Lab 8: Problem Solving using Informed Search

Preamble

A* (pronounced A-star) is a widely used algorithm for graph traversal. It is the process of finding a path between multiple nodes. It is very popular due to its accuracy and performance. Peter Hart, Nils Nilsson, and Bertram Raphael from Stanford Research Institute published the algorithm in 1968. It is a best first search algorithm and formulated in terms of weighted graphs. At each iteration A* has to decide on which path to extend. The A* selects the path that minimizes

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

$n;$ $next$ $node$ on the $path;$ $g(n) = path\ cost\ from\ start\ node\ to\ n, h(n)$
$= Heuristic\ function\ that\ estimates\ cost\ of\ cheapest\ cost\ from\ n\ to\ goal\ state;$

A* terminates when the path it chooses to extend is a path from start to goal or there are no paths to extend. Heuristic function $h(n)$ is specific to the problem and it is admissible. Typical implementation of A* uses priority queue.

Exercise:

a.) Given below are the initial and final states of an instance of 8-puzzle problem. Write a program to solve the 8-puzzle problem using the A* search. The program should be generic for any configuration of initial and goal states. Test your program with following configuration of initial and goal states.

Initial state

	5	2
1	8	3
4	7	6

Goal state

1	2	3
4	5	6
7	8	

Answer the following questions

1. Suggest appropriate heuristic functions?
2. Prove that they are admissible?
3. Compare the heuristic function in terms of number of nodes which are expanded from initial to goal state.
4. Compute the total cost computed by various heuristics function during graph traversal from Initial to final state.

5. Compare the results of A* search with BFS and DFS on following points
   a. Number of nodes expanded.
   b. Memory requirements
   c. Optimality of the search
   d. Completeness
6. Is A* able to find goal state starting from any initial state?

Exercise 2: (Optional)

Let us consider a variant of PacMan problem where goal is to locate the food and there are no ghosts. You may use a matrix to represent the Maze as shown below where character P represents the Pac Man, character '*' represents food , character '#' represents wall and character '-' represents free space for movement. Pac Man cannot move when there is wall.

#	#	#	#	#	#	#	#
#	-	-	-	-	-	-	#
#	-	#	#	#	-	-	#
#	-	#	*	#	-	-	#
#	-	-	-	#	-	-	#
#	-	#	#	#	-	-	#
#	P	-	-	-	-	-	#
#	#	#	#	#	#	#	#

Maze size : 8 x 8

Initial state : Position of Pac man : (7 , 2)

Goal state : Position of Food : (4, 4)

Next Possible move for Pac Man :

{(7,3), (6,2)}

a) Identify the paths from initial to goal state using A* algorithms.

b.) Write a program to help the Pac Man to locate food using the A* search functions algorithms.

References :

1. https://en.wikipedia.org/wiki/A*_search_algorithm