EC-350 AI and Decision Support Systems

Week 5

Informed Search Strategies

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NUST

Acknowledgement: Lecture slides material from Stuart Russell

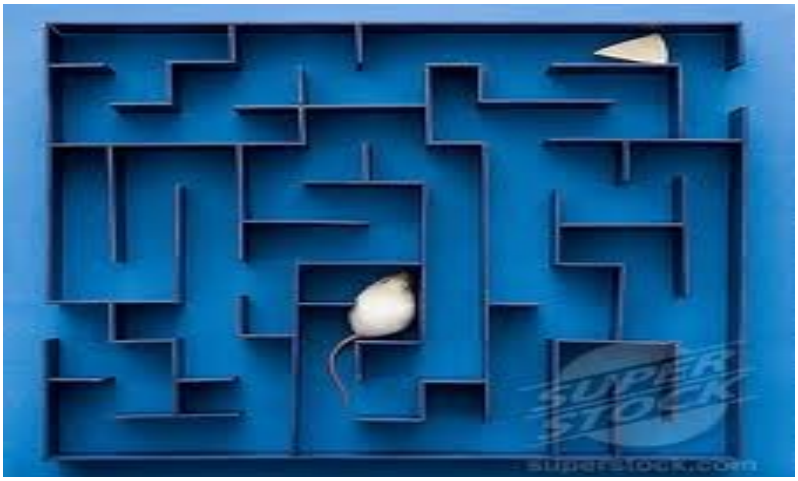
Informed (Heuristic) Searches

- One that uses problem specific knowledge beyond the definition of the problem itself
- Rather than trying all possible search paths, try to focus on paths that seems to be getting closer to goal using some kind of "guide"
- If not provided with a right guide, it may not give the correct solution

Heuristic

- Greek word which means find or discover
- Refers to estimated or experience based problem solving approaches, learning and discovery
  - *e.g., a physician, a car mechanic*

Mouse in a Maze



The strength of smell of cheese guides the mouse. The smell of cheese is heuristic for mouse.

Heuristic function

- Additional knowledge of the problem is imparted to the search algorithm.
- *h(n)* = estimated cost of the cheapest path from node n to goal
- If *n* is the goal node then *h(n)* = 0.
- Value of this function guide us whether we are close to our goal

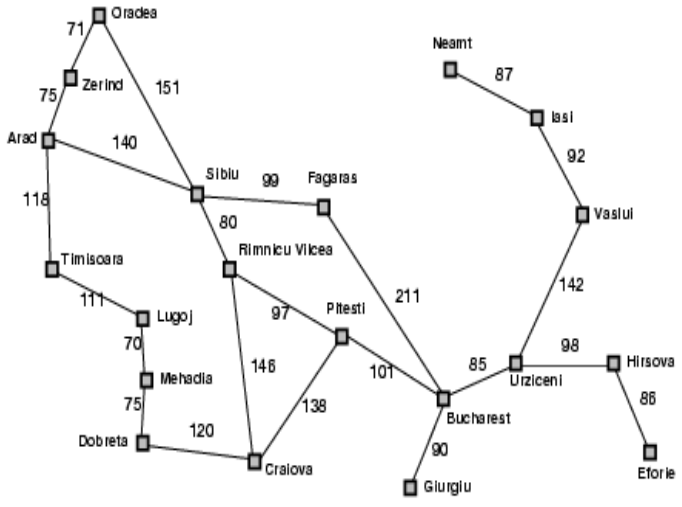
Best First Search

- The node selected for expansion based on an evaluation function *f(n)*.
- The node with the lowest evaluation (cost) is selected for expansion
- It can be implemented using a priority queue
- The fringe shall contain the *f* values in ascending order
- Special cases
  - *Greedy Best First Search*
  - *A* Search*

Greedy Best First Search

- Tries to expand a node which is closest to the goal
- $f(n) = h(n)$
- $f(n)$ = Estimated cost from n to goal
- $h_{SLD}(n)$ = the straight line distance from n to goal (Bucharest)
- $h_{SLD}(n)$ is an underestimate of the actual distance

Romania with Step Costs in km



Straight-line distance to Bucharest	
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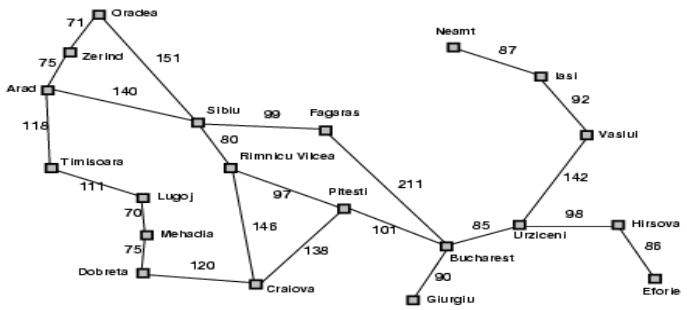
Greedy best-first search example



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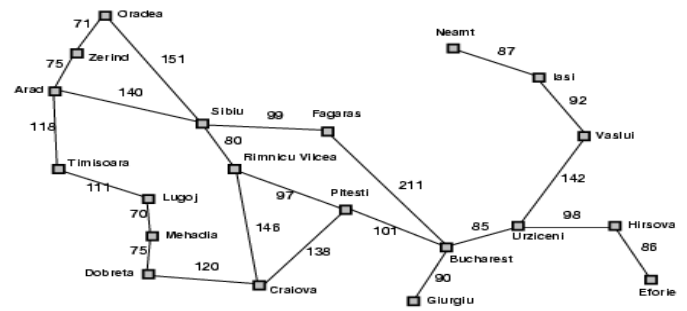

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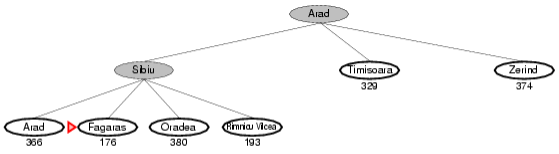

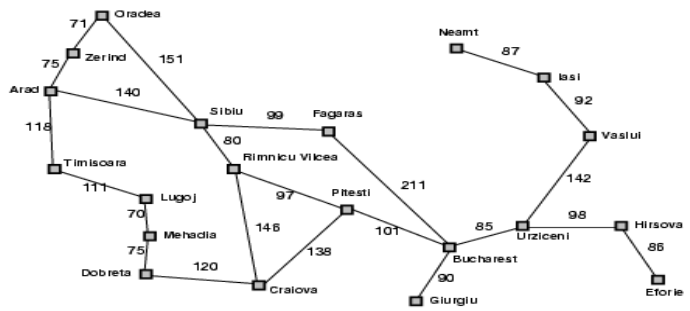

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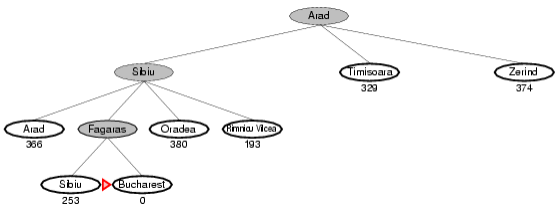

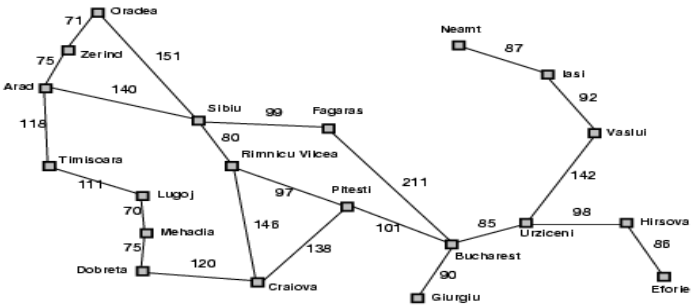

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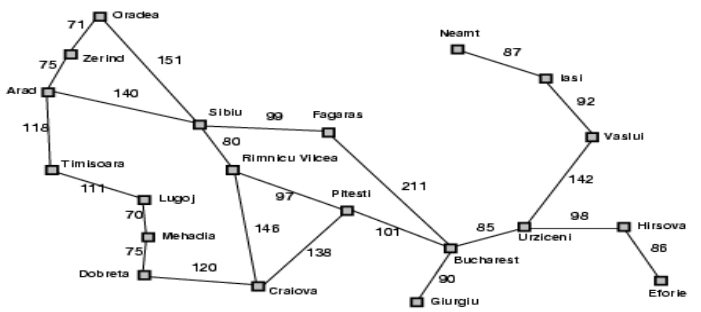
Properties of Greedy Best-First Search

- Resembles the depth-first search in a way that it prefers to follow a single path all the way to the goal
- Complete? No – 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
- Optimal? No

A* Search

- It evaluate nodes by introducing another function $g(n)$
- $g(n)$ = cost from start node to reach n
- $h(n)$ = estimated cost from n to goal
- $f(n)$ = estimated total cost of path through n to goal
- Evaluation function $f(n) = g(n) + h(n)$

A* search example



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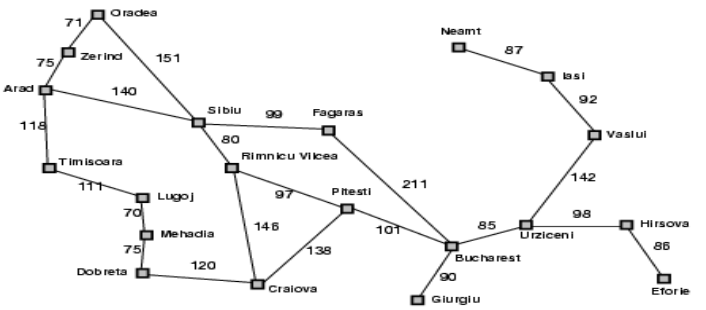

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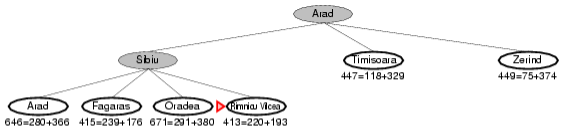

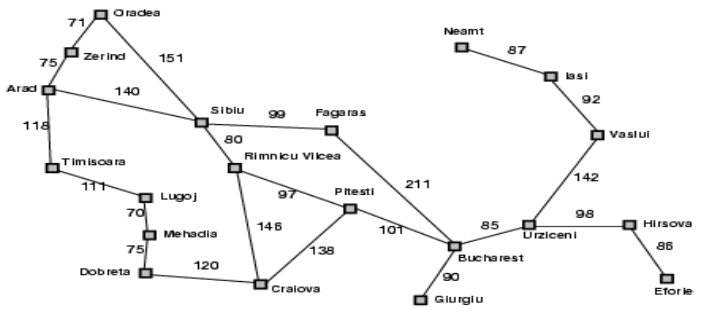

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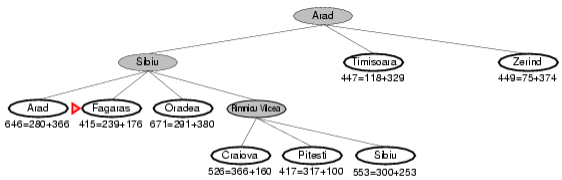

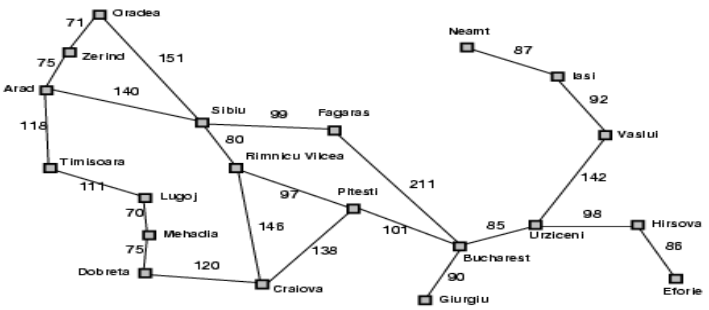

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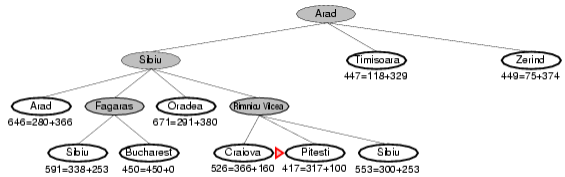

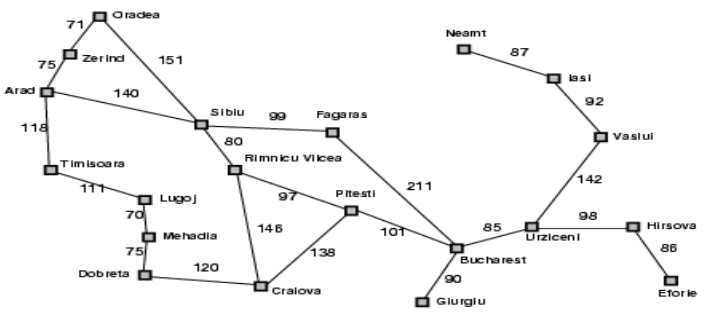

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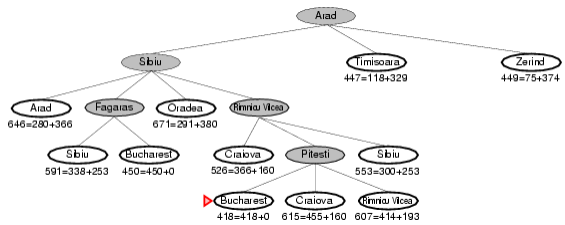

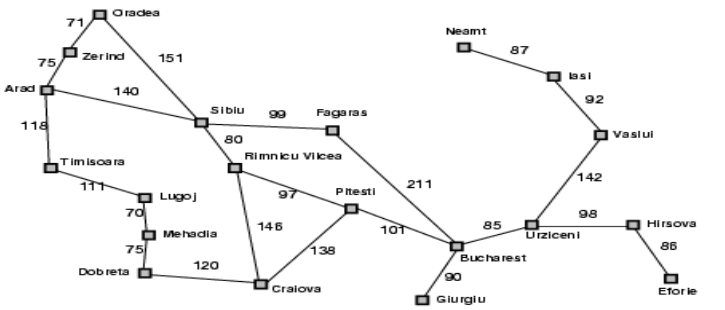

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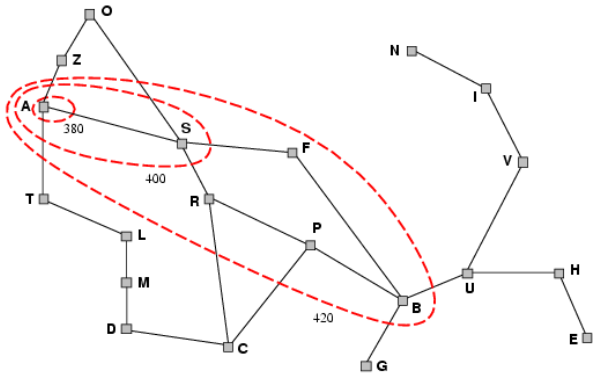
Properties of A*

- Complete? Yes (unless there are infinitely many nodes)
- Time? Exponential in *d*
- Space? $O(b^m)$ Keeps all nodes in memory
- Optimal? Yes
  - *Note: A* is also optimally efficient for a given heuristic: That is, no other optimal search algorithm is guaranteed to open fewer nodes*

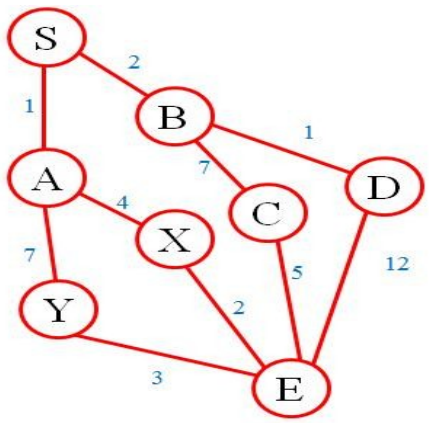
Optimality of A*

- A* expands nodes in order of increasing *f* value
- Gradually adds "*f*-contours" of nodes



Example

- Find path from S to E
- Using Greedy best first search
- Use A* search



- Values for h:

A:5, B:6, C:4, D:15, X:5, Y:8