United International University
CSI 342: Artificial Intelligence Laboratory, Section: A, Spring 2018

# Assignment 1
# Informed Search Strategies

## Assignment Information

- **Objective:** Solving the classical *8-puzzle problem* with informed search strategies.
- **Due Date and Time:** 11:10 AM, 20th March, 2018.
- **Submission:** Submit **only the source codes** through the corresponding ELMS course page.
- **Inquiries:** Mail your queries to jamshed@cse.uiu.ac.bd, or post them at the corresponding Facebook group thread for the assignment.
- **Reference Texts:** *Artificial Intelligence: A Modern Approach (3rd Edition) by Russel and Norvig.*

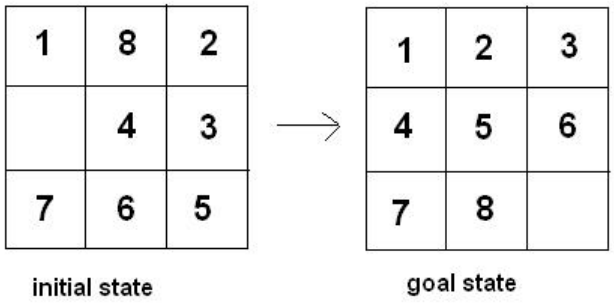
  The following subsections should be referred to for the theoretical basis.

  - A* search (at 4.1)
  - Heuristic Functions (4.2)

## Assignment Details

1. **Problem Description:** The 8-puzzle is a sliding puzzle that consists of a frame of numbered square tiles in random order with one tile missing. The objective of the problem is to place the tiles in order by making sliding moves that use the empty space.

   An example of the problem is as follows.

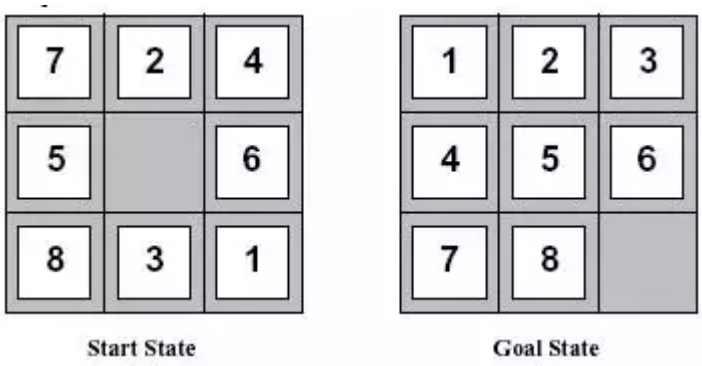



2. **Primary Constraint:** Only the empty tile can be moved around the board.
3. **State Representation:** You may represent a state of the problem as just the configuration of the puzzle board at that state using a 2-dimensional array. You may denote the empty tile with 0.
4. **Initial State:** The initial board state should be generated randomly.
5. **Goal Predicate:** The goal board configuration is the one presented at the example at 1.
6. **Actions:** There can be at most 4 actions possible at a state of the board (the 4 possible movements of the empty tile). Assume the cost of each of the actions to be 1.

7. **Heuristics Functions:**

   - **Manhattan Distance:** The Manhattan distance for a tile at a board configuration is the distance between the tile's position at that board and its goal position, considering only horizontal and vertical movements. The total Manhattan distance heuristic for that board configuration is the sum of the Manhattan distances of all the tiles (not counting the blank).
   - **Misplaced Tiles:** Number of tiles that are not in the final position (not counting the blank).
   - **Tiles Out of Row and Column:** Number of tiles out of row + number of tiles out of column (not counting the blank).

   For example, consider the following initial and goal board states.




   For the start state, considering the tiles at the initial state sequentially: $7, 2, 4, \ldots$ :

   - Manhattan distance $= 2 + 0 + 3 + 1 + 0 + 1 + 3 + 4 = 14$.
   - Number of misplaced tiles $= 6$ (every tile except 2 and 6).
   - Number of tiles out of row and column $= 1 + 0 + 2 + 1 + 0 + 1 + 2 + 2 = 9$.

8. **Inputs:** There's no input to this problem, as the initial board state should be generated randomly.

9. **Outputs:** The complete solution path description constructed by an $A^*$ strategy is to be output for the random initial board.
   *NB:* There are 9! possible different initial states. Exactly half of them has no solutions.

10. **Bonus Tasks:**

    - Besides the initial board configuration, generate the goal board configuration randomly too; and implement a solver that transforms the random initial configuration to the random goal configuration.
    - Generalize the solver for any dimensions, except for just $3 \times 3$.