Lab #5: Informed search (cont.)

The main aim of this lab is to solve the problem of an 8-puzzle using **Greedy Best First Search** and **A* Search**.

Deadline:23h59 06/11/2023.

For given states of the 8-puzzle problem as follows:

1	5	3
4		8
7	2	6

Initial State

1	2	3
4	5	6
7	8	

Goal State

Two measures can be used for computing heuristics:

- h_1: The number of tiles out of place
- h_2: Sum of distances of tiles from goal positions, using Manhattan distance

The computation of these measures is described in the following table:

Tile	**Index in Initial State**	**Index in Goal State**	**h_1**	**h_2**
1	(1,1)	(1,1)	0	0
2	(3,2)	(1,2)	1	2
3	(1,3)	(1,3)	0	0
4	(2,1)	(2,1)	0	0
5	(1,2)	(2,2)	1	1
6	(3,3)	(2,3)	1	1
7	(3,1)	(3,1)	0	0
8	(2,3)	(3,2)	1	2
SUM			4	6

The costs used in Greedy, and A* are as follows:

- **Greedy best-first search**: expand the node that is closest to the goal

$$\mathbf{f(n) = h(n)}$$

- **A* search**: combine UCS and Greedy (minimizing the total estimated solution cost)

$$\mathbf{f(n) = g(n) + h(n)}$$

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The main aim of the algorithm for solving 8 puzzles is based on moving white tile (**UP, DOWN, LEFT, RIGHT**) to get new successors. Then using the measure f(n) = g(n) + h(n) (as in A* algorithm) or f(n) = h(n) (in the case of Greedy Best First Search) to choose the next state -with the lowest f(n) to expand. The procedure is repeated until f(n) = 0.

In this lab, the initial state and the goal state are represented in **PuzzleMap.txt** and **PuzzleGoalState.txt.** The code for loading these states was implemented in **Puzzle** class.

Notice that: Ignore moves that return you to the previous state

Task 1. Implement the following methods in **Puzzle** class:

```
//Move white tile UP, DOWN, LEFT, RIGHT. Remember to check when a tile is
//out of the map.
public Node moveTile(Node currentState, char operator) {...}

public int computeH1(Node currentState) {...}

public int computeH2(Node currentState) {...}
```

The frontier is a PriorityQueue with comparator implementations defined in PuzzleUtils class:

```
PriorityQueue<Node> frontier = new
PriorityQueue<Node>(PuzzleUtils.HeuristicComparatorByH);
```

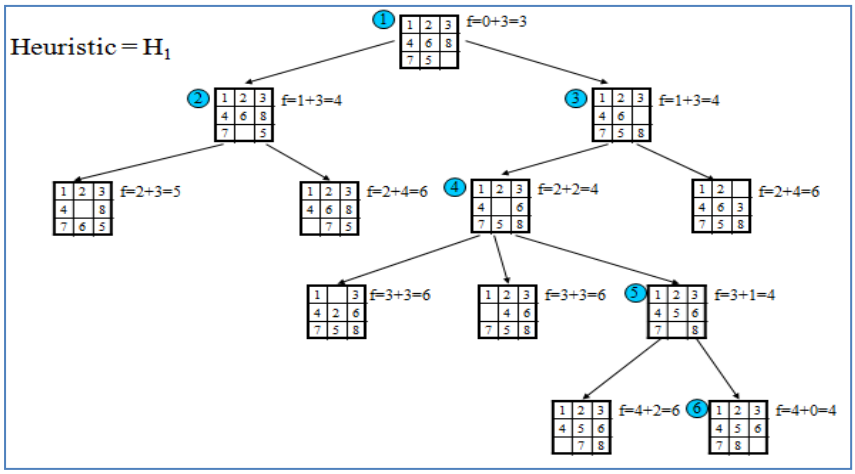
The pseudo-code based on graph search that can be used**:**

function GRAPH-SEARCH(*problem*) **returns** a solution, or failure
  initialize the frontier using the initial state of *problem*
  initialize the explored set to be empty
  loop do
    if the frontier is empty **then return** failure
    choose a leaf node and remove it from the frontier
    if the node contains a goal state **then return** the corresponding solution
    add the node to the explored set
    expand the chosen node, adding the resulting nodes to the frontier
      only if not in the frontier or explored set

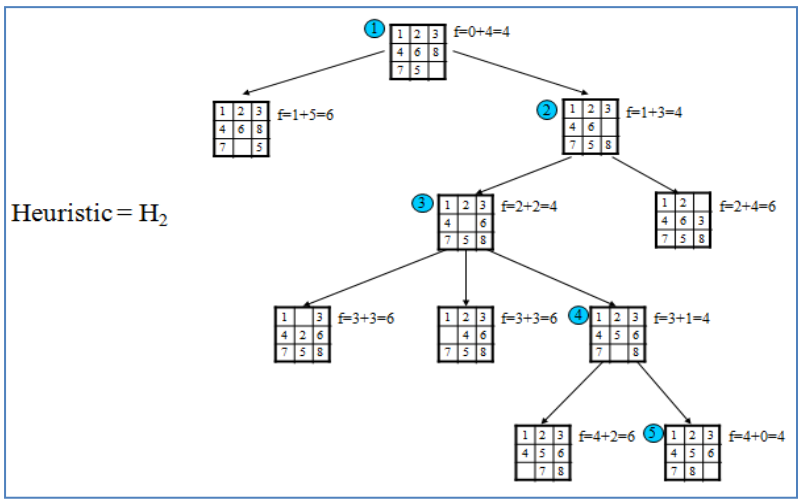
Task 2. Solve the 8 puzzle problem using **Greedy Best First Search** with *h1 or h2* introduced in the previous section (implements **IPuzzleAlgo** interface).

Task 3. Solve the 8 puzzle problem using A* Search with ***h(n)***, ***g(n)*** as the number of steps traversed from the **Start** node to get to the current node, function ***h*** could be ***h1*** or ***h2*** as introduced in the previous section.

Case 1: f(n) = g(n) + h1(n)



Case 2: f(n) = g(n) + h2(n)



Task 4. (Advanced) Apply other algorithms to solve the 8-puzzle problem such as *DFS*, *BFS*, and *local search (Hill climbing)* beside *Greedy best-first search* and *A** algorithms (implemented in the previous tasks). Then, present a comparison of selected algorithms in terms of **running time**, and **the number of steps** to reach the goal state from the initial state.