

Informed search algorithms

Chapter 3

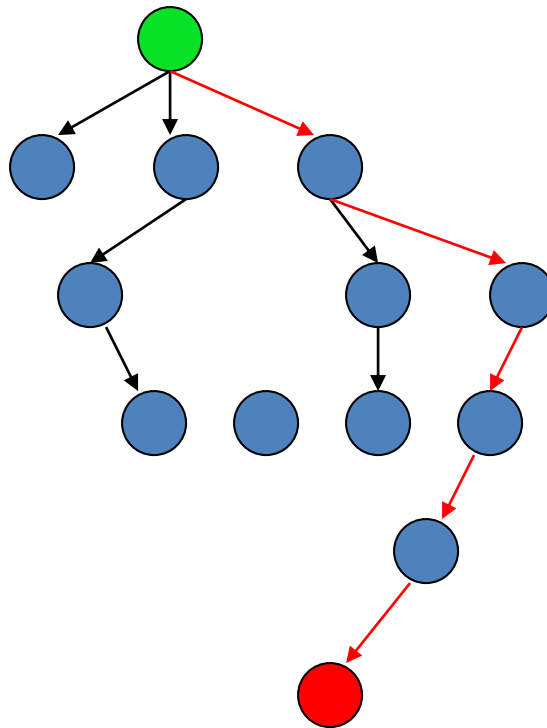
(Based on Slides by Stuart Russell,
Richard Korf, Subbarao Kambhampati,
and UW-AI faculty)

“Intuition, like the rays of the sun, acts only in an inflexibly straight line; it can guess right only on condition of never diverting its gaze; the freaks of chance disturb it.”

-- Honore de Balzac

Informed (Heuristic) Search

Idea: be **smart**
about what paths
to try.



Blind Search vs. Informed Search

- What's the difference?

- How do we formally specify this?

A node is selected for expansion based on an evaluation function that estimates cost to goal.

General Tree Search Paradigm

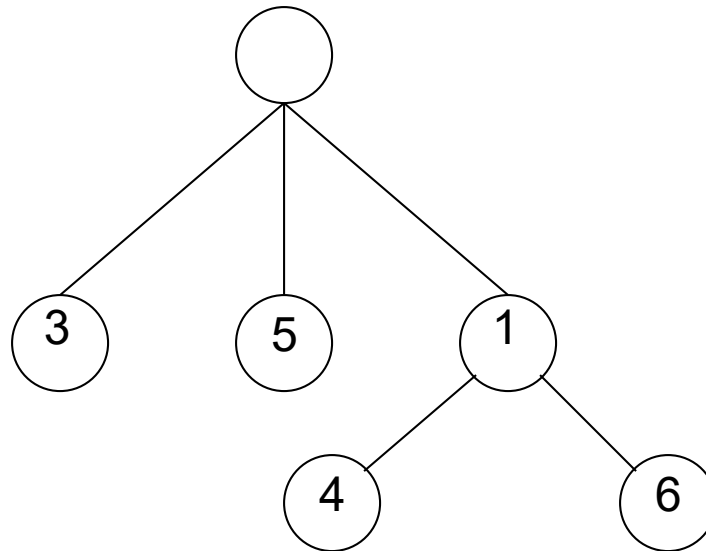
```
function tree-search(root-node)
  fringe ← successors(root-node)
  while ( notempty(fringe) )
    {node ← remove-first(fringe) //lowest f value
      state ← state(node)
      if goal-test(state) return solution(node)
      fringe ← insert-all(successors(node),fringe) }
  return failure
end tree-search
```

General Graph Search Paradigm

```
function tree-search(root-node)
  fringe ← successors(root-node)
  explored ← empty
  while ( notempty(fringe) )
    {node ← remove-first(fringe)
     state ← state(node)
     if goal-test(state) return solution(node)
     explored ← insert(node, explored)
     fringe ← insert-all(successors(node), fringe, if node not in explored)
    }
  return failure
end tree-search
```

Best-First Search

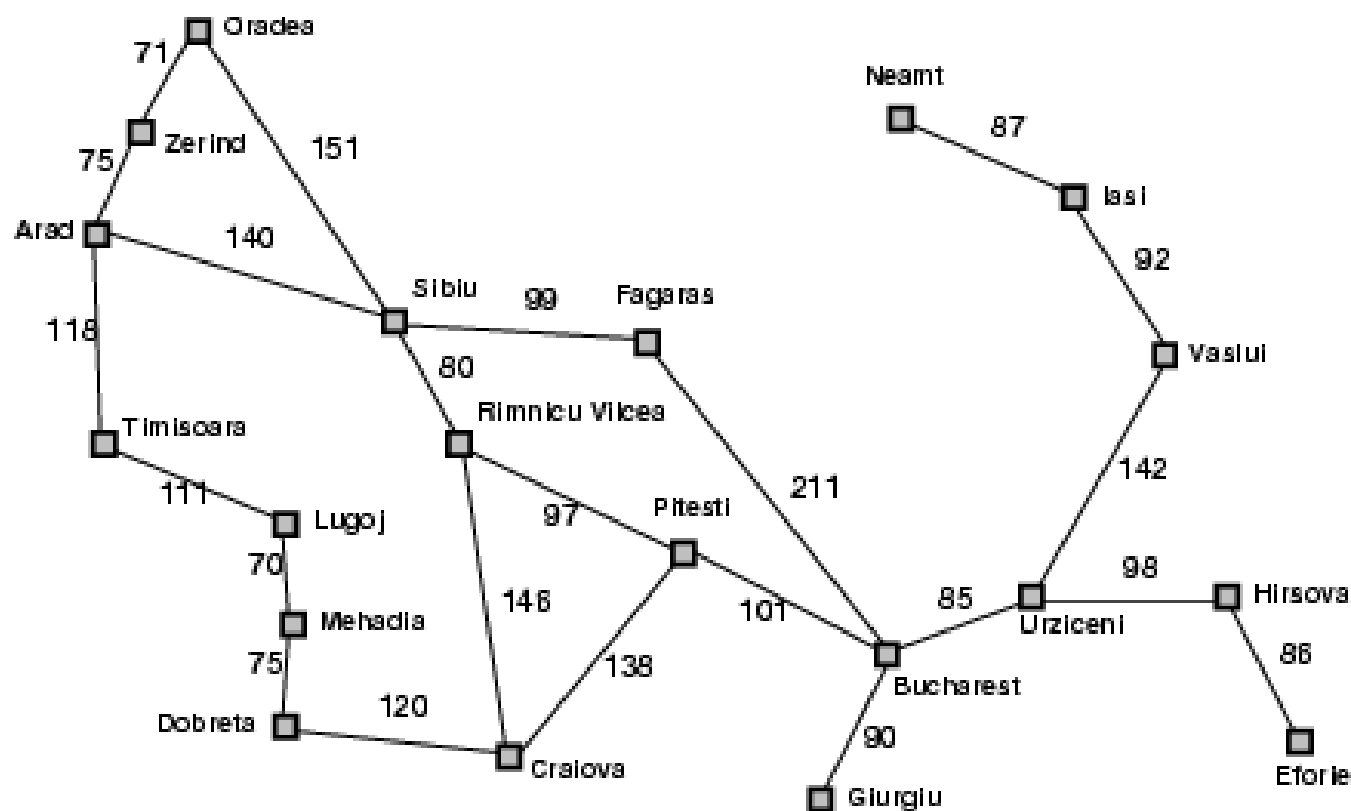
- Use an **evaluation function $f(n)$** for node n .
- Always choose the node from fringe that has the **lowest** f value.



Best-first search

- A search strategy is defined by picking the **order of node expansion**
- Idea: use an **evaluation function** $f(n)$ for each node
 - estimate of "desirability"
 - Expand most desirable unexpanded node
- Implementation:
Order the nodes in fringe in decreasing order of desirability
- Special cases:
 - greedy best-first search
 - A* search

Romania with step costs in km



Old (Uninformed) Friends

- Breadth First =
 - Best First
 - with $f(n) = \text{depth}(n)$
- Uniform cost search =
 - Best First
 - with $f(n) =$ the sum of edge costs from start to n $g(n)$

Greedy best-first search

- Evaluation function $f(n) = h(n)$ (**h**euristic function)
= estimate 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

Properties of greedy best-first search

- Complete?
 - No – can get stuck in loops, e.g., lasi \rightarrow Neamt \rightarrow lasi \rightarrow Neamt \rightarrow
- Time?
 - $O(b^m)$, but a good heuristic can give dramatic improvement
- Space?
 - $O(b^m)$ -- keeps all nodes in memory
- Optimal?
 - No