

# Introduction to Artificial Intelligence

## Unit # 4

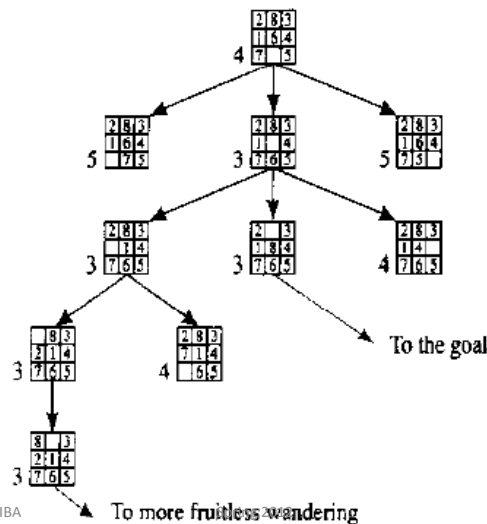
## Acknowledgement

- The slides of this lecture have been taken from the lecture slides of CS307 – “Introduction to Artificial Intelligence” by Dr. Sajjad Haider.

# Best-first search

- Best-first search expands the node that **appears** to be closest to goal
- Evaluation function  $f(n) = h(n)$  (**h**euristic)  
= estimate of cost from  $n$  to *goal*

## Best-first Search (Using Heuristic # 1)



1	2	3
8		4
7	6	5

Goal State

## Best-first Search (Using Heuristic # 2)

2	8	3
1	6	4
7		5

1	2	3
8		4
7	6	5

Goal State

- Expand the tree

Can you think of real-life  
applications of solving these  
puzzles?

## Applications

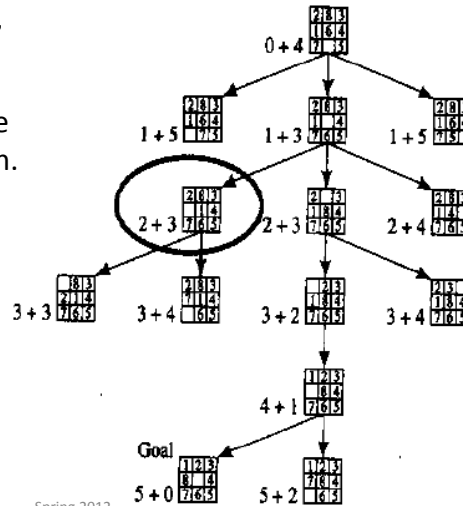
- Network Routing
- Transportation
- Shipment/Delivery
- Distribution
- ....

## 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 (Using Heuristic # 1)

- We add a “depth factor” to  $f$ :  $f(n) = g(n) + h(n)$ .
- $g(n)$  is an estimate of the “depth” of  $n$  in the graph.
- $h(n)$  is a heuristic evaluation of node  $n$ .



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## A\* Search (Using Heuristic # 2)

2	8	3
1	6	4
7		5

1	2	3
8		4
7	6	5

Goal State

- Expand the tree

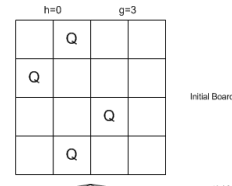
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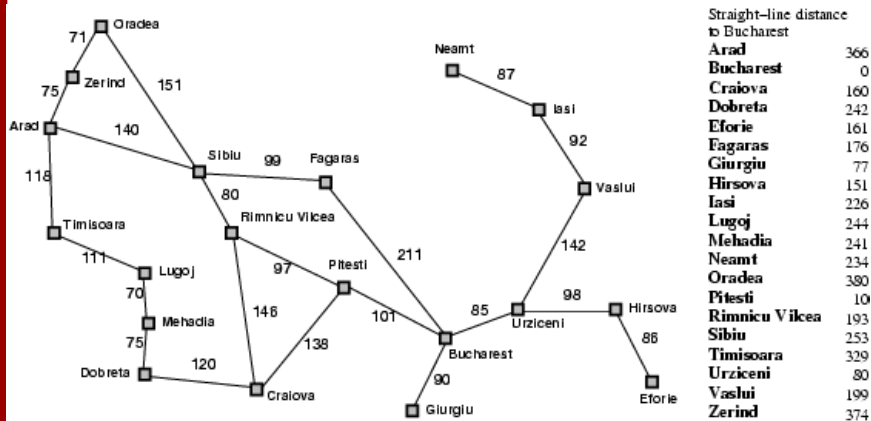
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## N-Queen

- The N-queens problem is a search problem where the desired result is an N by N board with N queens such that no queen threatens another
- The problem can be simplified by assigning a queen to each row on the board.
- Enumerating the search space is then defined as looking at the possible moves of queens horizontally.



## Romania with step costs in km (Russell & Norvig)



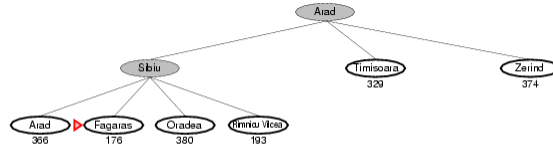
## Best-first search example



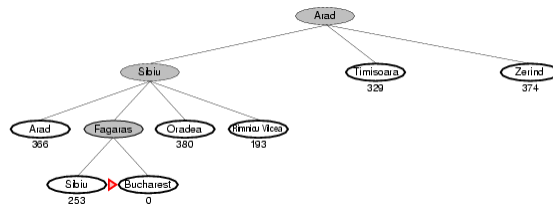
## Best-first search example



## Best-first search example



## Best-first search example





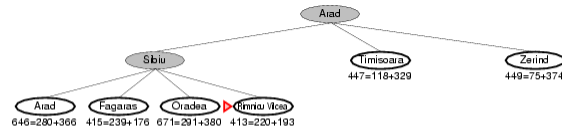
## A\* search example



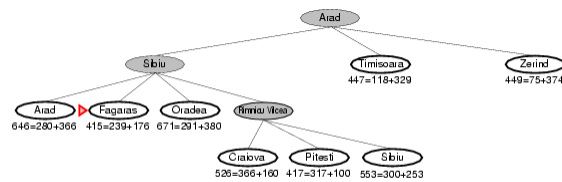
## A\* search example



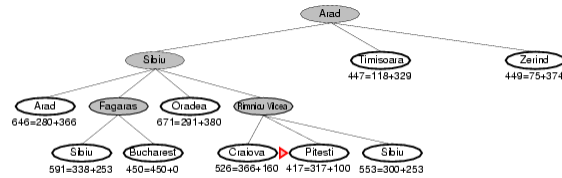
## A\* search example



## A\* search example



## A\* search example



## A\* search example

