

Penentuan Rute (*Route/Path Planning*)

Bagian 1: BFS, DFS, UCS, Greedy Best First Search

Bahan Kuliah IF2211 Strategi Algoritma

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Referensi

1. Materi kuliah IF3170 Inteligensi Buatan Teknik Informatika ITB, Course Website:

<http://kuliah.itb.ac.id> → STEI → Teknik Informatika → IF3170

2. Stuart J Russell & Peter Norvig, *Artificial Intelligence: A Modern Approach*, 3rd Edition, Prentice-Hall International, Inc, 2010, Textbook

Site: <http://aima.cs.berkeley.edu/> (2nd edition)

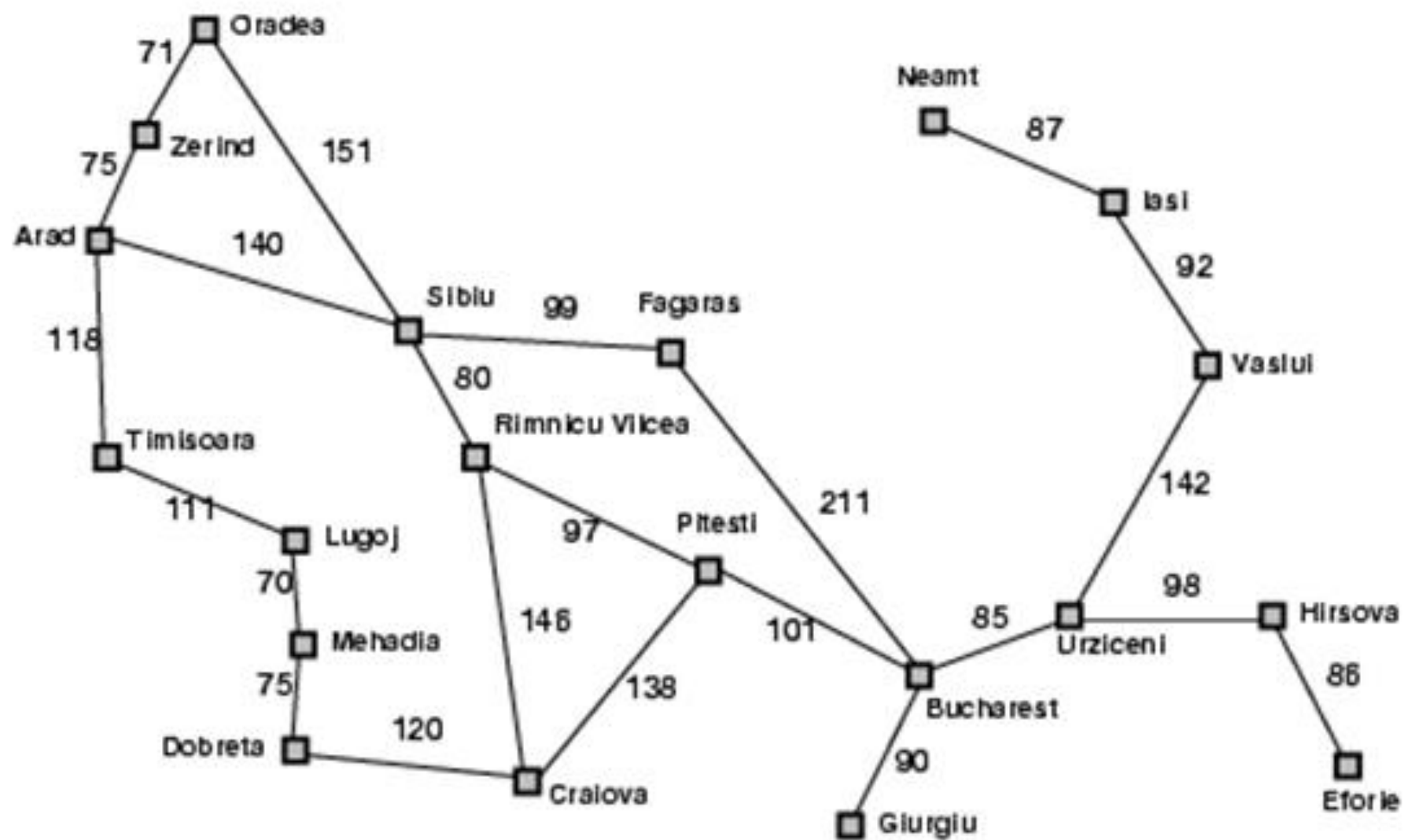
3. Free online course materials | MIT OpenCourseWare Website:

Site: <http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/>

4. Lecture Notes in Informed Heuristic Search, ICS 271 Fall 2008, <http://www.ics.uci.edu/~dechter/courses/ics-271/fall-08/lecture-notes/4.InformedHeuristicSearch.ppt>

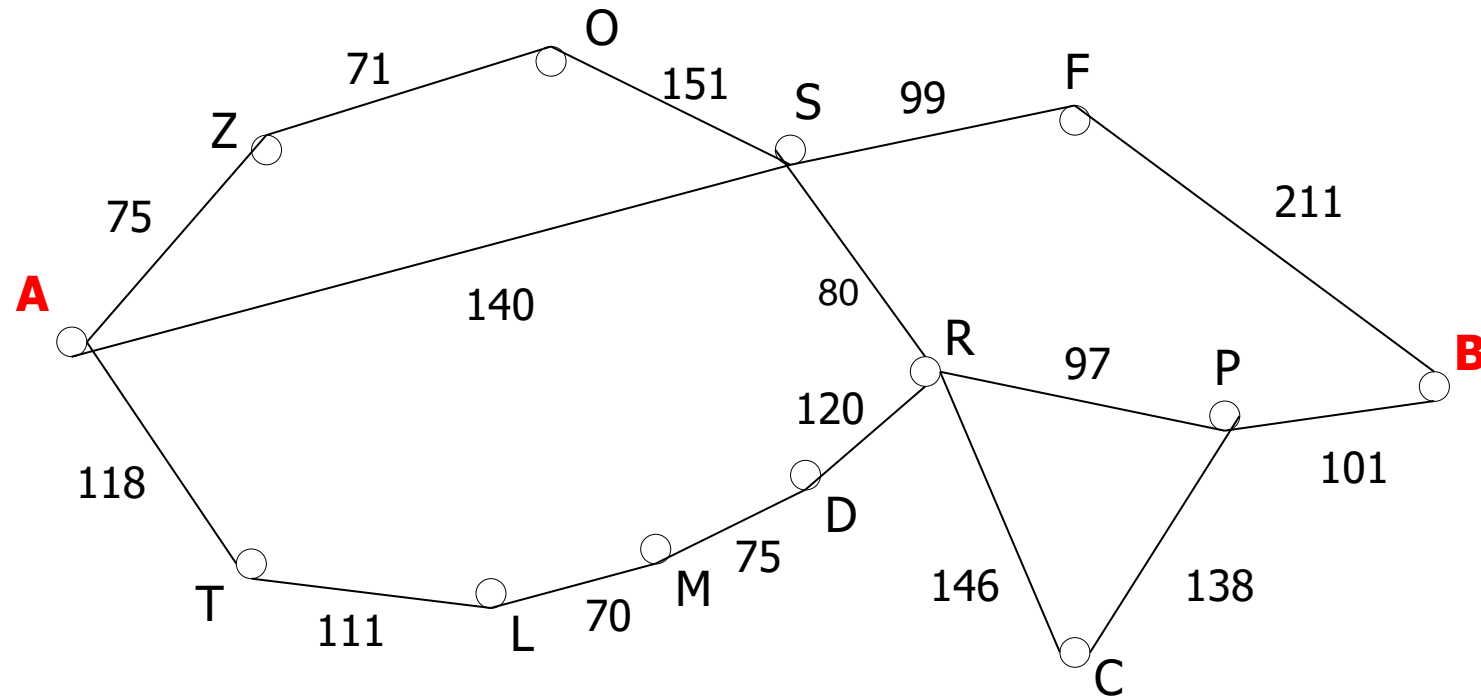
Route Planning





Source: Russell's book

Search



(a part of graph of Romania)

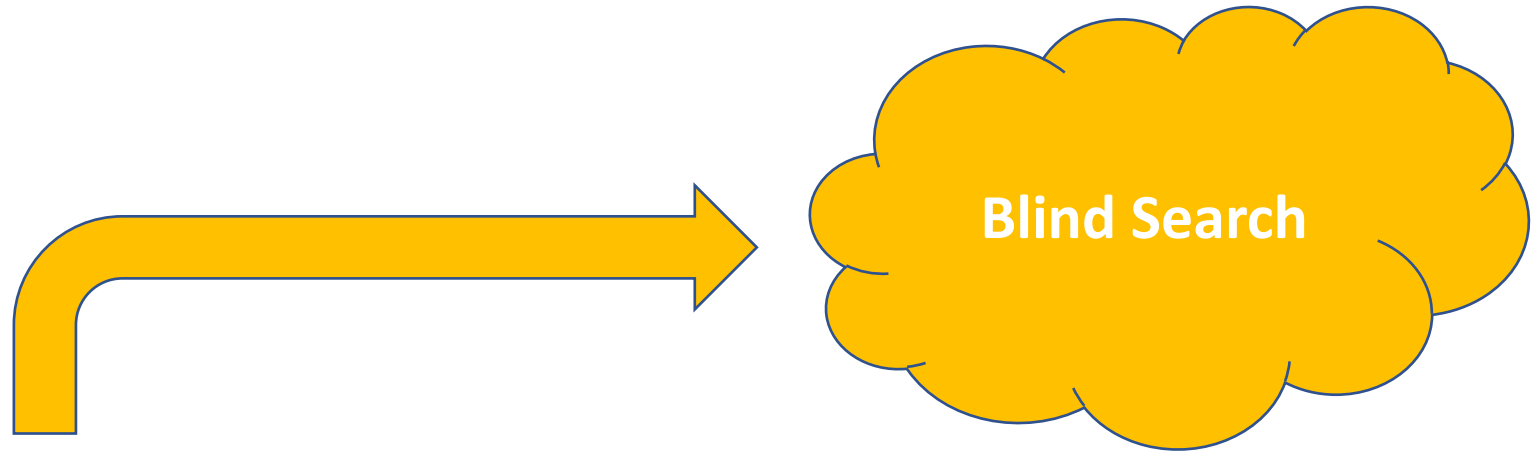
S: set of cities

i.s: A (Arad)

g.s: B (Bucharest)

Goal test: $s = B$?

Path cost: time ~ distance

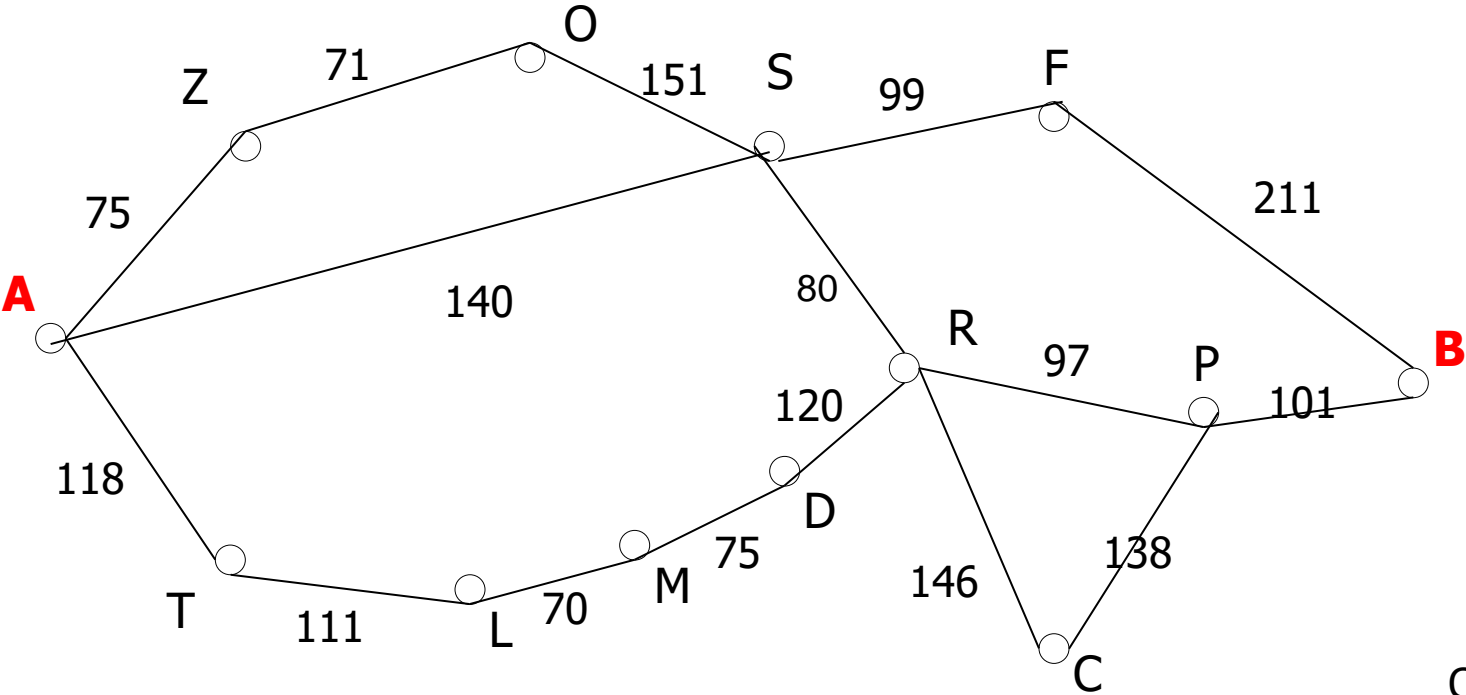


Uninformed Search

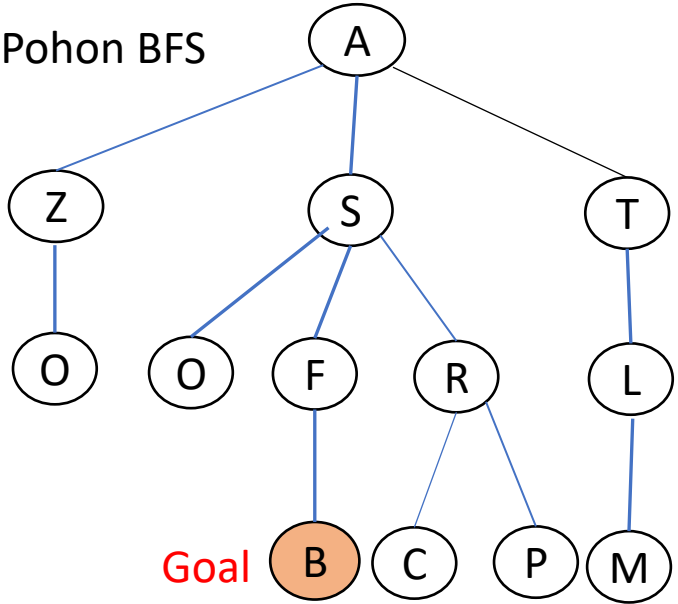
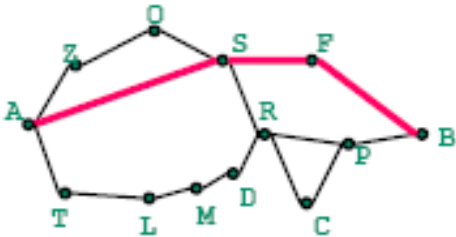
- BFS (*Breadth First Search*)
- DFS (*Depth First Search*)
- DLS (*Depth Limited Search*)
- IDS (*Iterative Deepening Search*)
- UCS (*Uniform Cost Search*)

Breadth-First Search (BFS)

Treat agenda as a queue (FIFO)



Path: **A → S → F → B**,
 Path-cost = 450

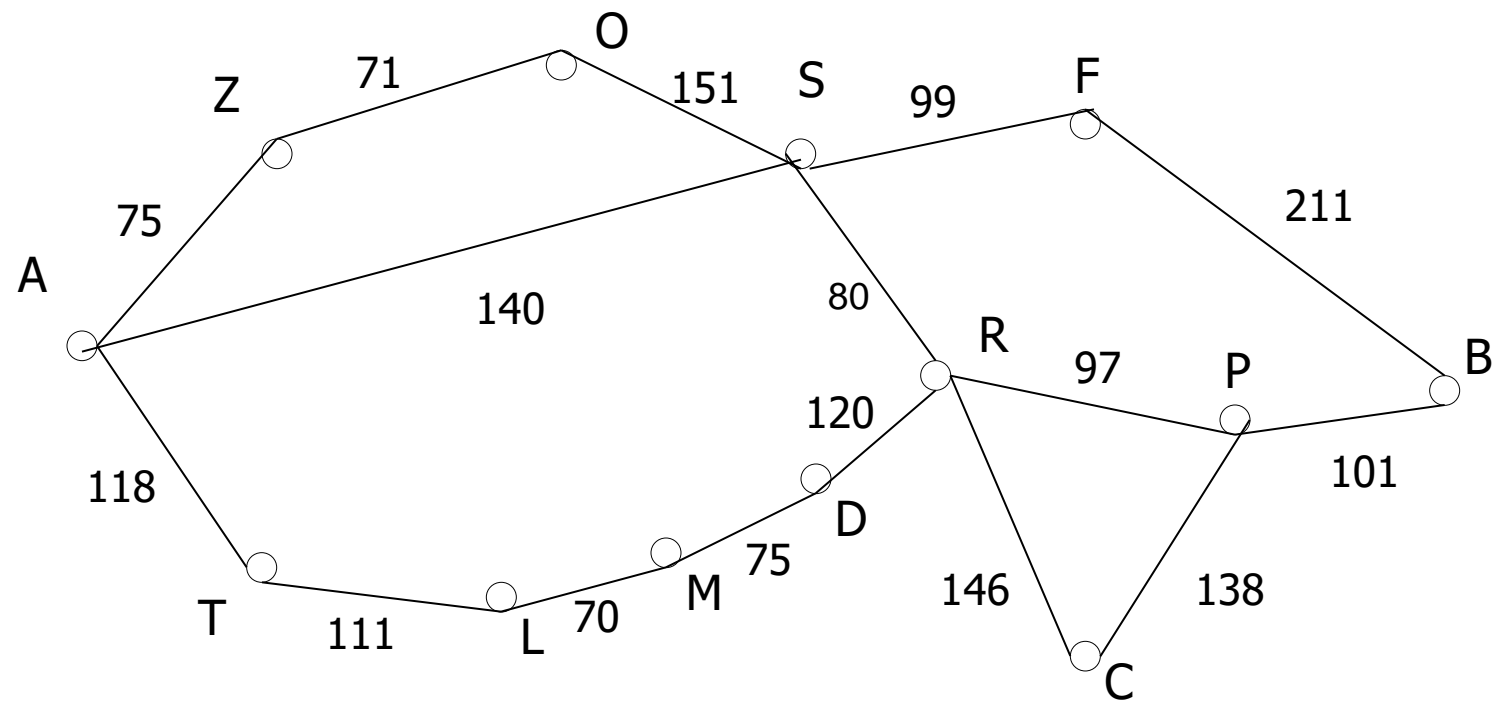


Simplu-E	Simplu Hidup
A	Z_A, S_A, T_A
Z_A	S_A, T_A, O_{AZ}
S_A	$T_A, O_{AZ}, O_{AS}, F_{AS}, R_{AS}$
T_A	$O_{AZ}, O_{AS}, F_{AS}, R_{AS}, L_{AT}$
O_{AZ}	$O_{AS}, F_{AS}, R_{AS}, L_{AT}$
O_{AS}	F_{AS}, R_{AS}, L_{AT}
F_{AS}	R_{AS}, L_{AT}, B_{ASF}
R_{AS}	$L_{AT}, B_{ASF}, D_{ASR}, C_{ASR}, P_{ASR}$
L_{AT}	$B_{ASF}, D_{ASR}, C_{ASR}, P_{ASR}, M_{ATL}$
B_{ASF}	Solusi ketemu

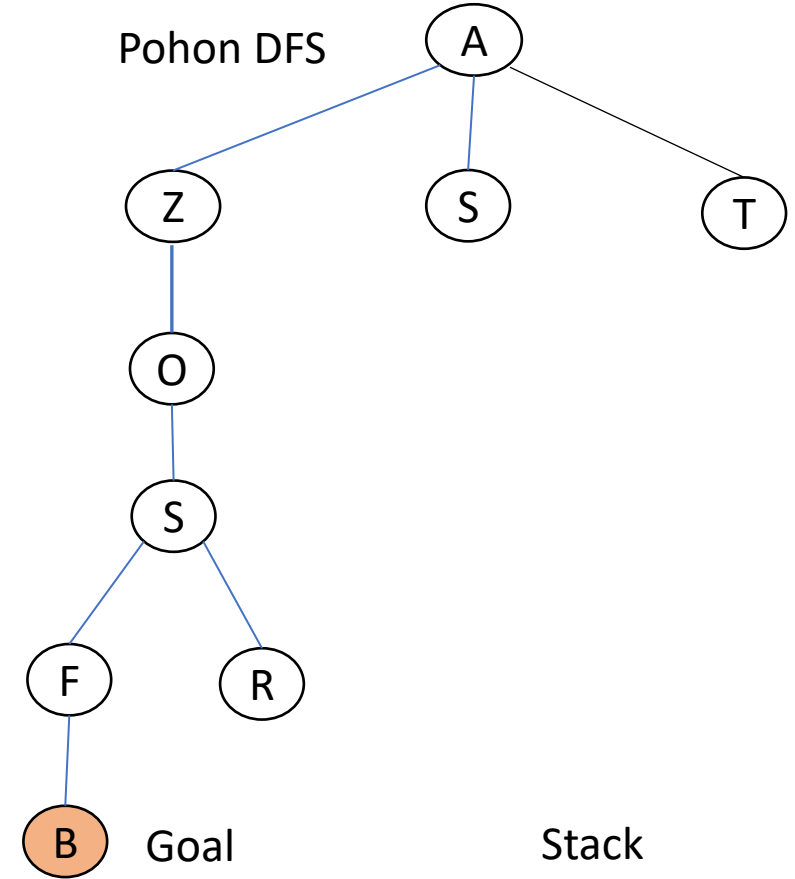
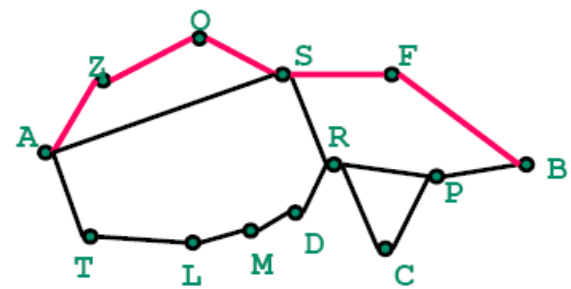
Queue

Depth-First Search (DFS)

Treat agenda as a stack (LIFO)

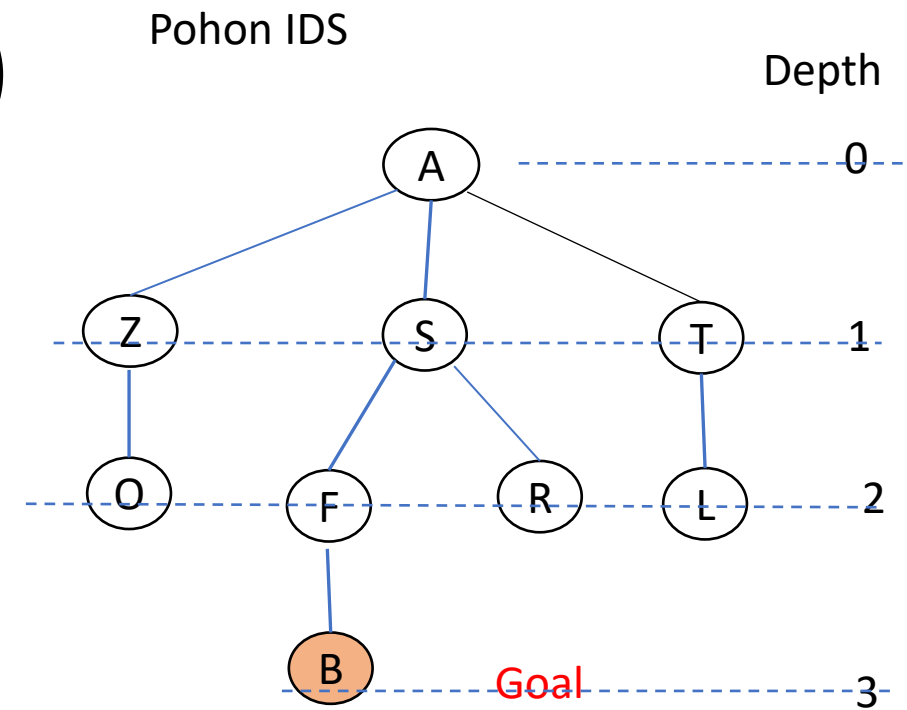
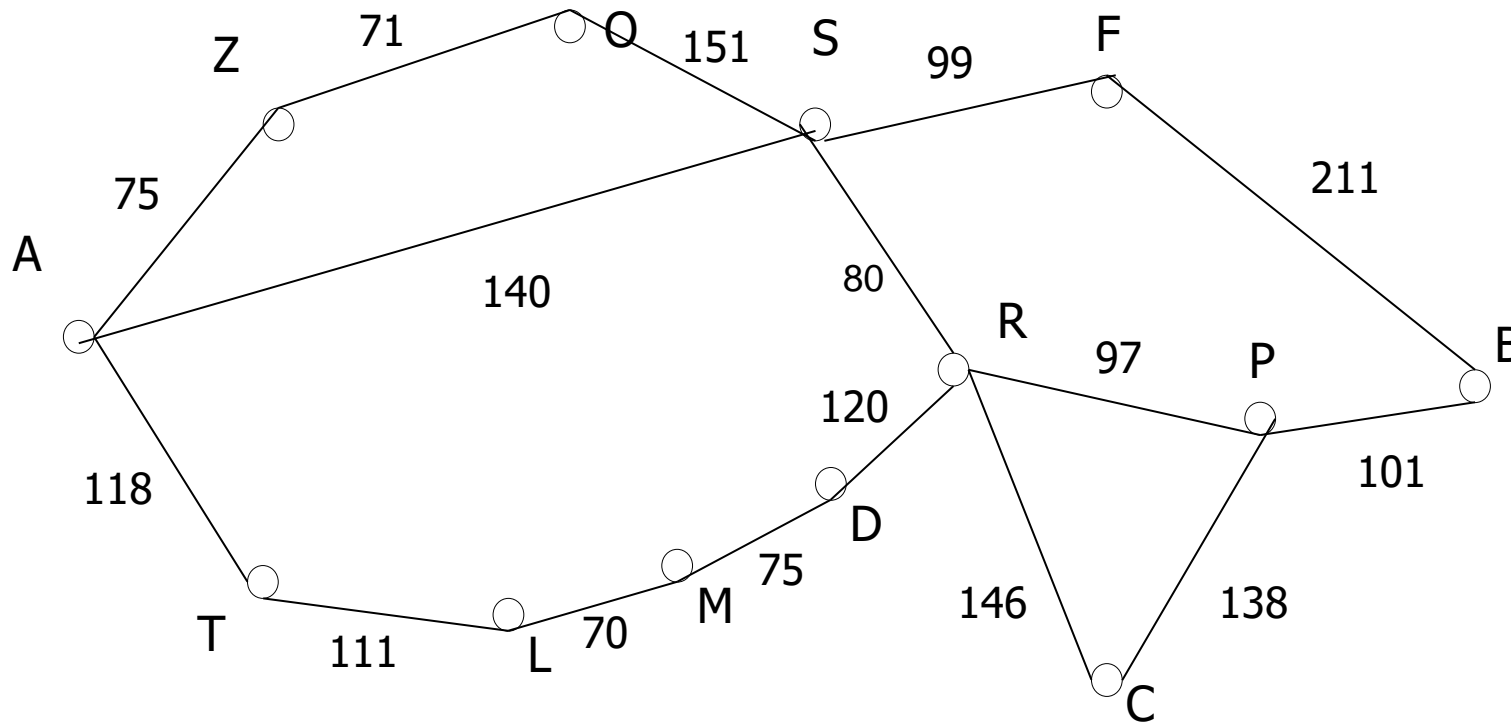


Path: $A \rightarrow Z \rightarrow O \rightarrow S \rightarrow F \rightarrow B$
Path-cost = 607



Stack	
Simplu-E	Simplu Hidup
A	Z_A, S_A, T_A
Z_A	O_{AZ}, S_A, T_A
O_{AZ}	S_{AZO}, S_A, T_A
S_{AZO}	$F_{AZOS}, R_{AZOS}, S_A, T_A$
F_{AZOS}	$B_{AZOSF}, R_{AZOS}, S_A, T_A$
B_{AZOSF}	Solusi ketemu

Iterative Deepening Search (IDS)



Depth=0: A: cutoff

Depth=1: A → Z_A, S_A, T_A → Z_A : cutoff, S_A : cutoff, T_A : cutoff

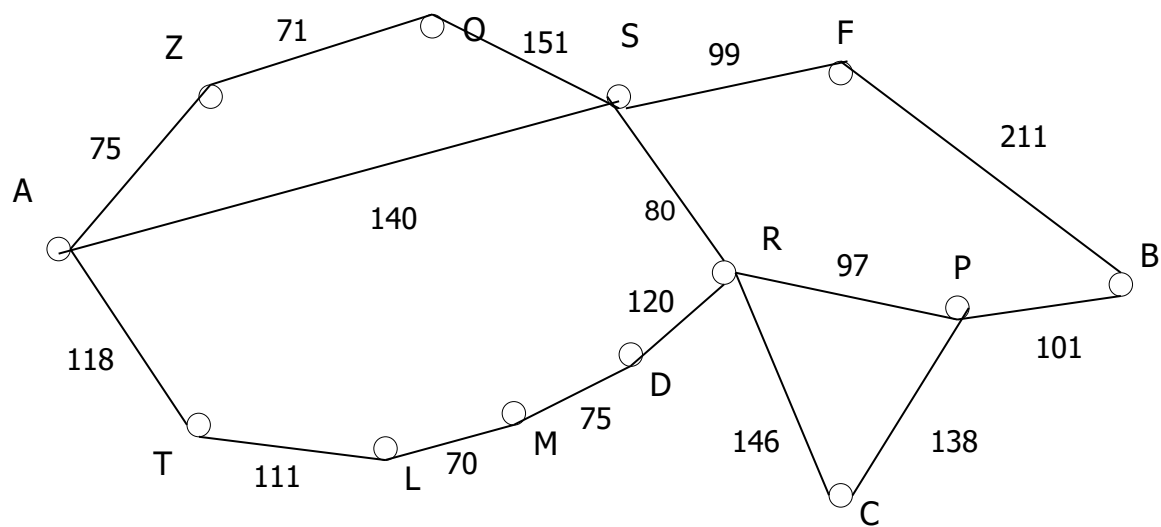
Depth=2: A → Z_A, S_A, T_A → O_{AZ}, S_A, T_A → O_{AZ} : cutoff → F_{AS}, R_{AS}, T_A → F_{AS} : cutoff → R_{AS} : cutoff → L_{AT}
 → L_{AT} : cutoff

Depth=3: A → Z_A, S_A, T_A → O_{AZ}, S_A, T_A → S_{AZO}, S_A, T_A → S_{AZO} : cutoff → F_{AS}, R_{AS}, T_A → B_{ASF}, R_{AS}, T_A → B_{ASF}

Stop: B=goal, path: A → S → F → B, path-cost = 450

Uniform Cost Search (UCS)

- BFS & IDS find path with fewest steps (A-S-F-B)
- If steps \neq cost, this is not relevant (to optimal solution)
- How can we find the shortest path (measured by sum of distances along path)?
- $g(n)$ = path cost from root to n

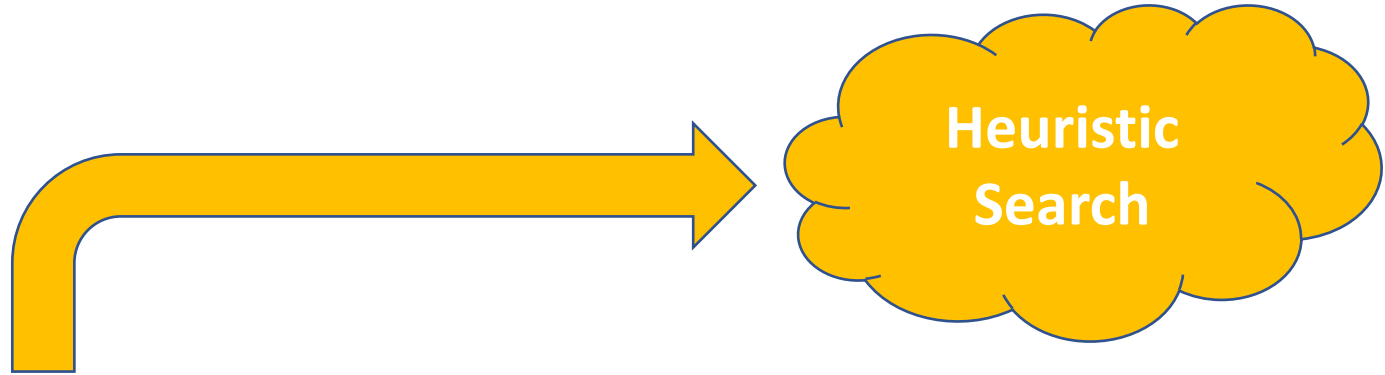


Path: **A → S → R → P → B**
Path-cost = 418 → optimal solution

Simpul-E	Simpul Hidup
A	Z _{A-75} , T _{A-118} , S _{A-140}
Z _{A-75}	T _{A-118} , S _{A-140} , O _{AZ-146}
T _{A-118}	S _{A-140} , O _{AZ-146} , L _{AT-229}
S _{A-140}	O _{AZ-146} , R _{AS-220} , L _{AT-229} , F _{AS-239} , O _{AS-291}
O _{AZ-146}	R _{AS-220} , L _{AT-229} , F _{AS-239} , O _{AS-291}
R _{AS-220}	L _{AT-229} , F _{AS-239} , O _{AS-291} , P _{ASR-317} , D _{ASR-340} , C _{ASR-366}
L _{AT-229}	F _{AS-239} , O _{AS-291} , M _{ATL-299} , P _{ASR-317} , D _{ASR-340} , C _{ASR-366}
F _{AS-239}	O _{AS-291} , M _{ATL-299} , P _{ASR-317} , D _{ASR-340} , C _{ASR-366} , B _{ASF-450}
O _{AS-291}	M _{ATL-299} , P _{ASR-317} , D _{ASR-340} , C _{ASR-366} , B _{ASF-450}
M _{ATL-299}	P _{ASR-317} , D _{ASR-340} , D _{ATLM-364} , C _{ASR-366} , B _{ASF-450}
P _{ASR-317}	D _{ASR-340} , D _{ATLM-364} , C _{ASR-366} , B _{ASRP-418} , C _{ASRP-455} , B _{ASF-450}
D _{ASR-340}	D _{ATLM-364} , C _{ASR-366} , B _{ASRP-418} , C _{ASRP-455} , B _{ASF-450}
D _{ATLM-364}	C _{ASR-366} , B _{ASRP-418} , C _{ASRP-455} , B _{ASF-450}
C _{ASR-366}	B _{ASRP-418} , C _{ASRP-455} , B _{ASF-450}
B _{ASRP-418}	Solusi ketemu

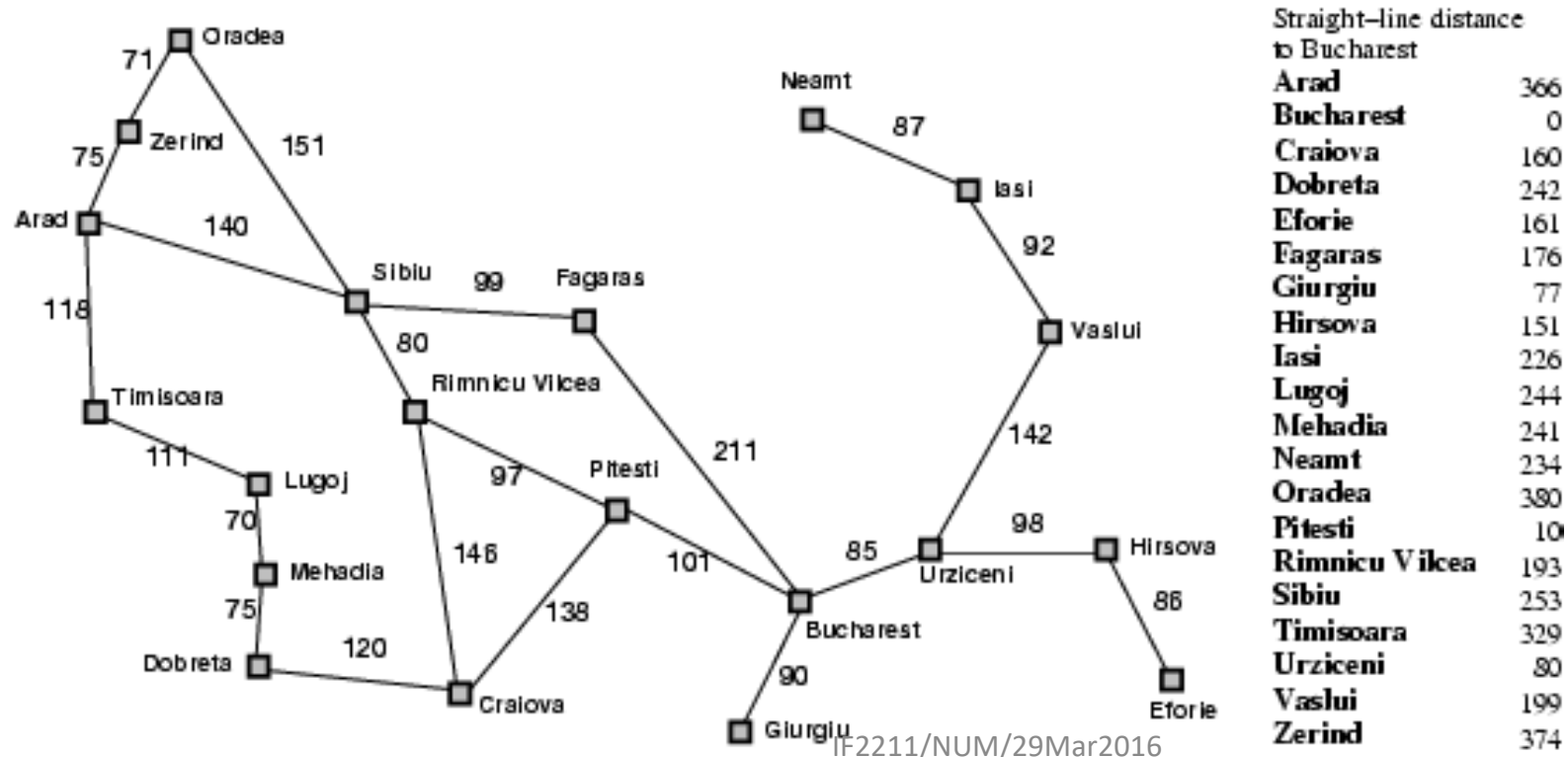
Informed Search

- Greedy Best First Search
- A^*



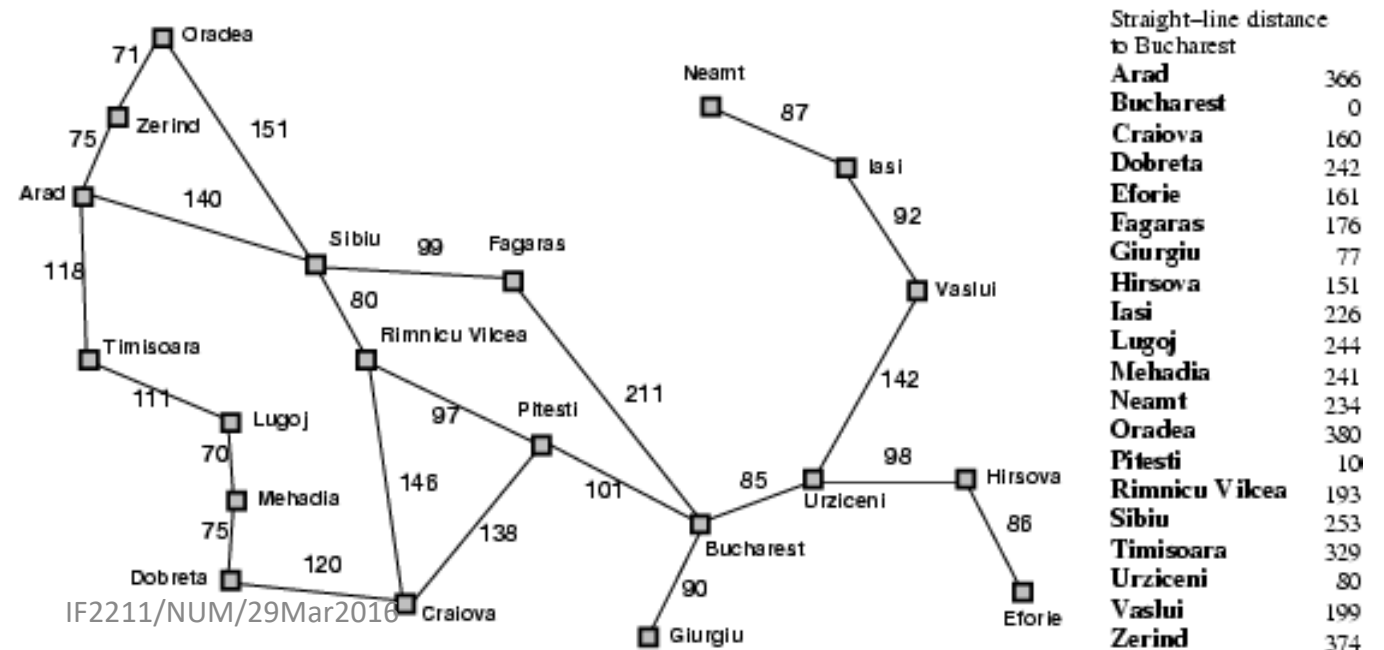
Greedy Best-First Search

- Idea: use an **evaluation function** $f(n)$ for each node
 - $f(n) = h(n) \rightarrow$ estimates of cost from n to goal
 - e.g., $h_{SLD}(n)$ = straight-line distance from n to Bucharest
- Greedy best-first search expands the node that **appears** to be closest to goal

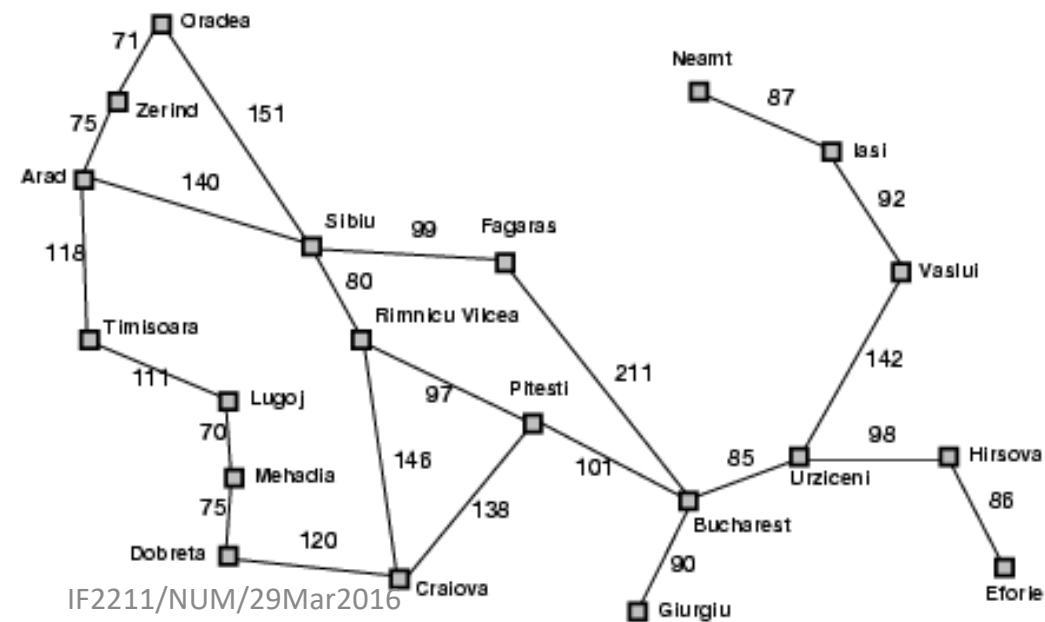


Romania with step costs in km:

Greedy best-first search example



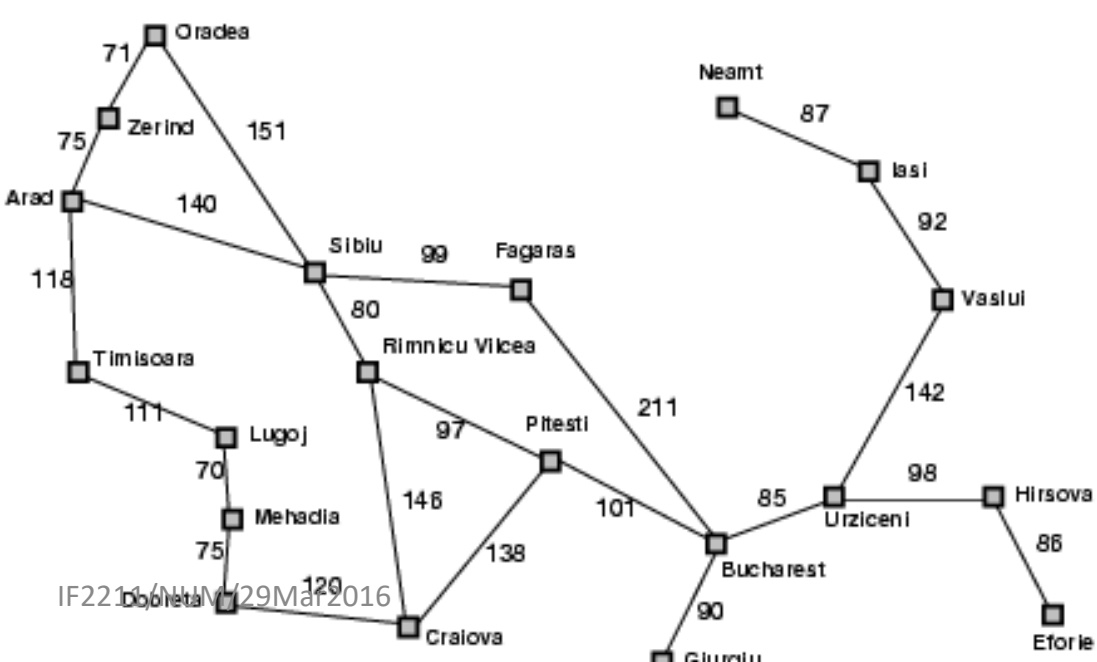
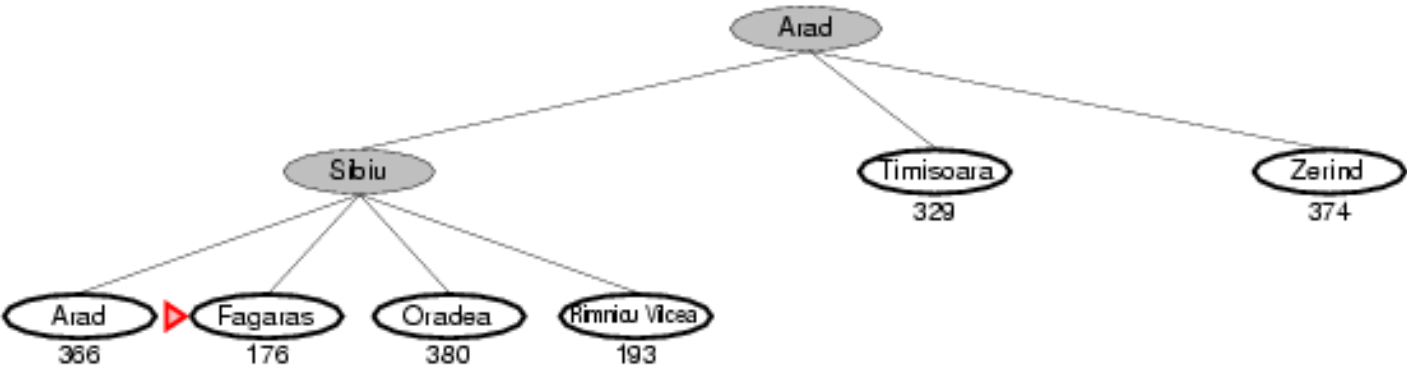
Greedy best-first search example



Straight-line distance to Bucharest

Arad	366
Bucharest	0
Craiova	160
Dobreta	242
Eforie	161
Fagaras	176
Giurgiu	77
Hirsova	151
Iasi	226
Lugoj	244
Mehadia	241
Neamt	234
Oradea	380
Pitesti	10
Rimnicu Vilcea	193
Sibiu	253
Timisoara	329
Urziceni	80
Vaslui	199
Zerind	374

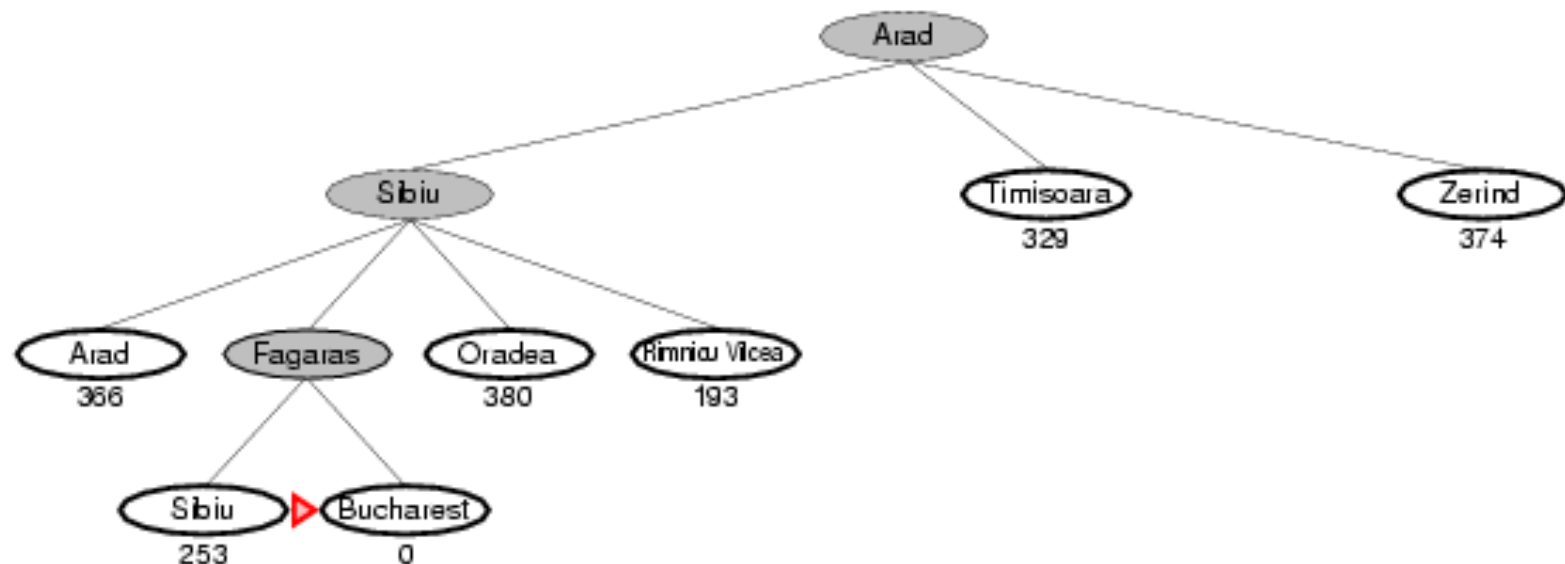
Greedy best-first search example



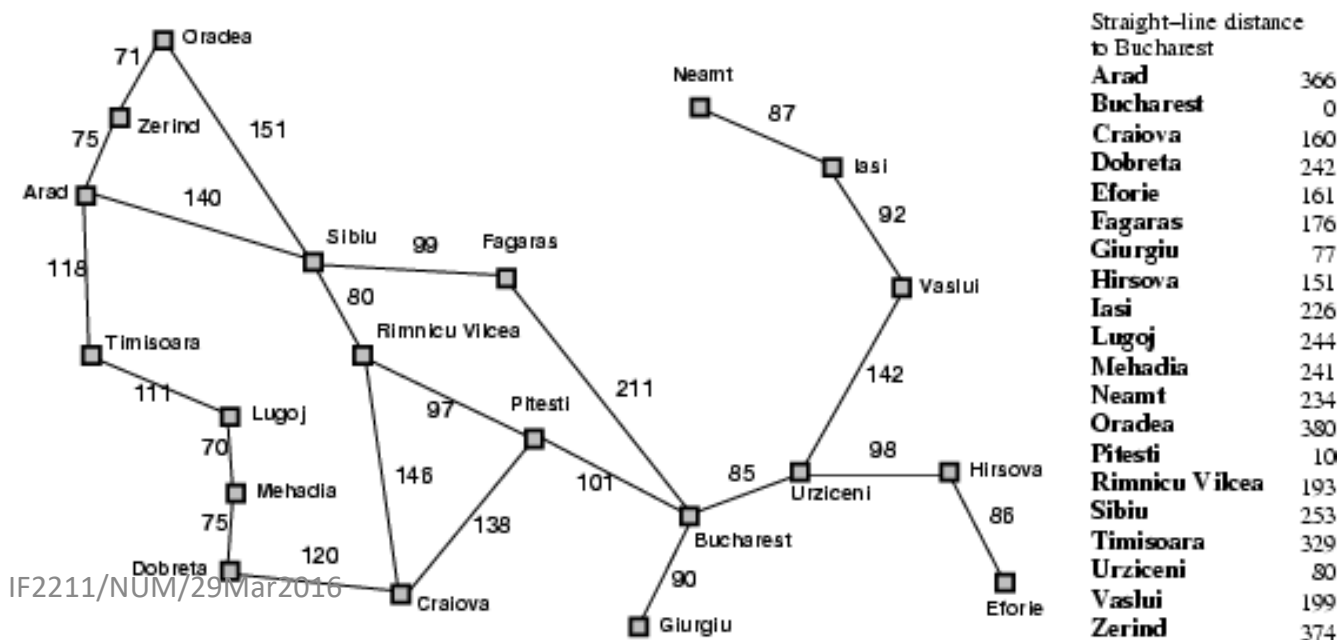
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Timisoara	329
Urziceni	80
Vaslui	199
Zerind	374

Greedy best-first search example

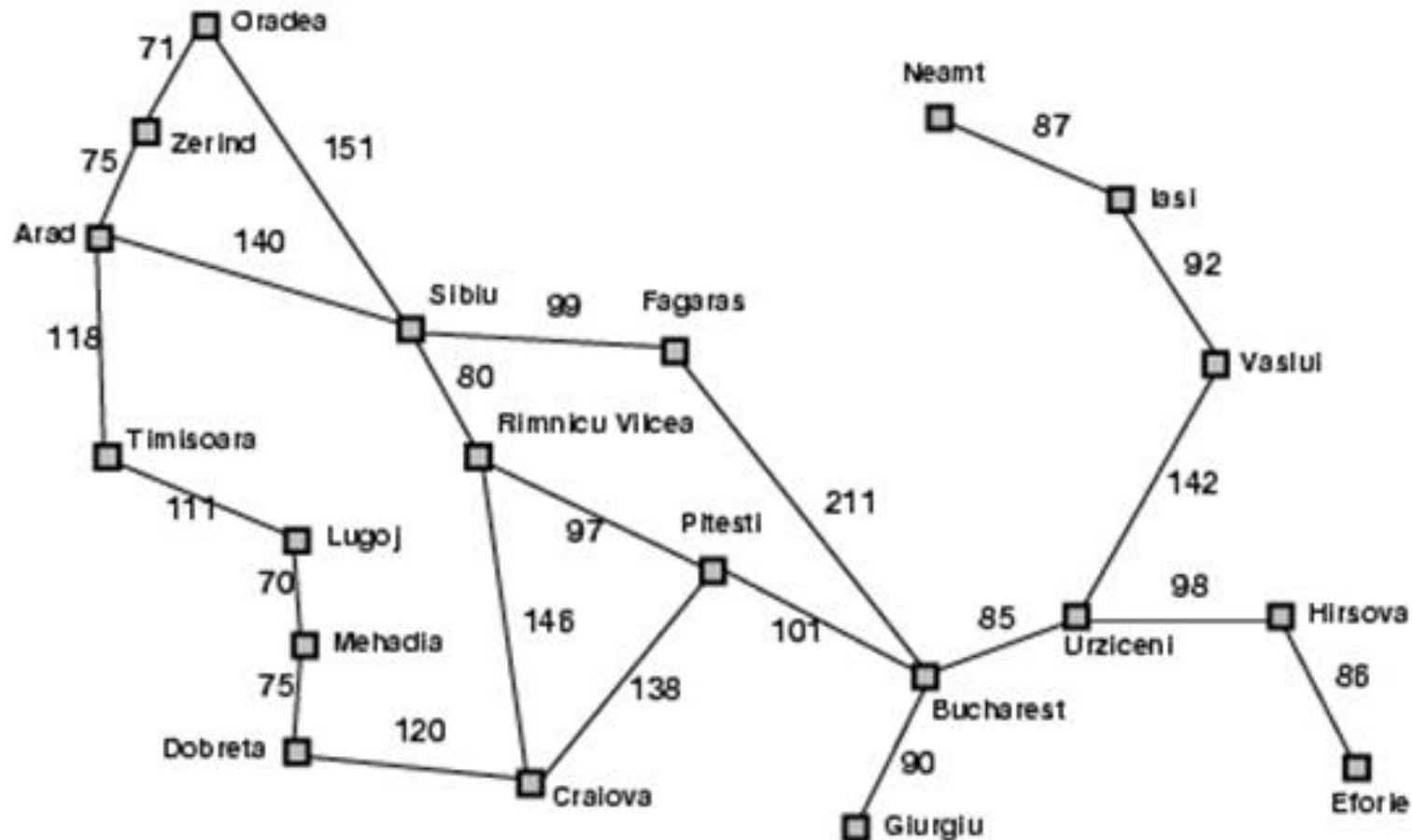


Path: Arad → Sibiu → Fagaras → Bucharest,
Path-cost = 450 → not optimal solution



Problems with Greedy Best First Search

1. Not complete



Lasi to Fagaras?

Problems with Greedy Best First Search

2. Get stuck with local minima/plateau
3. Irrevocable (not able to be reversed/changed)
4. Can we incorporate heuristics in systematic search?

(Bersambung pada Bagian 2)