Artificial Intelligence-Lab

Lab 04:	Search Problems in Artificial Intelligence Informed Searches

The objective of this is to understand the search problems in Artificial Intelligence using informed search i.e. A*, greedy best.

So far we have talked about the uninformed search algorithms which looked through search space for all possible solutions of the problem without having any additional knowledge about search space. But informed search algorithm **contains an array of knowledge** such as how far we are from the goal, path cost, how to reach to goal node, etc. This knowledge helps agents to explore less to the search space and find more efficiently the goal node.

The informed search algorithm is more useful for large search space. Informed search algorithm uses the idea of heuristic, so it is also called Heuristic search.

Heuristics function: Heuristic is a function which is used in Informed Search, and it finds the most promising path. It takes the current state of the agent as its input and produces the estimation of how close agent is from the goal. The heuristic method, however, might not always give the best solution, but it guaranteed to find a good solution in reasonable time. Heuristic function estimates how close a state is to the goal. It is represented by **h(n)**, and it calculates the **cost of an optimal path between the pair of states**. The value of the heuristic function is always positive.

Admissibility of the heuristic function is given as:

h(n) <= h*(n)

Here h(n) is heuristic cost, and h*(n) is the estimated cost. Hence heuristic cost should be less than or equal to the estimated cost.

Pure Heuristic Search:

Pure heuristic search is the simplest form of heuristic search algorithms. It expands nodes based on their heuristic value h(n). It maintains two lists, OPEN and CLOSED list. In the CLOSED list, it places those nodes which have already expanded and in the OPEN list, it places nodes which have yet not been expanded.

On each iteration, each node n with the lowest heuristic value is expanded and generates all its successors and n is placed to the closed list. The algorithm continues unit a goal state is found.

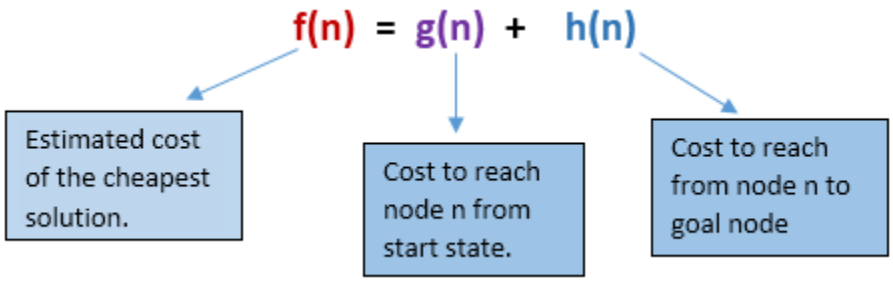
In the informed search we will discuss two main algorithms which are given below:

- Best First Search Algorithm (Greedy search)
- A* Search Algorithm

For this lab we will going to implement A* algorithm.

A* search is the most commonly known form of best-first search. It uses heuristic function h(n), and cost to reach the node n from the start state g(n). It has combined features of UCS and greedy best-first search, by which it solve the problem efficiently. A* search algorithm finds the shortest path through the search space using the heuristic function. This search algorithm expands less search tree and provides optimal result faster. A* algorithm is similar to UCS except that it uses g(n)+h(n) instead of g(n).

In A* search algorithm, we use search heuristic as well as the cost to reach the node. Hence we can combine both costs as following, and this sum is called as a **fitness number**.



Algorithm of A* search:

Step1: Place the starting node in the OPEN list.

Step 2: Check if the OPEN list is empty or not, if the list is empty then return failure and stops.

Step 3: Select the node from the OPEN list which has the smallest value of evaluation function (g+h), if node n is goal node then return success and stop, otherwise

Step 4: Expand node n and generate all of its successors, and put n into the closed list. For each successor n', check whether n' is already in the OPEN or CLOSED list, if not then compute evaluation function for n' and place into Open list.

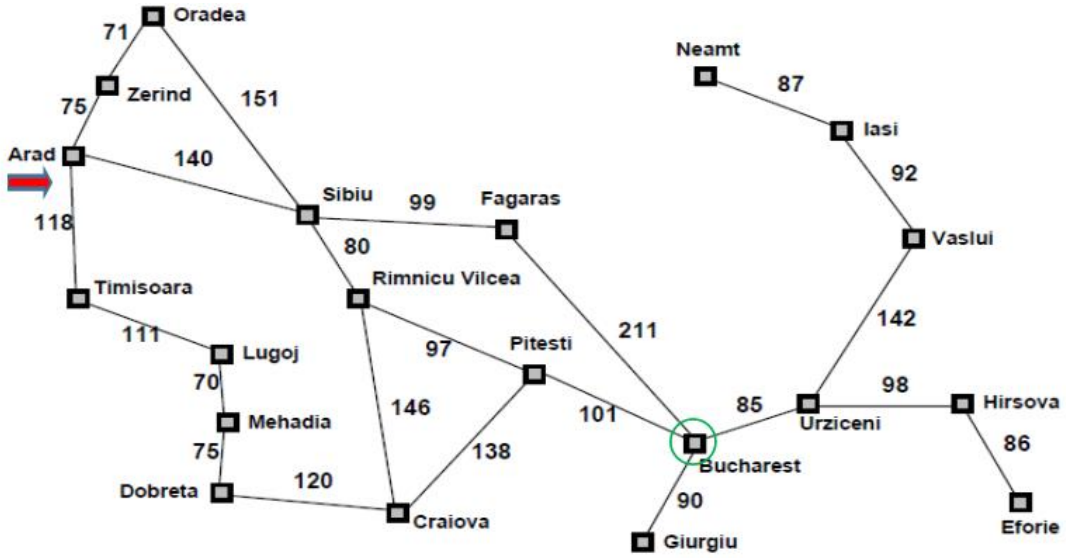
Step 5: Else if node n' is already in OPEN and CLOSED, then it should be attached to the back pointer which reflects the lowest g(n') value.

Step 6: Return to **Step 2**

Lab Task

Problem

Find an Optimal Path at lowest cost of time as well as path cost on **Map of Romania.**



Code Provided:

- Provided code file named A_Star.ipynb contains skeleton code which Connect the different cities of graph along with their cost
- **self.graph_dict** contains cost of each edge traversal of (u,v)

Tasks to Perform:

1**)** Create All Connections of Romania Map in Code with following Function

graph.connect(Arad, Zerind, 75)

2) Create and store all heuristics (Straight Line Distance To **Bucharest** in this case) Provided in Example in **Heuristics** Dictionary defined in code in following Fashion

heuristics['Arad'] = 366

3) Implement A-Star function on Graph (Map of Romania) to find optimal path from source to destination with the help of Heuristics provided.

4) Run the code given at end to see all paths and shortest path find by your A_Start

Output:

```
75 : Arad - Zerind
140 : Arad - Siblu
118 : Arad - Timisoara
71 : Zerind - Oradea
75 : Zerind - Arad
151 : Oradea - Siblu
71 : Oradea - Zerind
99 : Siblu - Fugaras
80 : Siblu - Rimnicu Vilcea
140 : Siblu - Arad
151 : Siblu - Oradea
97 : Rimnicu Vilcea - Pitesti
80 : Rimnicu Vilcea - Siblu
146 : Rimnicu Vilcea - Craiova
111 : Timisoara - Lugoj
118 : Timisoara - Arad
70 : Lugoj - Mehadia
111 : Lugoj - Timisoara
75 : Mehadia - Dobreta
70 : Mehadia - Lugoj
120 : Dobreta - Craiova
75 : Dobreta - Mehadia
146 : Craiova - Rimnicu Vilcea
138 : Craiova - Pitesti
120 : Craiova - Dobreta
211 : Fugaras - Bucharest
99 : Fugaras - Siblu
101 : Pitesti - Bucharest
97 : Pitesti - Rimnicu Vilcea
138 : Pitesti - Craiova
90 : Giurgiu - Bucharest
211 : Bucharest - Fugaras
101 : Bucharest - Pitesti
90 : Bucharest - Giurgiu
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FINAL COST -> 418
PATH:  ['Arad', 'Siblu', 'Rimnicu Vilcea', 'Pitesti', 'Bucharest']
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Submission Format:

File Naming	Roll_No_Lab_04.ipynb
Lab Report	Roll_No_Lab_04.pdf

Submission	On teams

Note: If you do not follow the submission guideline result in zero for the particular lab.