, 2022

Solving problems by Search

Goal-based Agents

Atomic-Factored-Structured

Dr. Bilal Hoteit

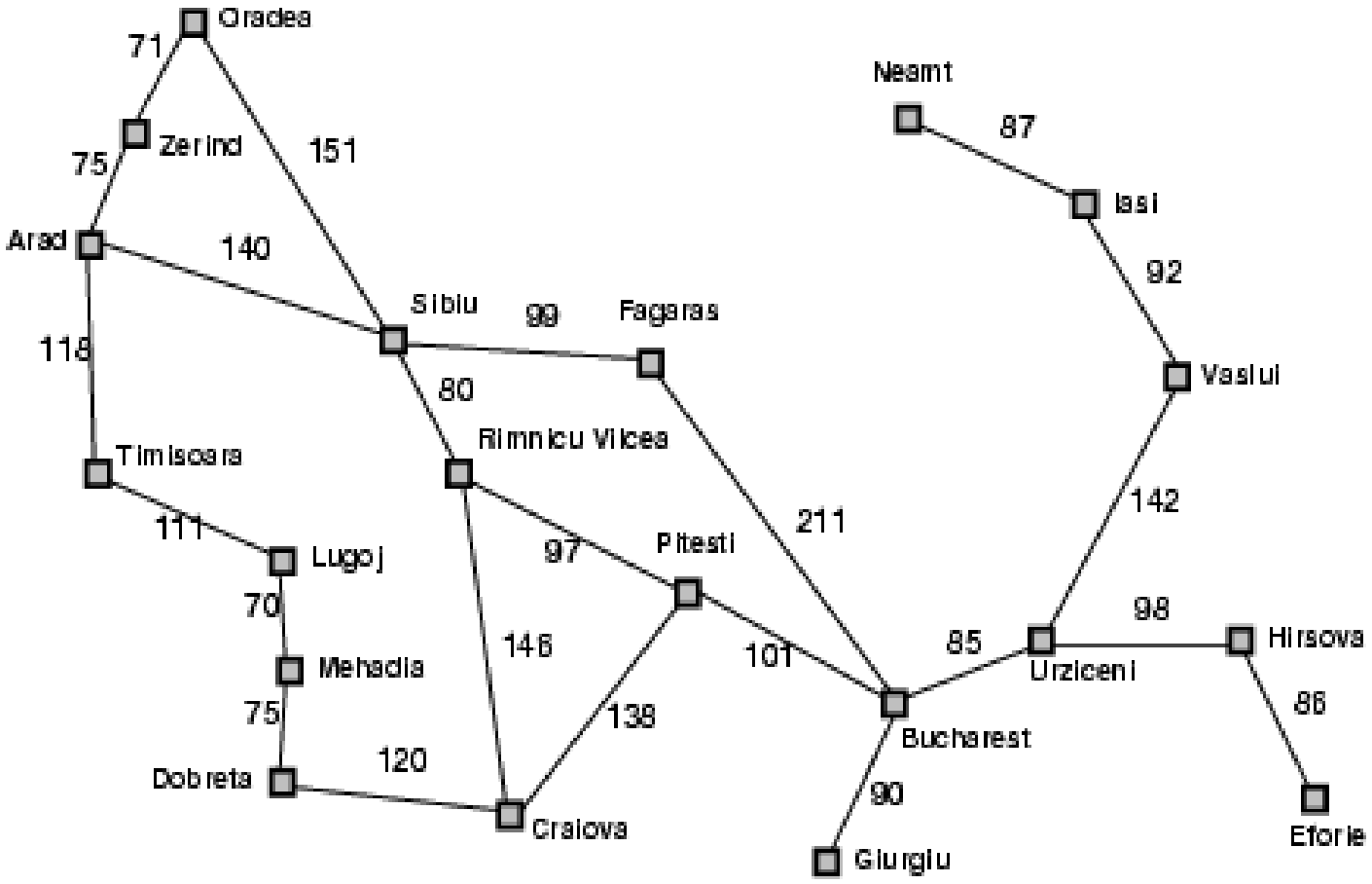
Introduction to Artificial Intelligence

Table of contents

INFORMED (HEURISTIC) SEARCH STRATEGIES

- Uses problem-specific knowledge beyond the definition of the problem itself.
- Uniform search used g(n) to choose from the nodes.(shortest cost).
- Informed search: a node is selected for expansion based on an evaluation function, f(n).
- h(n) = estimated cost of the cheapest path from the state at node *n* to a goal state.
- h(n) takes a node as input, but, unlike g(n), it depends only on the state at that node.)

From Arad to Bucharest with step costs in km: 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

INFORMED (HEURISTIC) SEARCH STRATEGIES

- Idea: use an evaluation function f(n) for each node
  a. estimate of "desirability"
  b. Expand most desirable unexpanded node

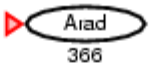
- Implementation:
  a. Order the nodes in fringe in decreasing order of desirability

- Special cases:
  a. greedy best-first search
  b. A* search

Greedy best-first search

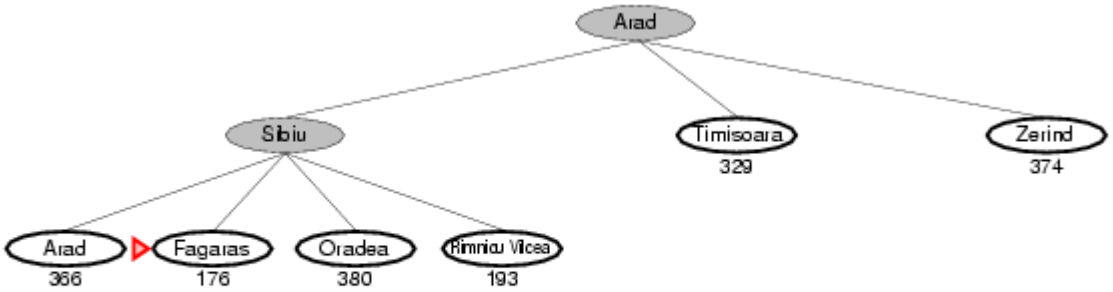
- Evaluation function f(n) = h(n) (heuristic)
- Estimation of cost from n to goal
- hSLD(n) = straight-line distance from n to Bucharest
- Greedy best-first search expands the node that appears to be closest to goal

Greedy best-first search simulation

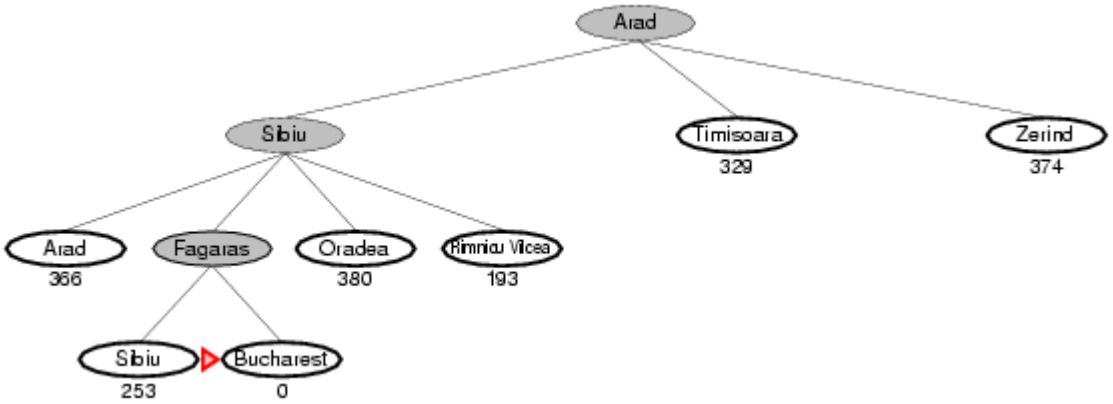


Greedy best-first search simulation

Greedy best-first search simulation



Greedy best-first search simulation



Greedy best-first search Evaluation

- The algorithm is called “greedy”—at each step since it tries to get as close to the goal as it can.
- Incomplete, because it may be fall in a dead end.

  can get stuck in loops, e.g., Iasi → Neamt → Iasi → Neamt →
- Time? $O(b^m)$, but a good heuristic can give dramatic improvement
- Space? $O(b^m)$ -- keeps all nodes in memory.
- Not optimal.

Greedy best-first search Evaluation

Demostration: p:179 – 228.

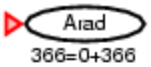
What is going wrong: p:229 – 231.

Demostration idea for A*: p:232 – 263.

A* search

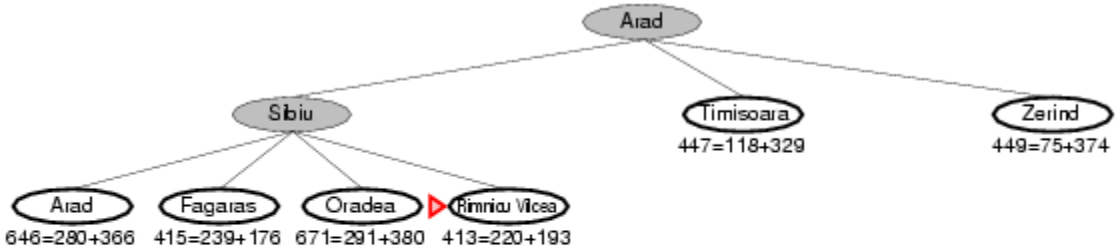
- Idea: avoid expanding paths that are already expensive
- Evaluation function f(n) = g(n) + h(n)
- g(n) = cost so far to reach n
- h(n) = estimated cost from n to goal
- f(n) = estimated total cost of path through n to goal

A* search simulation

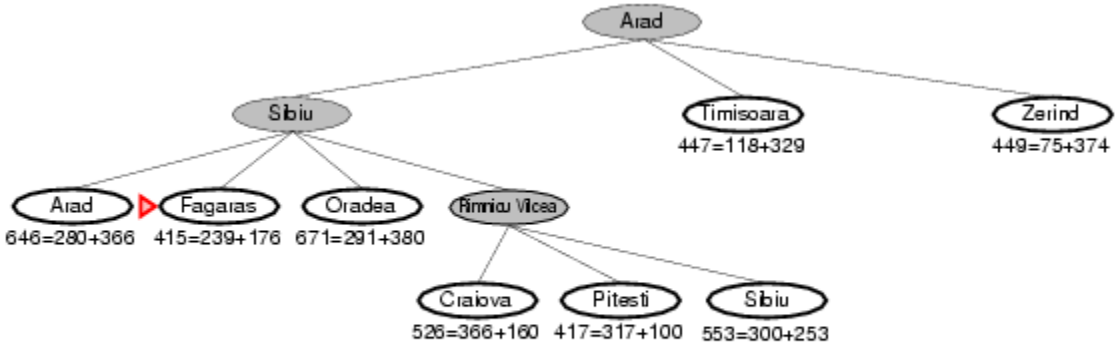


A* search simulation

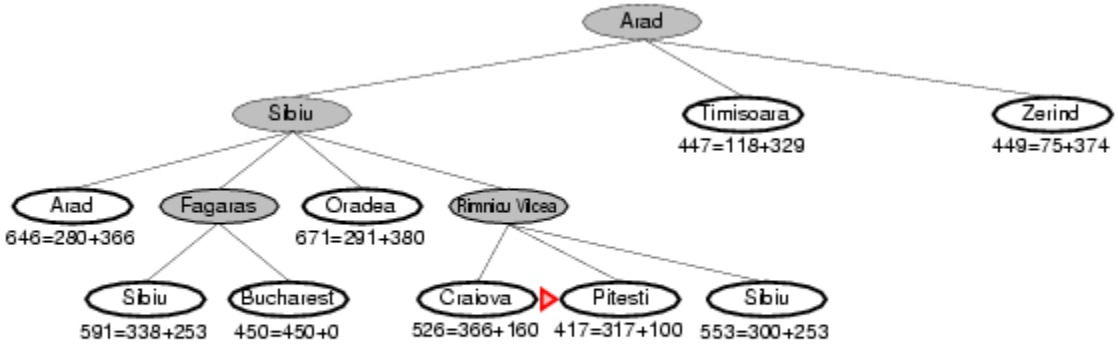
A* search simulation



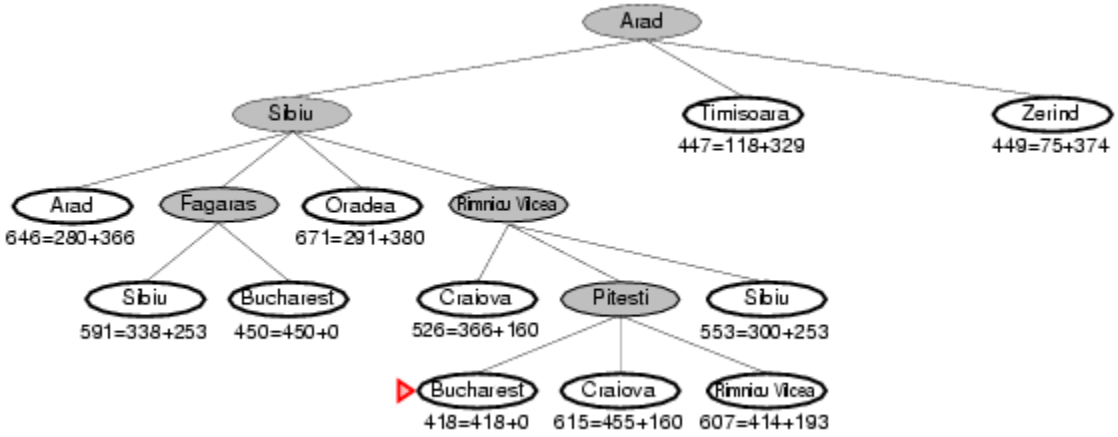
A* search simulation



A* search simulation



A* search simulation



A* search Evaluation

- Complete - (unless there are infinitely many nodes with $f \leq f(G)$)
- Time - Exponential
- Space - Keeps all nodes in memory
- Optimal.

Thank you for your attention!

Questions?