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Workbook: Depth-first search (backtracking)

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DSIC

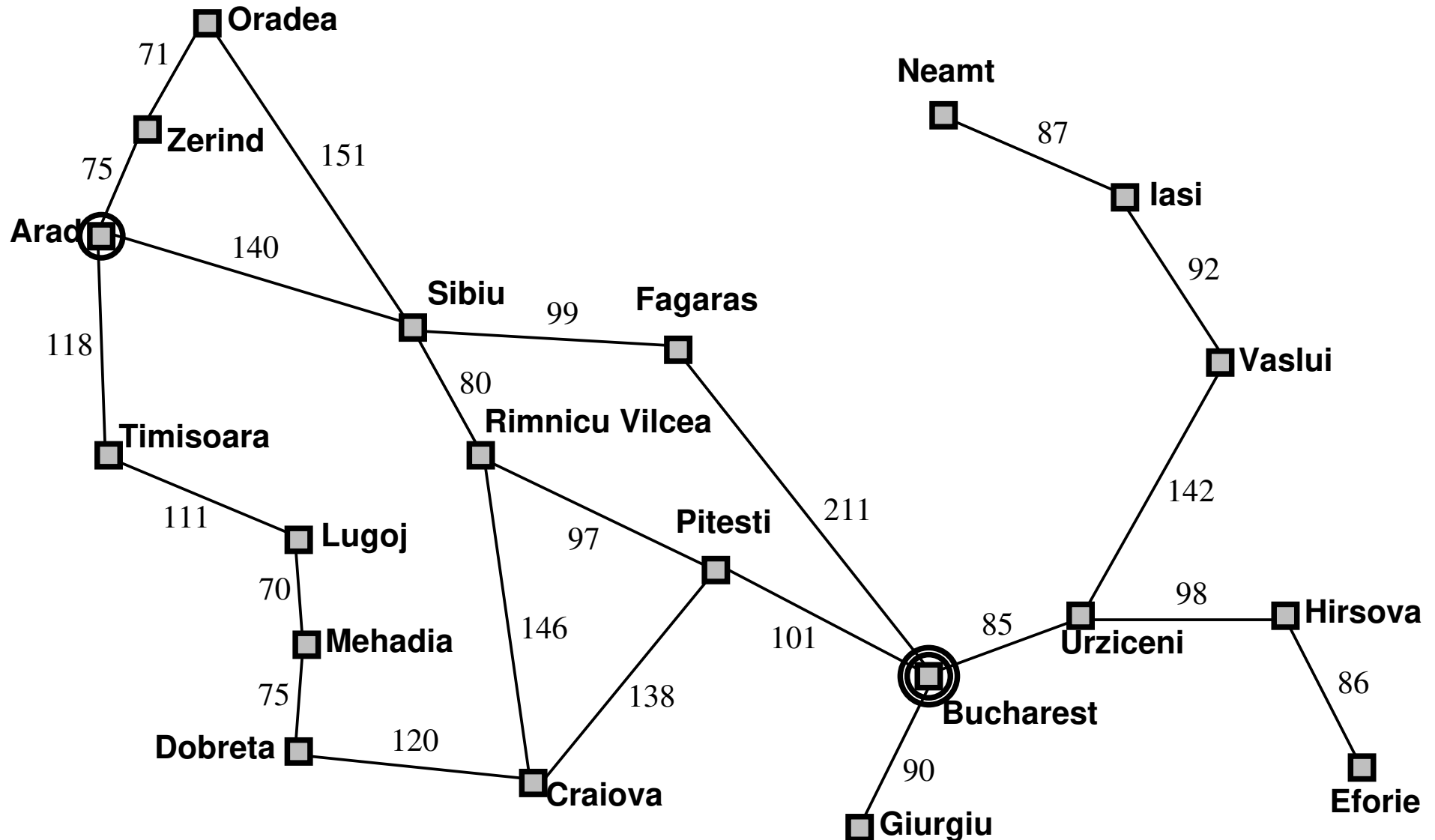
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Learning objectives

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

Problem: Shortest path between two points

Shortest path from Arad to Bucarest [1]:



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

Backtracking

DFS (recursive) variant with individual child generation:

```
BT( $G, s, m$ )           // Backtracking with maximum depth of  $m$   
  if  $Goal(s)$  return  $s$            // solution found!  
  if  $m = 0$  return NULL           // maximum depth reached  
   $n = FirstAdjacent(G, s)$            // generation:  $n$  first child of  $s$   
  while  $n \neq NULL$ :  
     $r = BT(G, n, m - 1)$            // current child result  
    if  $r \neq NULL$ : return  $r$            // if  $r$  is solution, stop  
     $n = NextAdjacent(G, s, n)$            // generation:  $n$  next child of  $s$   
  return NULL           // no solution found
```

- **Question 1:** Draw the search tree as a result of applying the **DFS** algorithm (backtracking) to the problem of finding the shortest path from Arad to Bucarest with maximum depth $m = 3$.

- ▶ **Question 2:** Does the DFS algorithm (backtracking) find a solution?
Yes
- ▶ **Question 3:** 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 (backtracking)?
Search exploring first the deepest paths, but exploring and expanding nodes one by one up to the maximum depth
- ▶ **Question 4:** What happens if a maximum depth is not defined?
The solution would not be found, since the algorithm goes into a loop between Arad and Sibiu

References

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