answer is “Yes”:
  - What is the solution found?
  - What is the cost of this solution?
  - Is this the solution of minimum cost?
  - What type of solution is found by the BFS algorithm?

References

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

[2] E. Moore. The shortest path through a maze. In *Proc. of the Int. Symposium on the Theory of Switching, Part II*, pages 285–292. Harvard University Press, 1959.

[3] C. Y. Lee. An algorithm for path connections and its applications. *IRE Trans. on Electronic Computers*, EC-10, 1961.

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