Informed Search

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Informed Search

An informed search method uses domain knowledge related to the location of the goal state and it could help reach the goal state faster than uninformed search methods.

Domain knowledge is represented using some heuristic function $\boldsymbol{h(n)}$. It is a mathematical estimate for how far each state is from the goal.

$$\boldsymbol{h(n) = estimated\ cost\ of\ the\ cheapest\ path\ from\ the\ state\ at\ node\ n\ to\ the\ goal\ state}$$
$$\boldsymbol{= straight\ line\ distance\ from\ each\ node\ to\ the\ goal.}$$

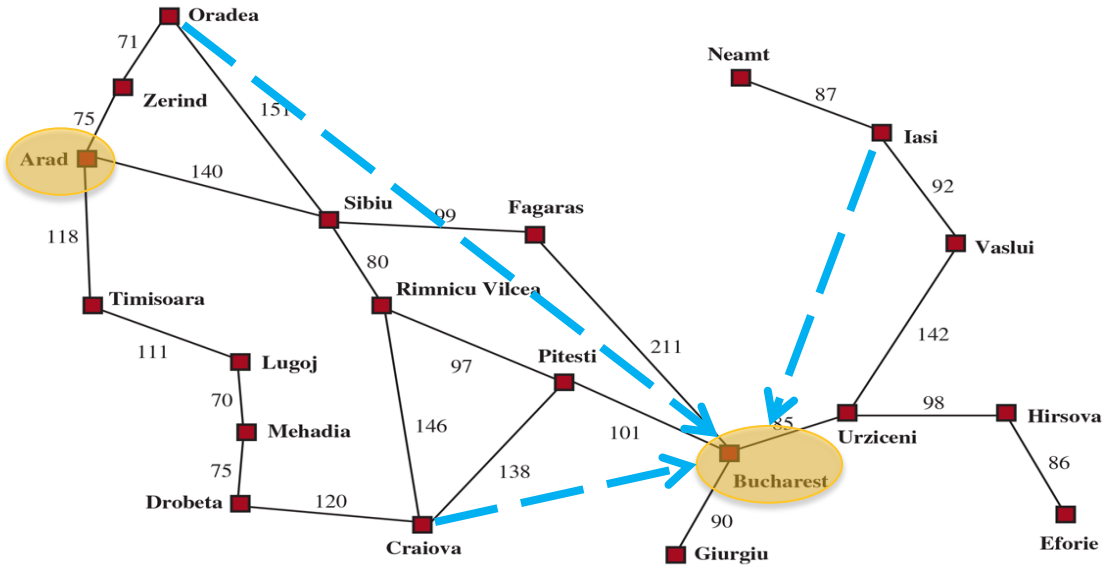

Fig 3.1, Russell & Norvig's Textbook

Informed Search

- Greedy Best-First Search
- A* (A-Star)
- Bidirectional Heuristic Search

Greedy Best-First Search

It expands the node with the lowest $h(n)$ first, as it appears to be closest to the goal state!

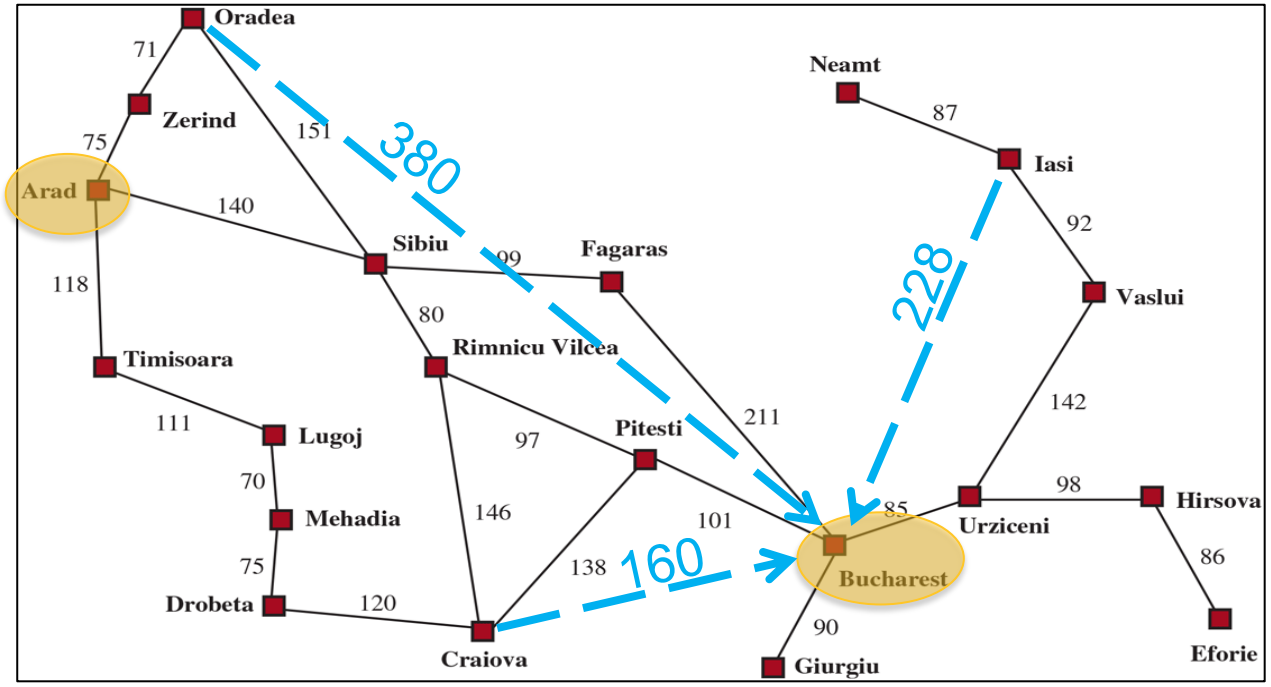

Fig 3.1, Russell & Norvig's Textbook

$h(n) = straight\ line\ distance\ from\ each\ city\ to\ goal\ (Bucharest)$

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

Fig 3.16, Russell & Norvig's Textbook

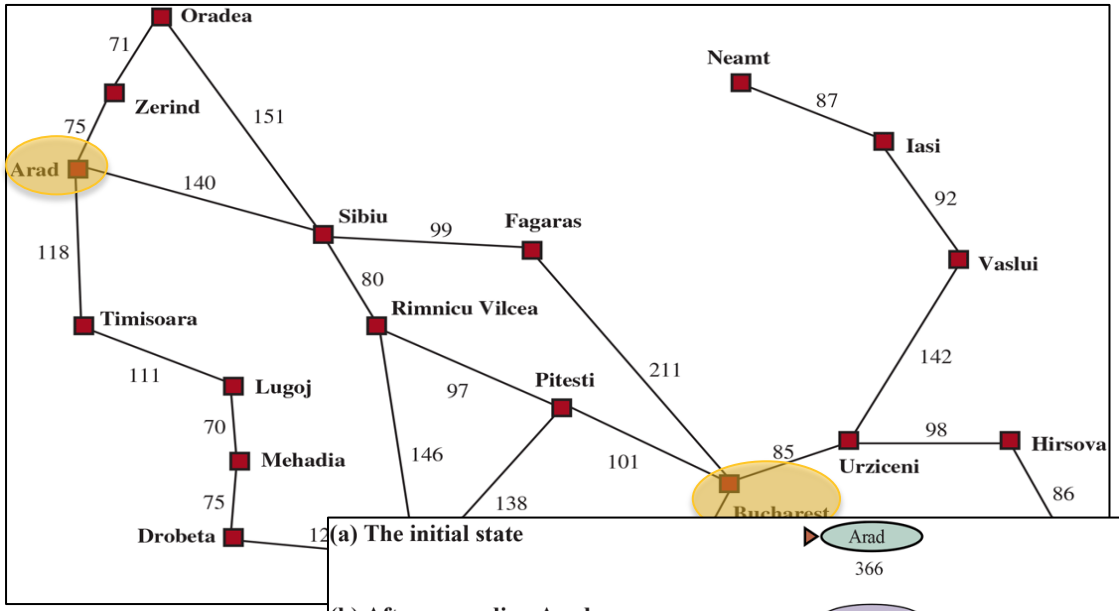

Fig 3.

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Fig 3.16, Russell & Norvig's Textbook

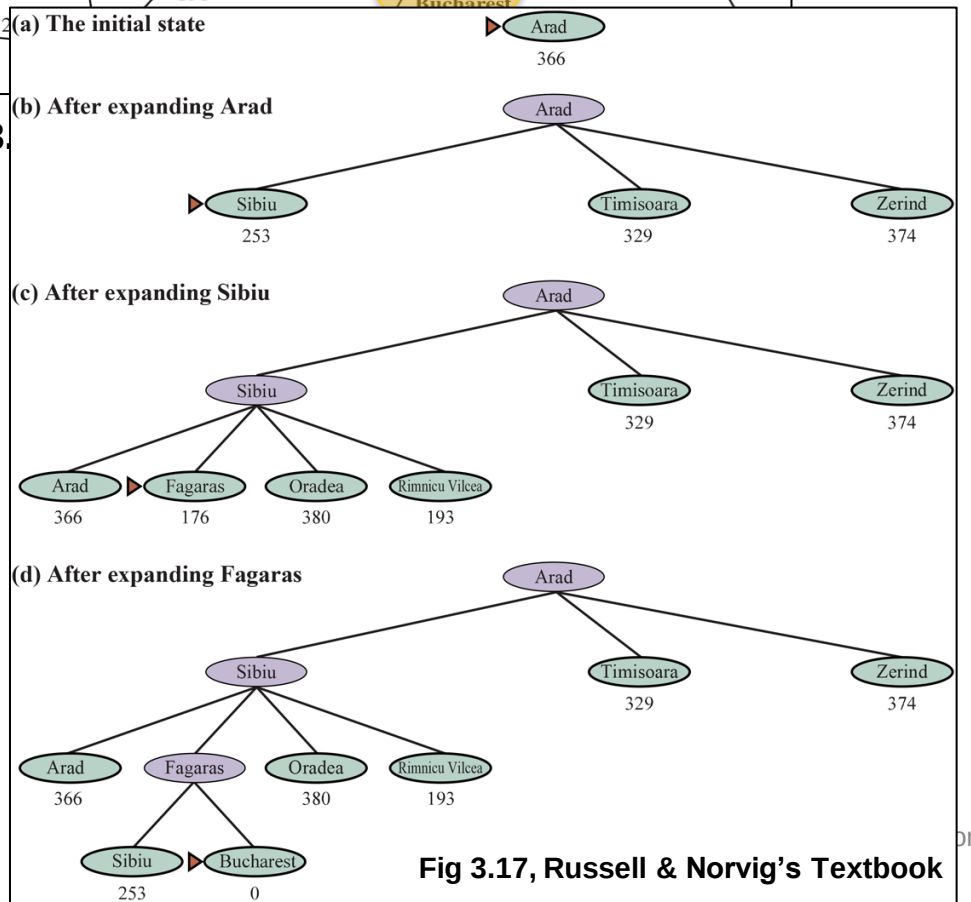

Fig 3.17, Russell & Norvig's Textbook

Not Cost Optimal ➔ Returned solution is not always the minimum-cost one. That's because the greedy approach does not look ahead. It only looks into the current step.

A* Search

It considers, not only how far each node is to the goal, but also the cost of reaching each node.

A is the most common informed search algorithm.*

Domain knowledge is represented using $f(n)$:

$$f(n) = g(n) + h(n)$$

$$g(n) = \textit{actual cost of reaching node n from initial state node}$$

$$h(n) = \textit{estimated cost of the cheapest path from the state at node n to the goal state}$$
$$= \textit{straight line distance from each node to the goal.}$$

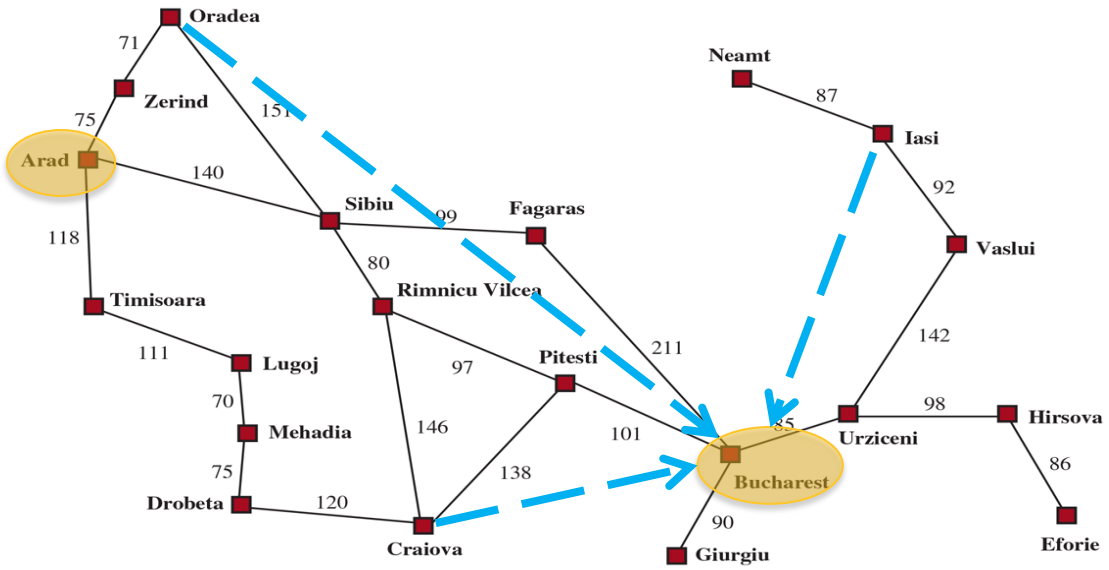

Fig 3.1, Russell & Norvig's Textbook

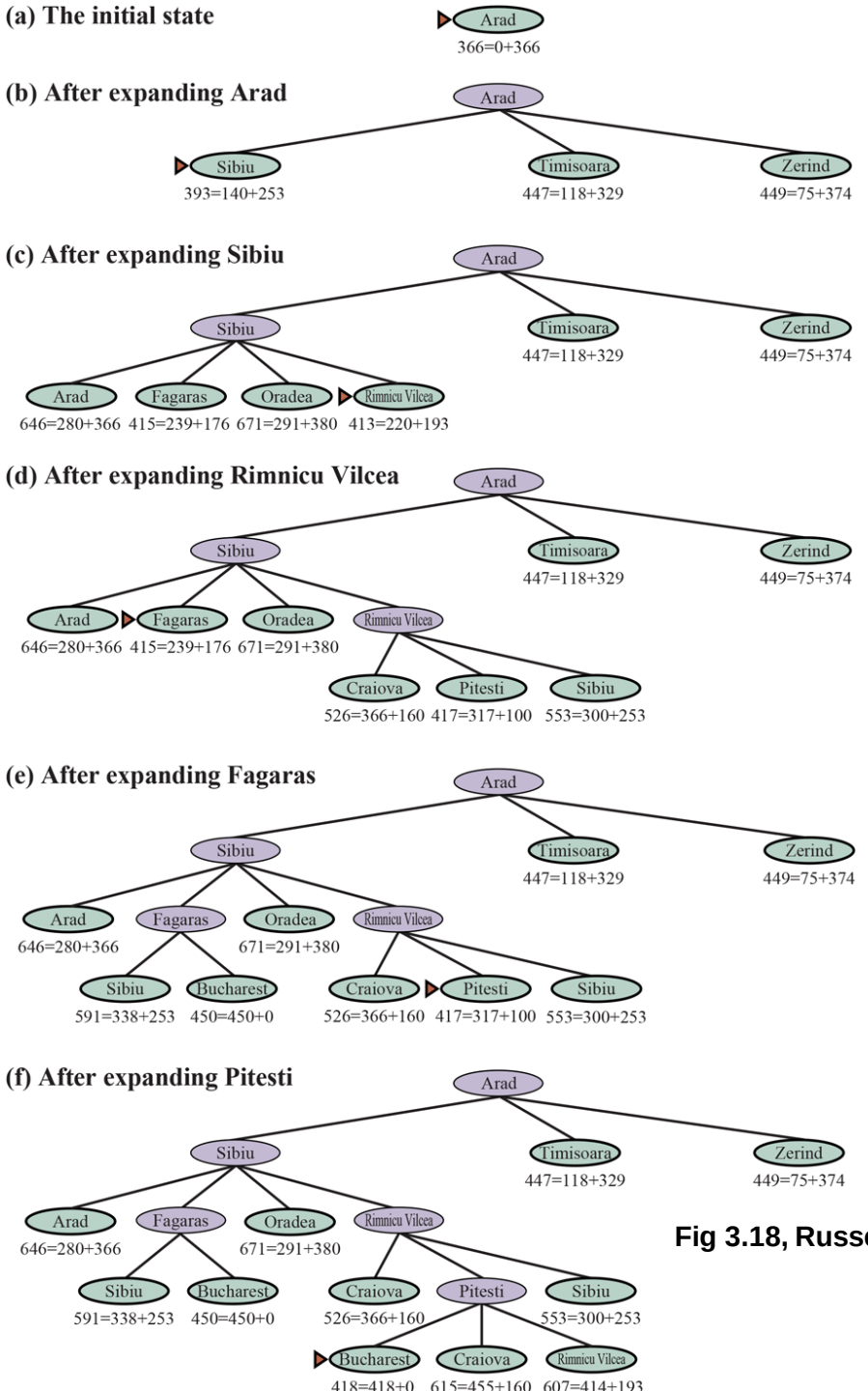

Fig 3.18, Russell & Norvig's Textbook

Cost Optimal if the heuristic is ***admissible*** (never overestimates cost) and ***consistent*** (triangle inequality holds) ➔ Returned solution is always the minimum-cost one.

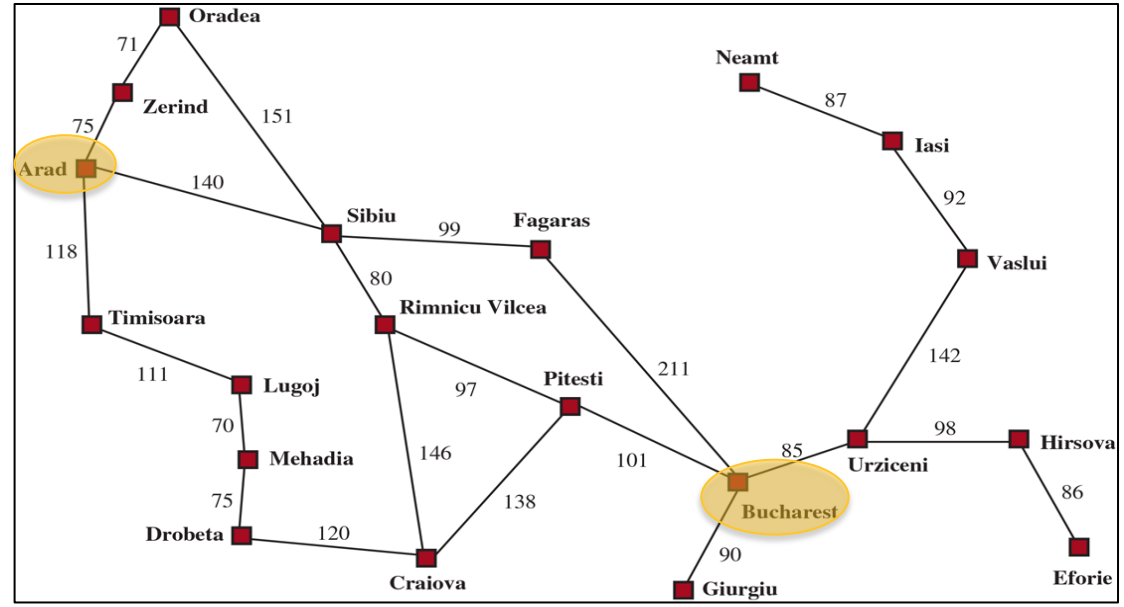

Fig 3.1, Russell & Norvig's Textbook

$$h(n) = \textit{straight line distance from each city to goal (Bucharest)}$$

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Bidirectional Heuristic Search

It considers searching from both directions:

- starting from the initial state forward
- starting from the goal state backward

There are many variations of bidirectional search.

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$$= \textit{straight line distance from each node to the goal.}$$

When a node is reached from both directions, a solution has been found! It is not necessarily the cost-optimal solution.

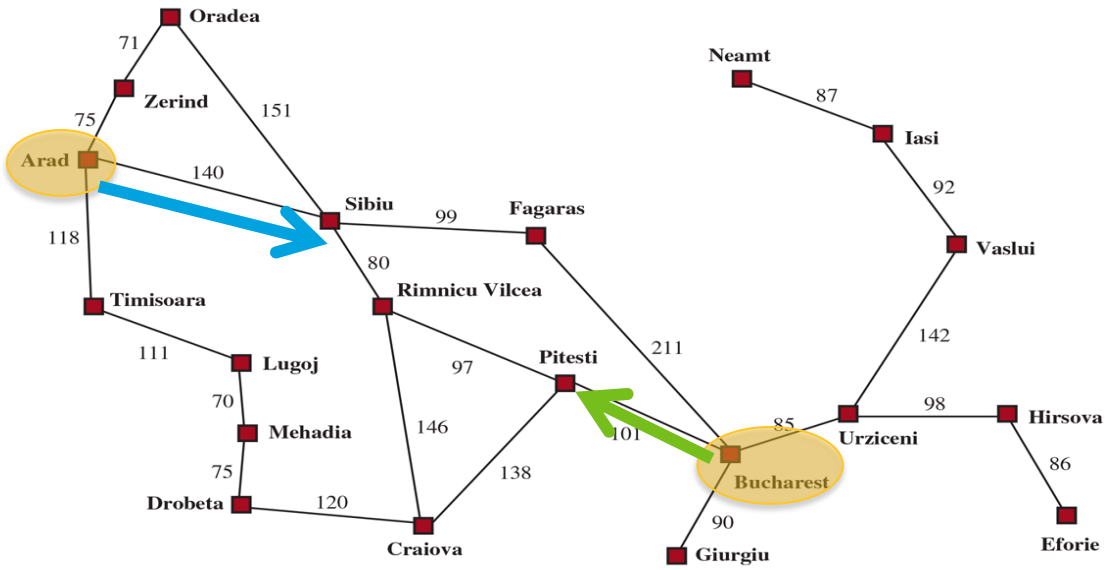
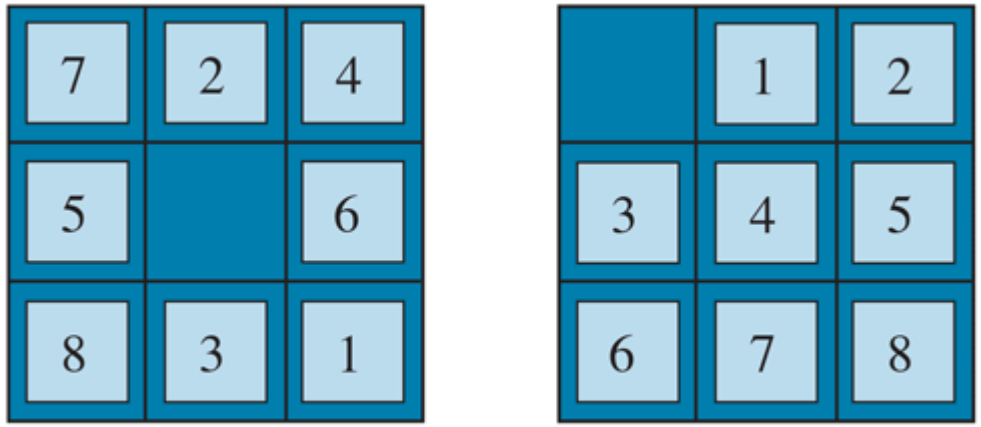


Fig 3.1, Russell & Norvig's Textbook

The performance of A* and its variants depends on the chosen heuristic function.

Fig 3.25, Russell & Norvig's Textbook



Start State Goal State

$h_1(n) = number\ of\ misplaced\ tiles$

$h_2(n) = sum\ of\ distances\ of\ tiles\ from\ their\ goalposition$

Which heuristic do you think is better ?
By "better" we mean leads to finding a solution faster