INFORMED SEARCH

Today

- Today
  - What is informed search?
  - A* search algorithm
  - Generating heuristics

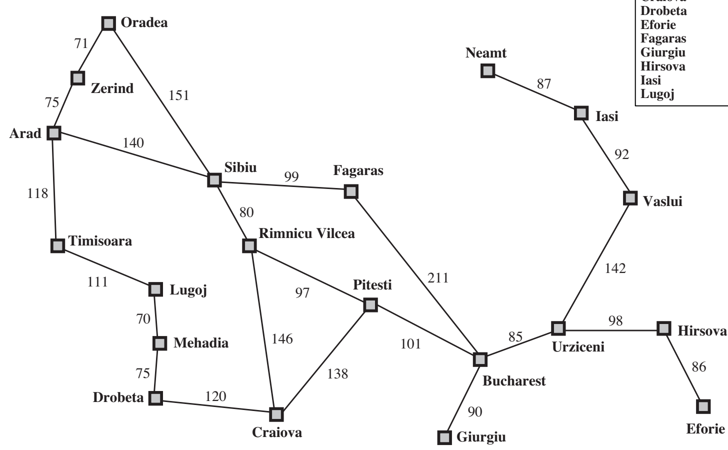
Informed Search

A^* search

- Developed in 1968 by Hart et al. as a principled framework for using heuristic information to find minimum cost paths
- Uses GraphSearch algorithm
- Frontier ordered by $f(n) = g(n) + h(n)$
- Must do goal test after popping off frontier
- Must include additional else-if statement

A* search example

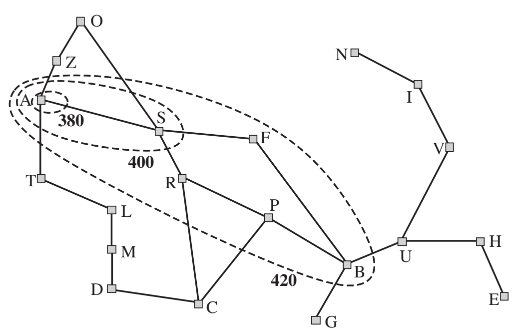
Arad	366	**Mehadia**	241
Bucharest	0	**Neamt**	234
Craiova	160	**Oradea**	380
Drobeta	242	**Pitesti**	100
Eforie	161	**Rimnicu Vilcea**	193
Fagaras	176	**Sibiu**	253
Giurgiu	77	**Timisoara**	329
Hirsova	151	**Urziceni**	80
Iasi	226	**Vaslui**	199
Lugoj	244	**Zerind**	374



A* search example

A^* search: conditions for optimality

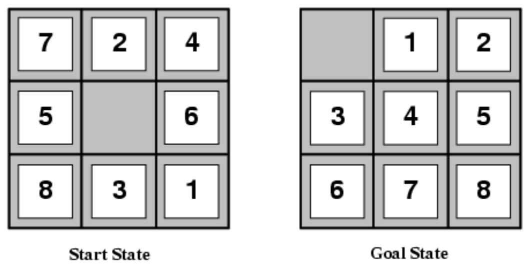
Properties of A^* search



- A* expands
  - all nodes with f(n) < C*
  - some nodes with f(n) = C*
  - no nodes with f(n) > C*
- Optimally efficient
- Complete if finite number of nodes with f(n) ≤ C*

Creating heuristic functions

- J. Pearl, "On the discovery and generation of certain heuristics", 1983.
- Solve relaxed versions of the problem

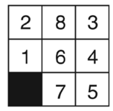
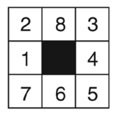
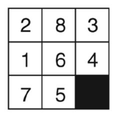


Creating heuristic functions

- A tile can move from square A to square B if
  - Rule 1: A is horizontally or vertically adjacent to B
  - Rule 2: B is blank

Creating heuristic functions

Goal

	Tiles out of place	Sum of distances out of place
	5	6
	3	4
	5	6

Creating heuristic functions

	Number nodes expanded for solution depth d		
	d = 4	d = 8	d= 12
IDS	112	6384	3.6 million
$A^*(h_1)$	13	39	227
$A^*(h_2)$	12	25	73

Creating heuristic functions

- Some heuristics are better than others
  - If $h_1(n) \leq h_2(n) \leq h^*(n)$ then h2 dominates h1
  - Manhattan distance dominates tiles out of place
  - A-star search using h_2 will never expand more nodes than A-star search using h_1
  - Can combine admissable heuristics using max

Informed search summary

- Uses additional information to guide search process
  - Greedy best-first uses estimate of cost to goal
  - A^* uses both cost from start + estimate to goal
  - A^* is optimal with admissable/consistent heuristic
- A good heuristic is the key!
  - Consider solutions to relaxed problems

Homework 2

- Have all you need to get started!
- You can use whichever heuristic you want.
- Determining if a puzzle can be solved:

parity(number of inversions + row dist. of blank tile)