Penentuan Rute
(*Route/Path Planning*)

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

IF221 Strategi Algoritma

Program Studi Informatika
STEI-ITB

Referensi

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

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

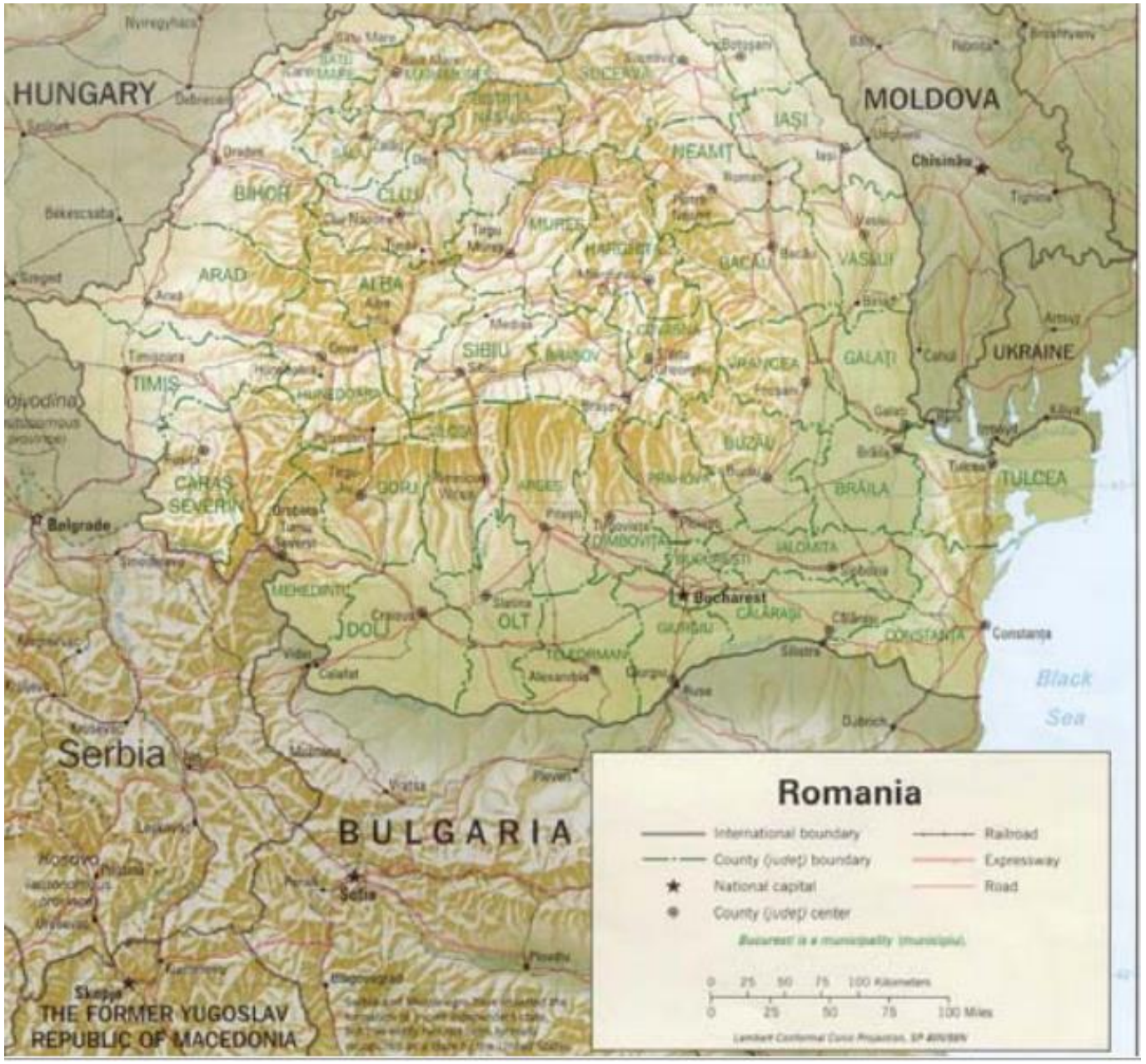
2. Stuart J Russell & Peter Norvig, *Artificial Intelligence: A Modern Approach, 3rd Edition*, Prentice-Hall International, Inc, 2010, Textbook

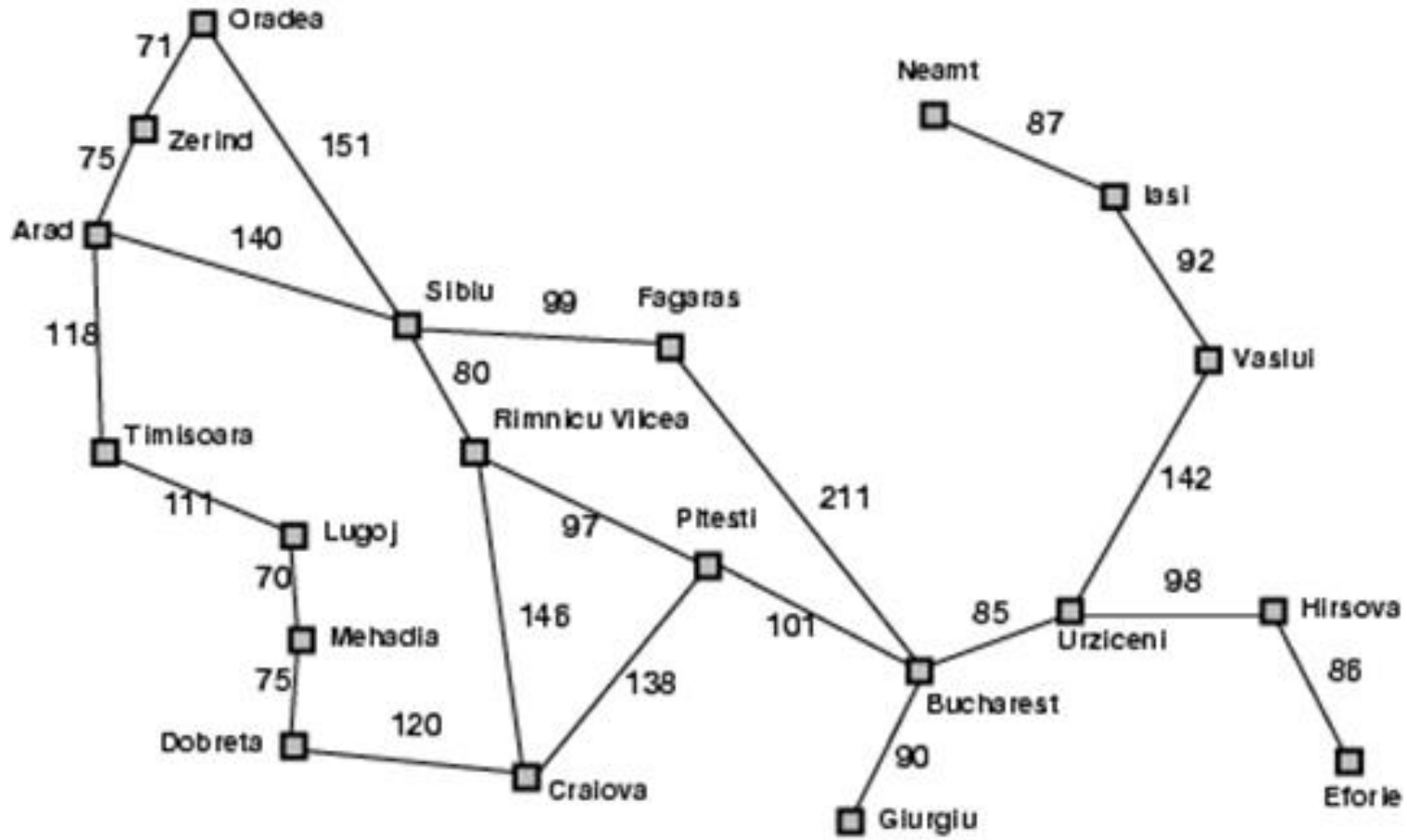
   Site: http://aima.cs.berkeley.edu/ (2nd edition)

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

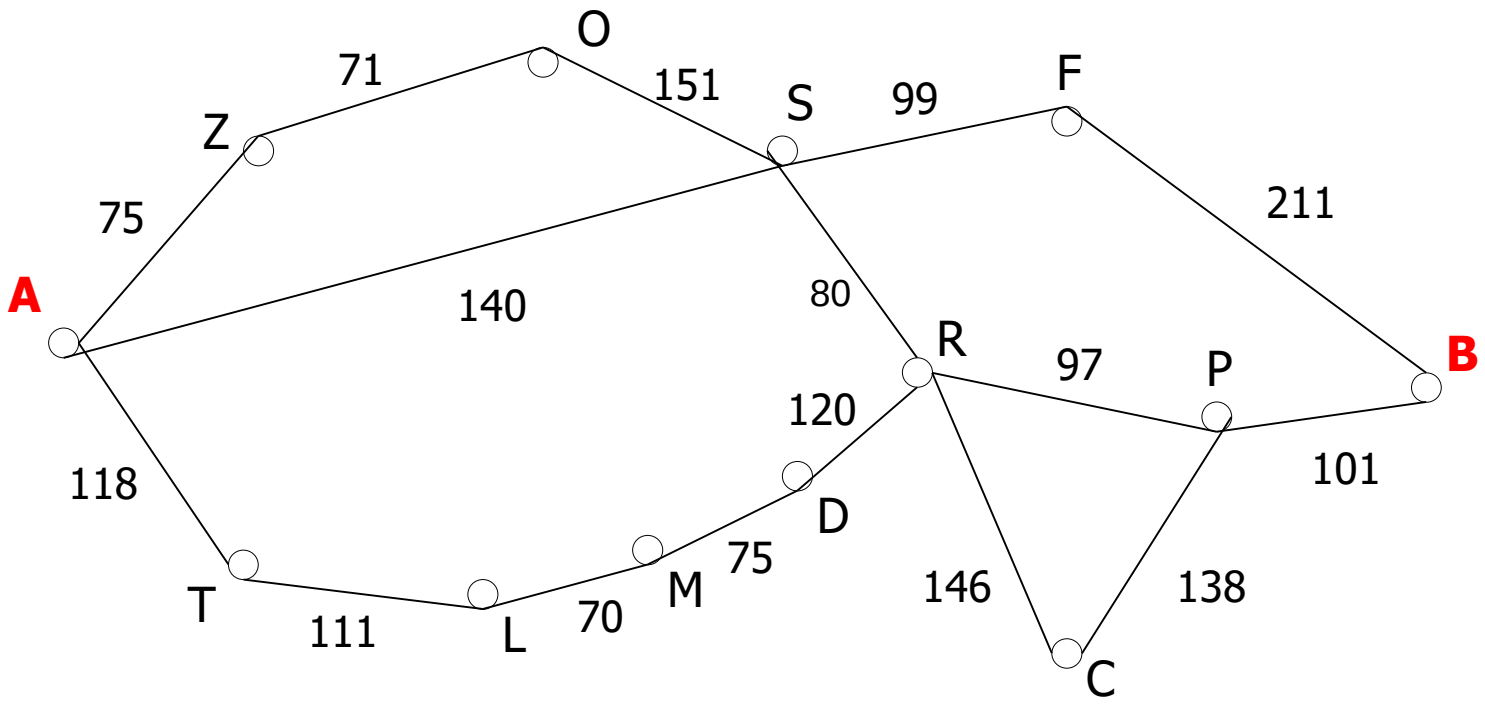
Route Planning




Oradea
71
Neamt
87
Zerind
75
151
Iasi
Arad
140
92
Sibiu
99
Fagaras
118
Vaslui
80
Rimnicu Vilcea
Timisoara
142
111
211
Pitesti
97
Lugoj
98
70
85
Hirsova
Mehadia
146
101
Urziceni
75
138
86
Bucharest
120
Dobreta
90
Craiova
Eforie
Giurgiu

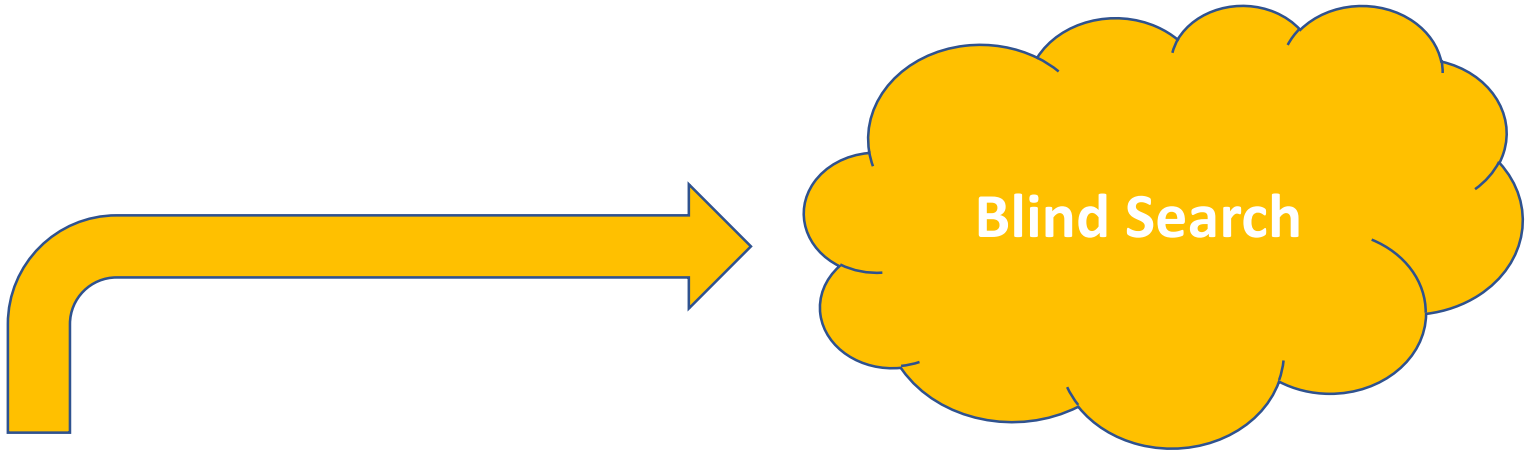
Source: Russell's book

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

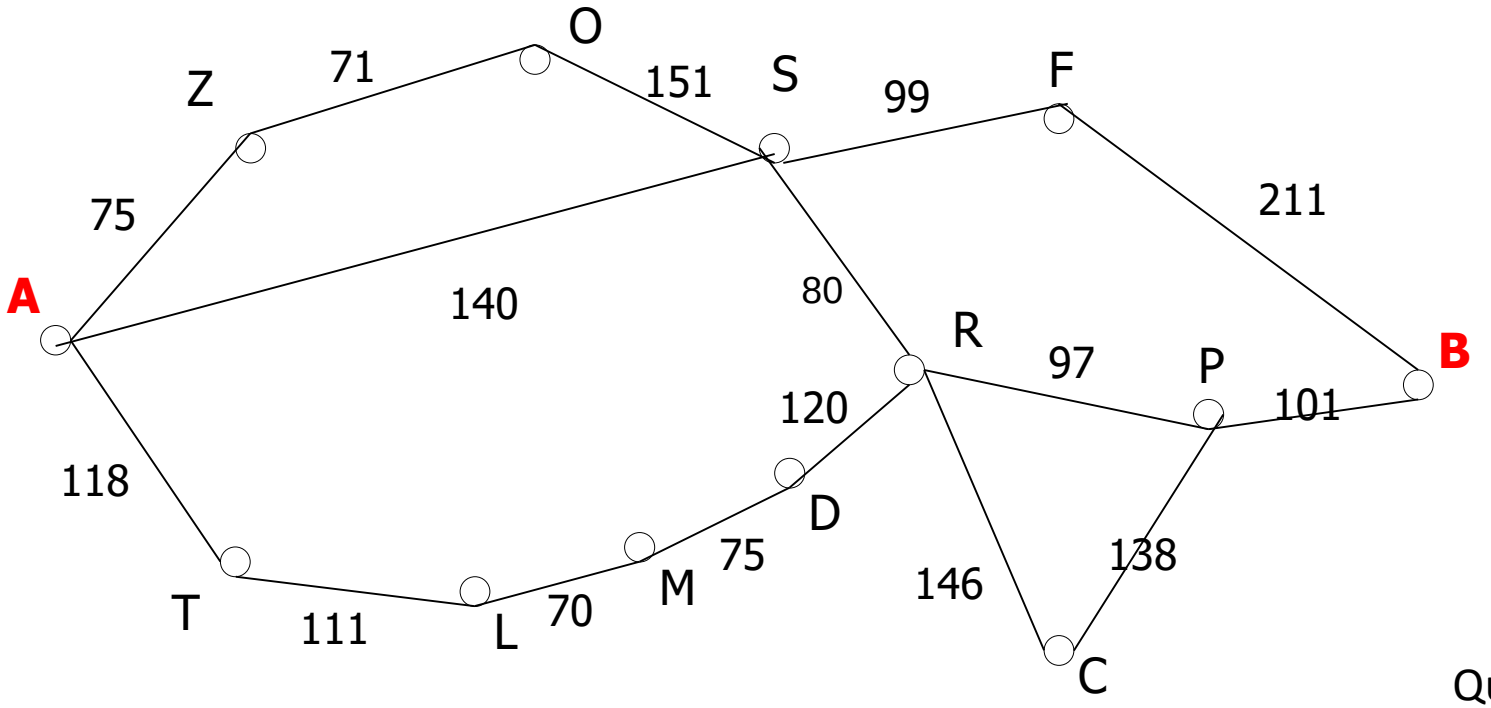


Uninformed Search

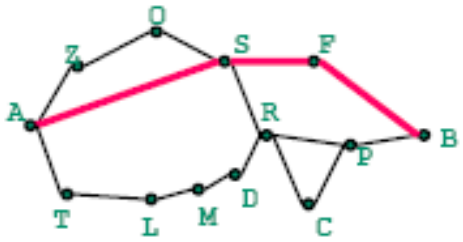
- BFS (*Breadth First Search*)
- DFS (*Depth First Search*)
- DLS (*Deep Limited Search*)
- IDS (*Iterative Deepening Search*)
- UCS (*Uniform Cost Search*)

Breadth-First Search (BFS)

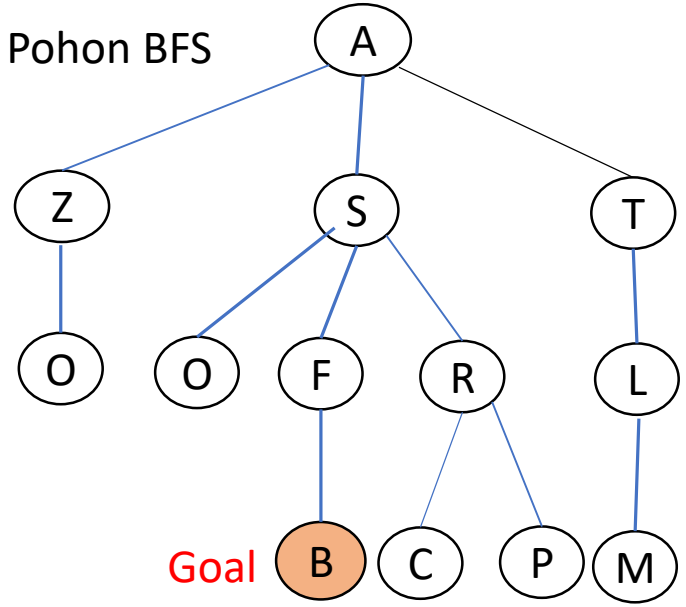
Treat agenda as a queue (FIFO)



Path: A→ S → F → B,
Path-cost = 450



Pohon BFS

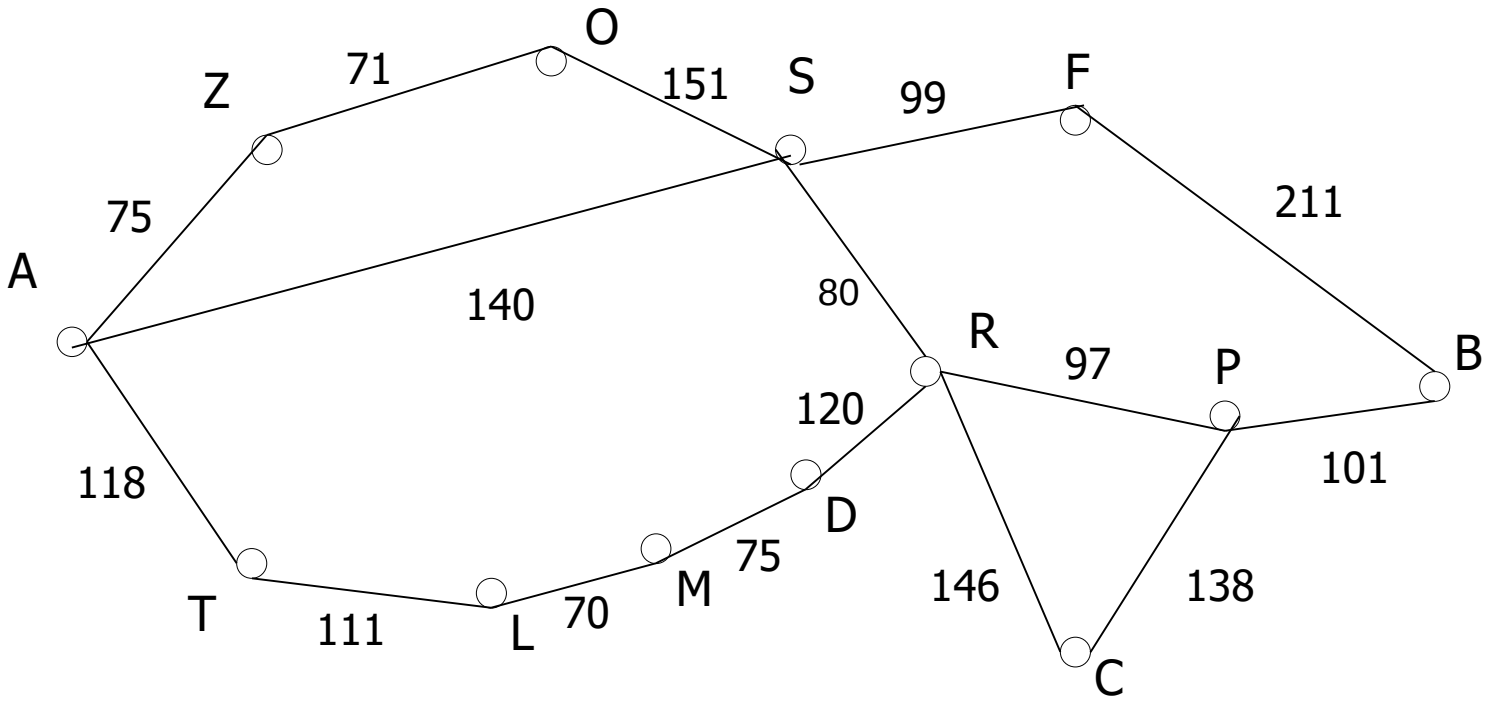


Queue

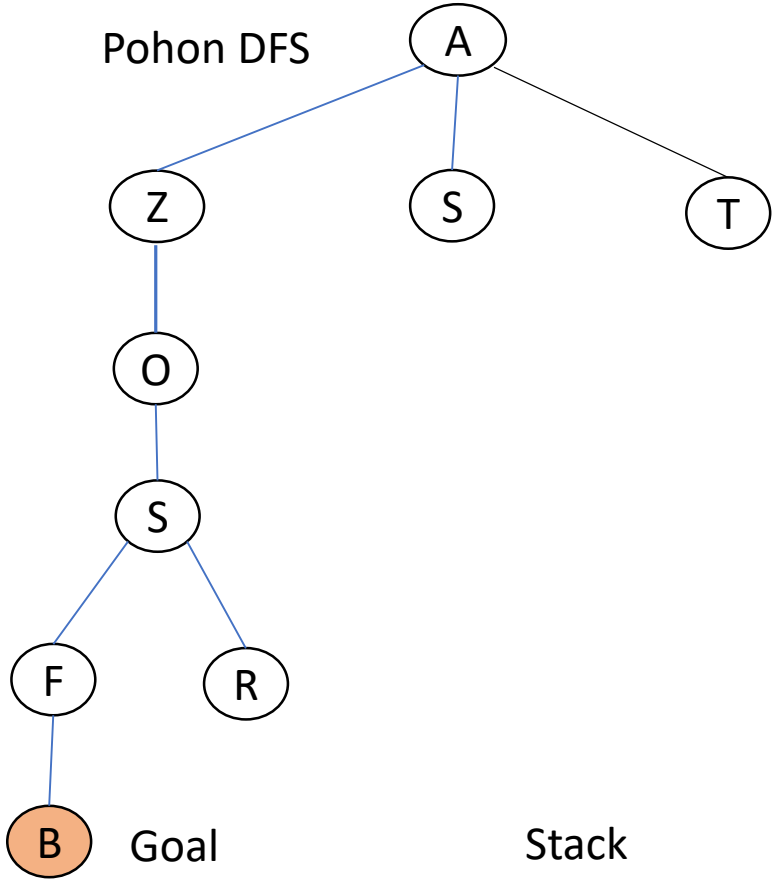
Simpul-E	Simpul Hidup
A	Z_A,S_A,T_A
Z_A	S_A,T_A,O_{AZ}
S_A	T_A,O_{AZ},O_{AS},F_{AS},R_{AS}
T_A	O_{AZ},O_{AS},F_{AS},R_{AS},L_{AT}
O_{AZ}	O_{AS},F_{AS},R_{AS},L_{AT}
O_{AS}	F_{AS},R_{AS},L_{AT}
F_{AS}	R_{AS},L_{AT},B_{ASF}
R_{AS}	L_{AT},B_{ASF},D_{ASR},C_{ASR},P_{ASR}
L_{AT}	B_{ASF},D_{ASR},C_{ASR},P_{ASR},M_{ATL}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

Depth-First Search (DFS)

Treat agenda as a stack (LIFO)

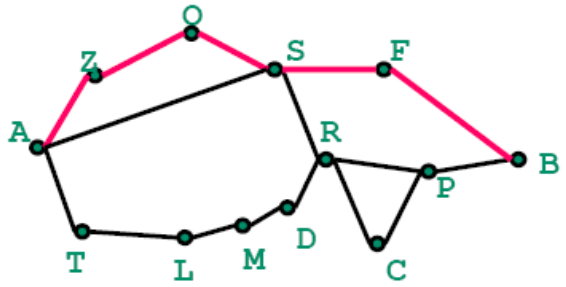


Pohon DFS



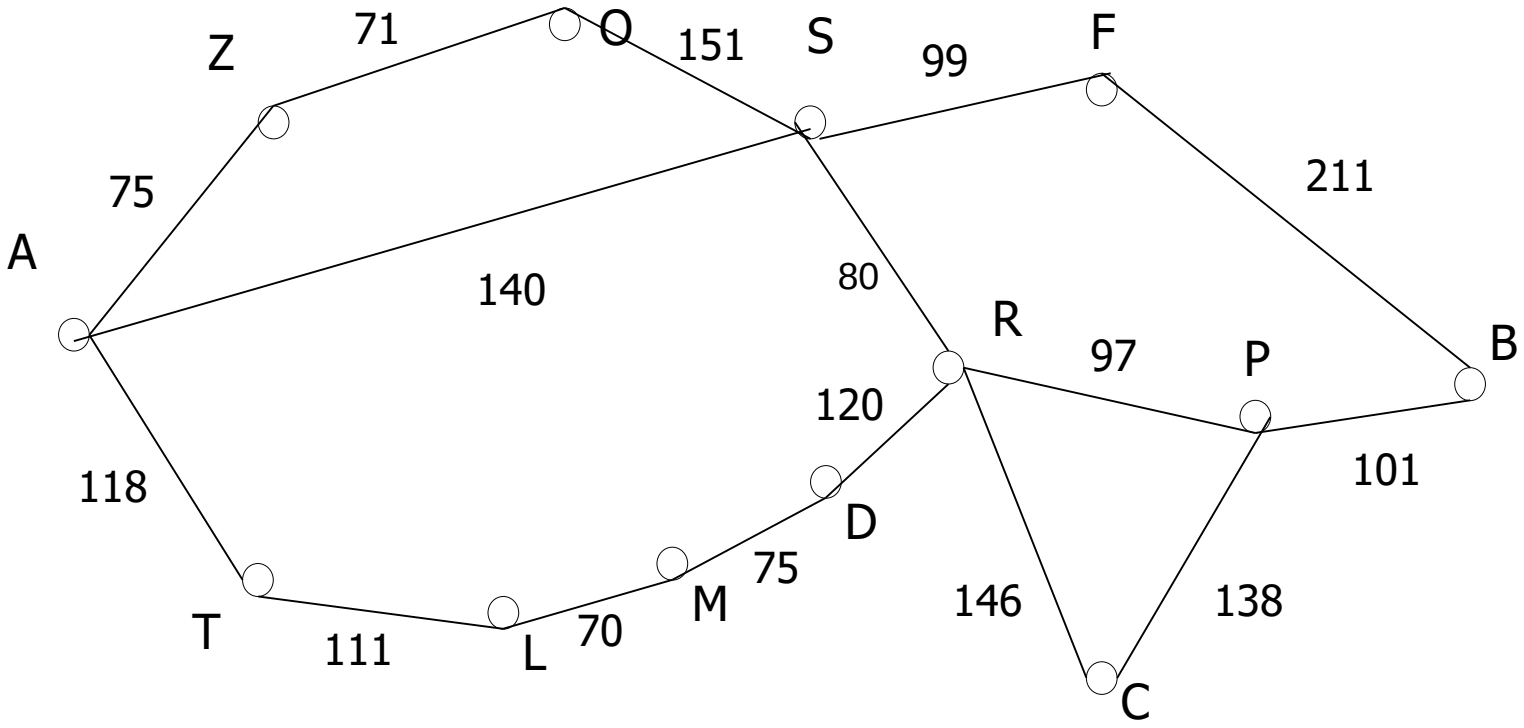
Path: A→ Z → O → S → F → B

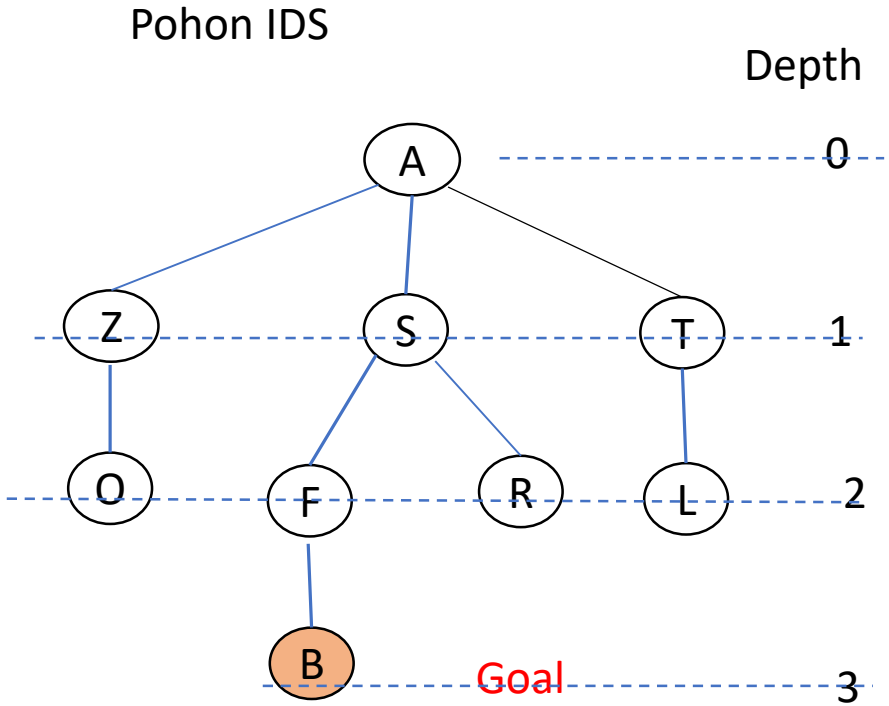
Path-cost = 607



Simpul-E	Simpul 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

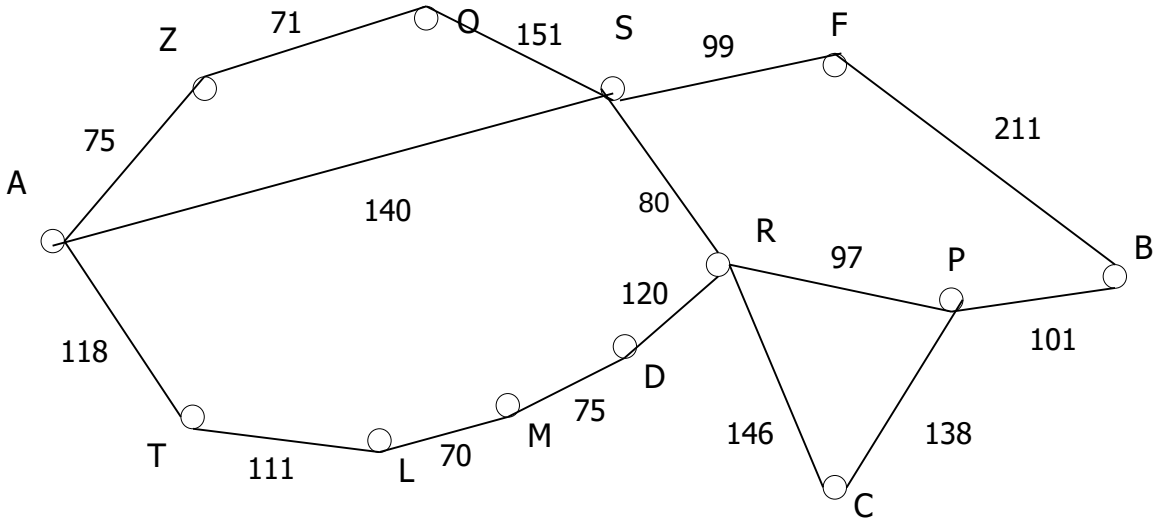
Depth=2: A → Z_A,S_A,T_A → O_{AZ}, S_A,T_A → O_{AZ} : cutoff → F_{AS}, R_{AS},T_A → F_{AS} : cutoff → R_{AS} : cutoff → L_{AT} → L_{AT} : cutoff

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)

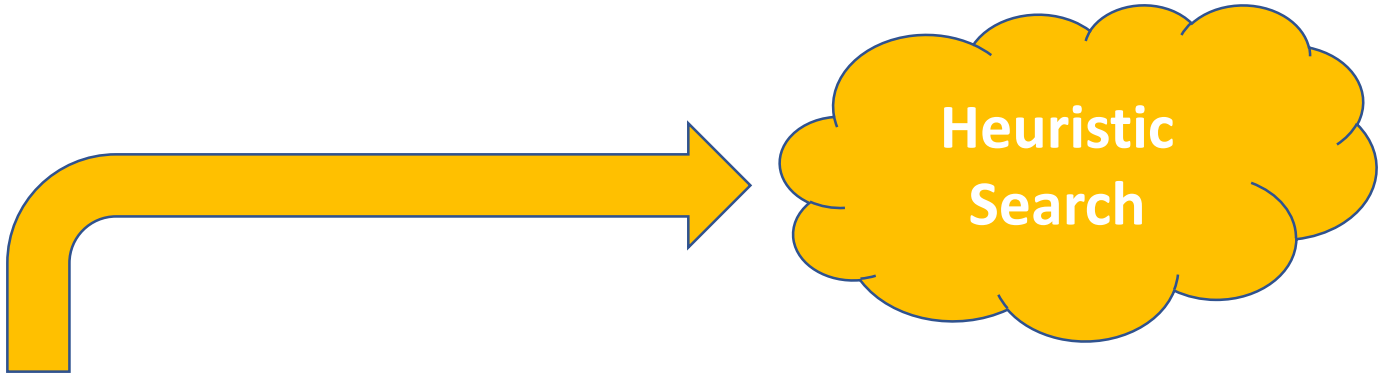
- BFS & IDS find path with fewest steps (A-S-F-B)
- If steps ≠ cost, this is not relevant (to optimal solution)
- How can we find the shortest path (measured by sum of distances along path)?
- $g(n)$ = path cost from root to n



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

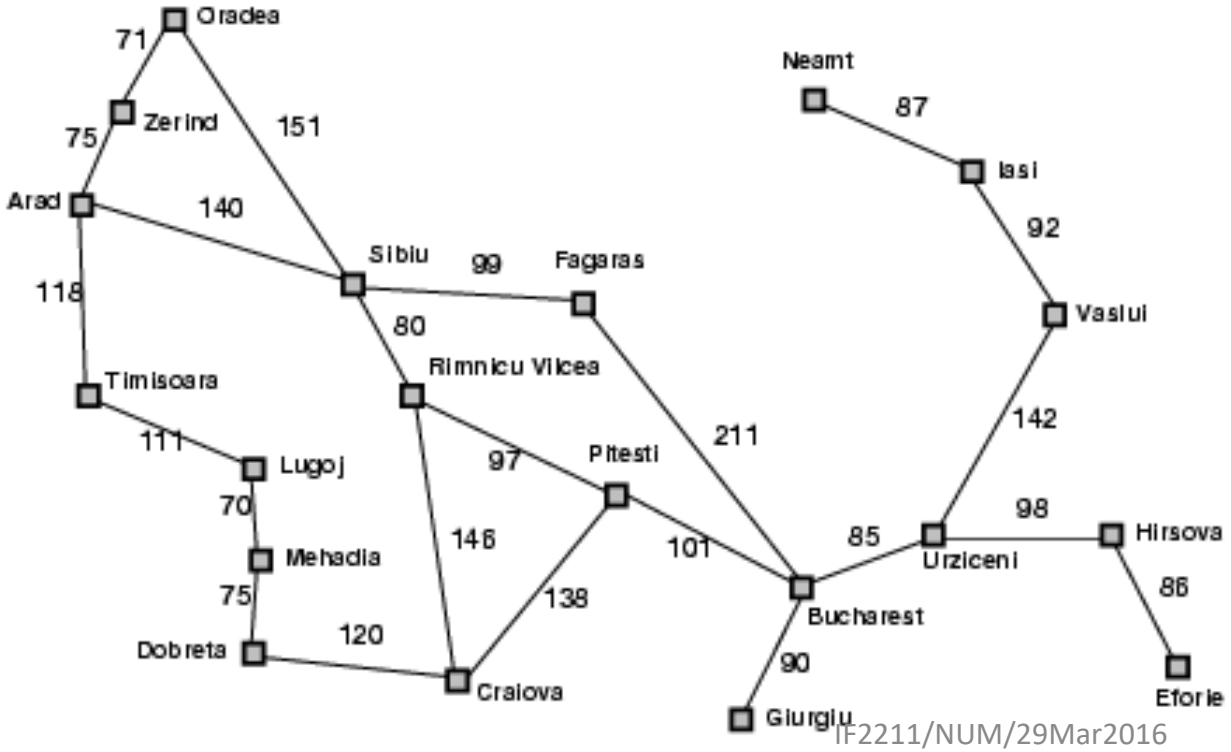


Informed Search

- Greedy Best First Search
- A*

Greedy Best-First Search

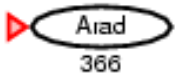
- Idea: use an evaluation function *f(n)* for each node
  - *f(n) = h(n)* → *estimates of cost from n to goal*
  - e.g., $h_{SLD}(n)$ = straight-line distance from *n* to Bucharest
- Greedy best-first search expands the node that appears to be closest to goal

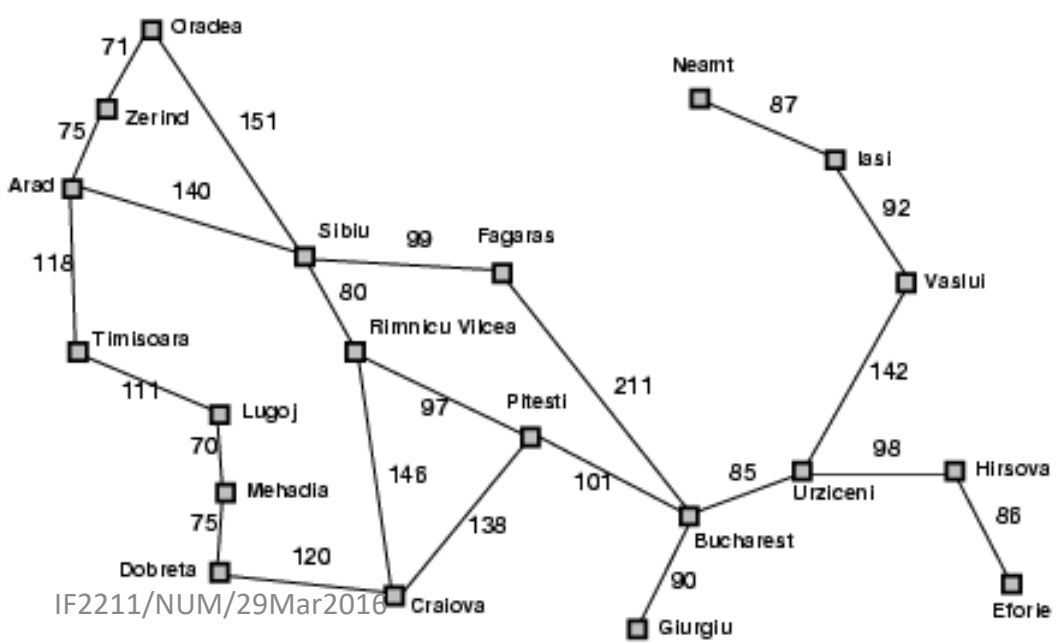


Straight–line distance to Bucharest	
Arad	366
Bucharest	0
Craiova	160
Dobreta	242
Eforie	161
Fagaras	176
Giurgiu	77
Hirsova	151
Iasi	226
Lugoj	244
Mehadia	241
Neamt	234
Oradea	380
Pitesti	10
Rimnicu Vilcea	193
Sibiu	253
Timisoara	329
Urziceni	80
Vaslui	199
Zerind	374

Romania with step costs in km:

Greedy best-first search example





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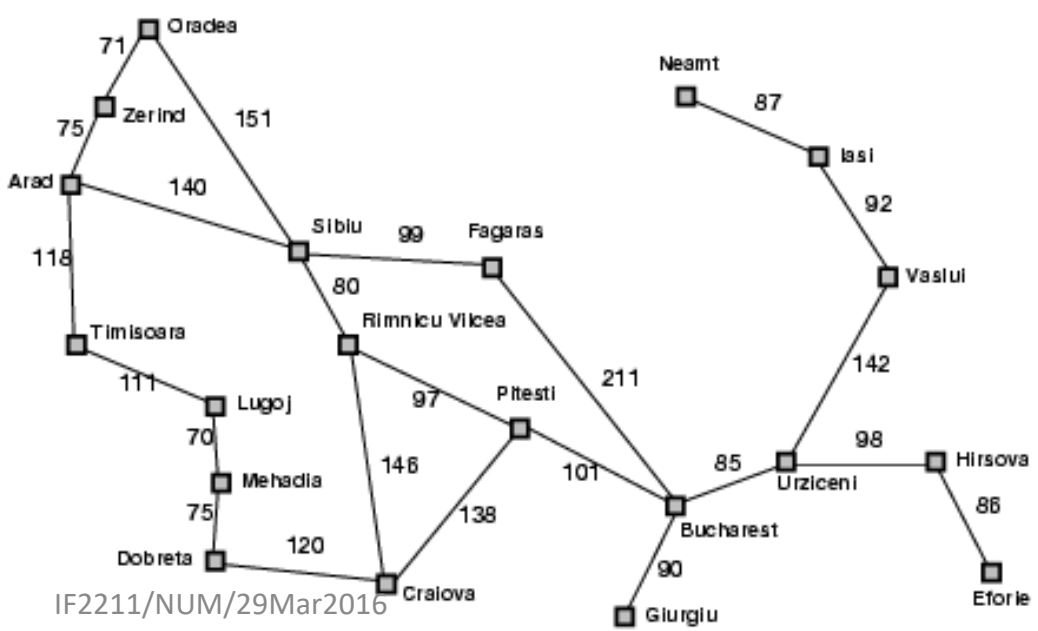
Greedy best-first search example



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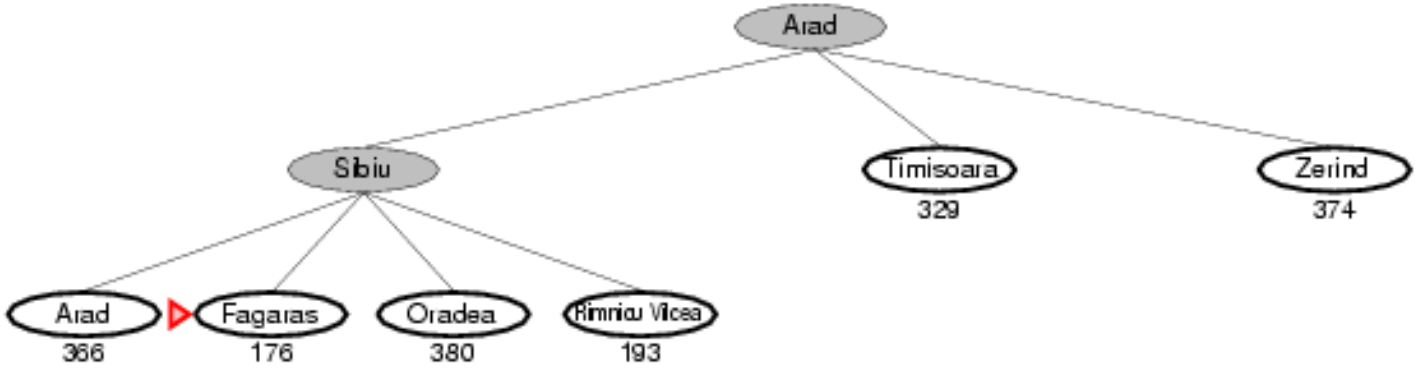
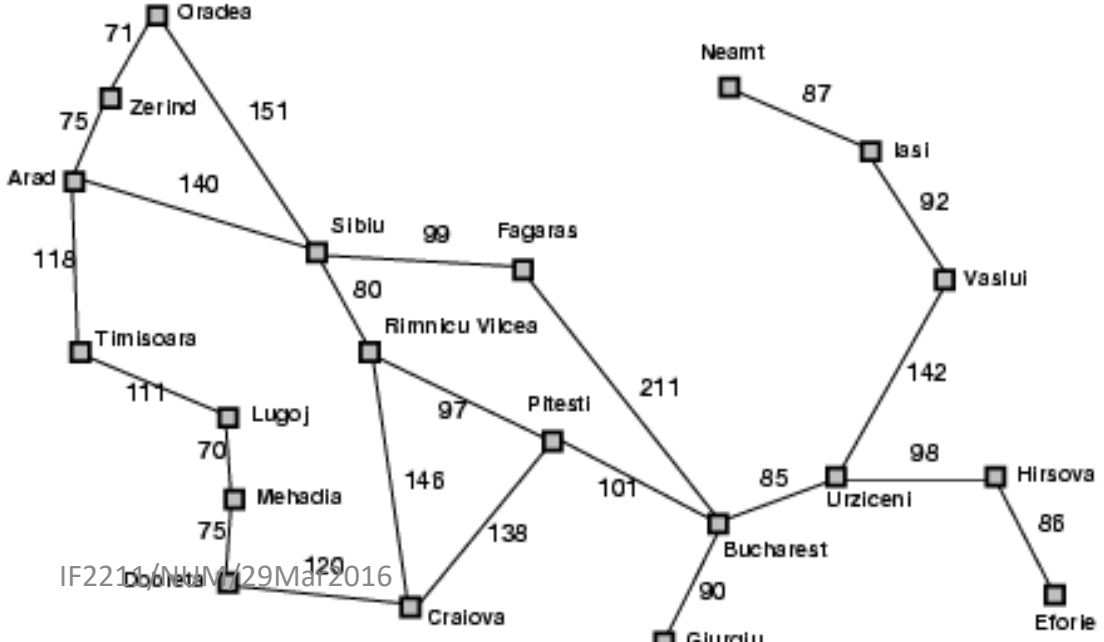
Greedy best-first search example





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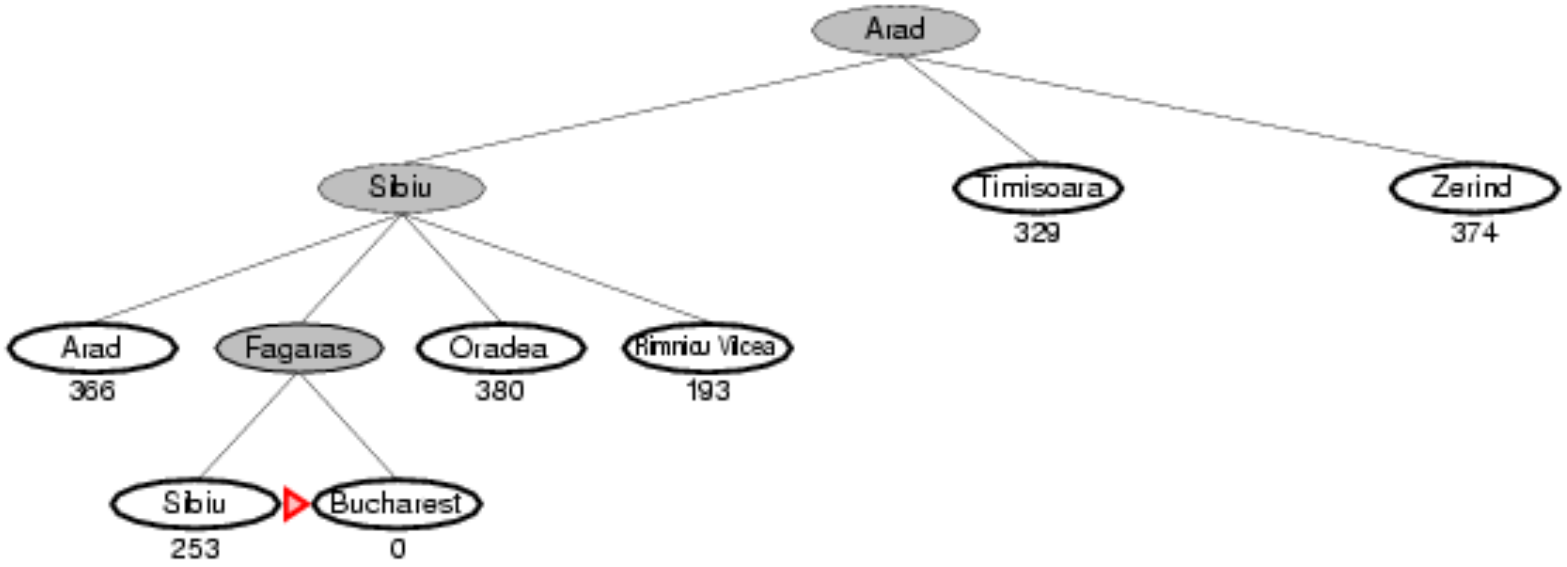
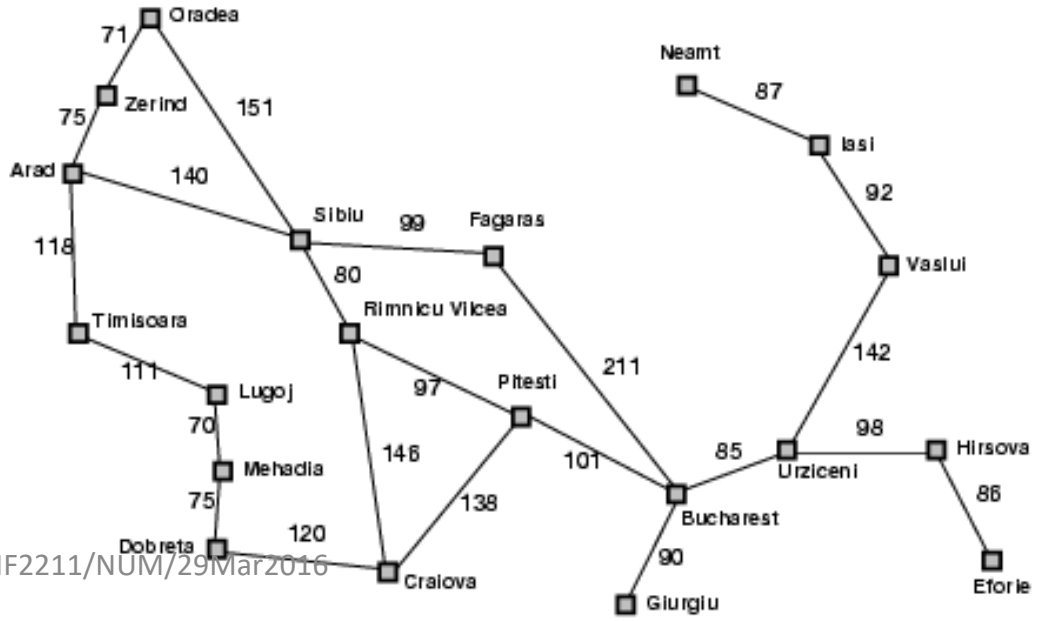
Greedy best-first search example





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Sibiu	253
Timisoara	329
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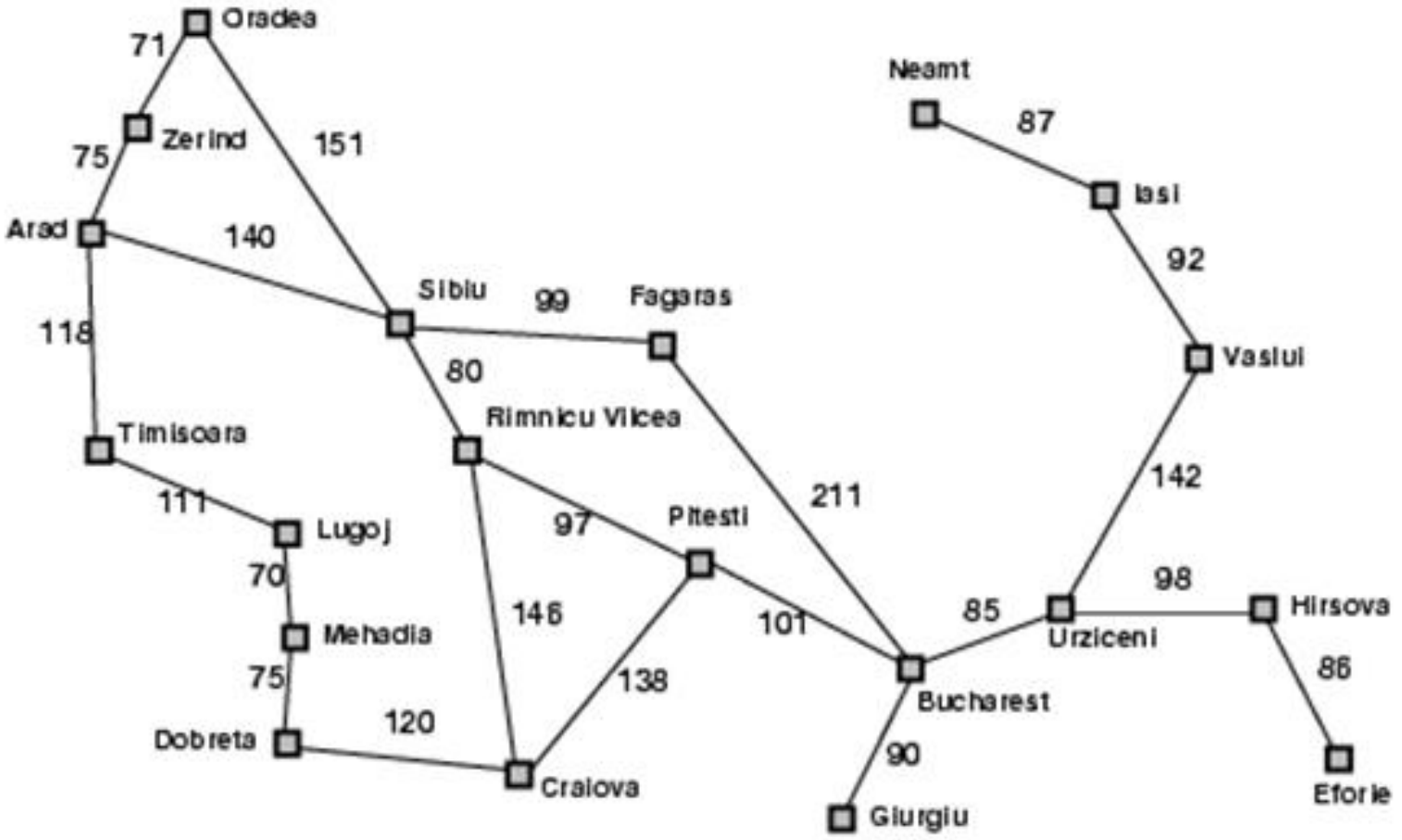
Zerind	374

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

Problems with Greedy Best First Search

1. Not complete



Lasi to Fragaras?

Problems with Greedy Best First Search

2. Get stuck with local minima/plateu

3. Irrevocable (not able to be reversed/changed)

4. Can we incorporate heuristics in systematic search?

(Bersambung pada Bagian 2)