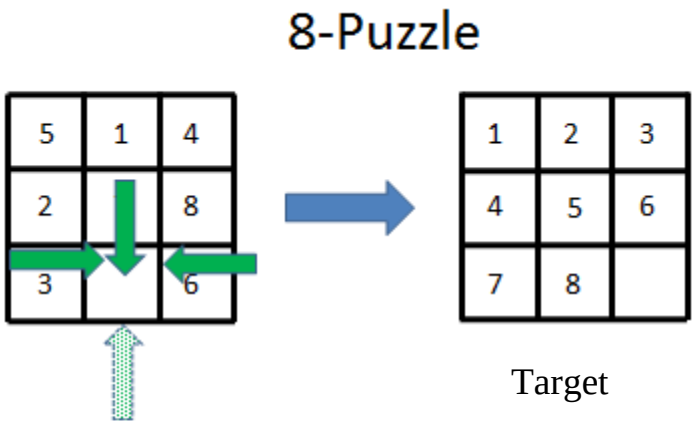
COM1005: Machines and Intelligence
Semester 2: Experiments with AI Techniques
Assignment 1 2017
The 8-puzzle and A*

This assignment carries 12.5% of the assessment for COM1005.

1. The 8-puzzle problem



Rearrange the tiles to the desired pattern by sliding adjacent tiles into the space.

In this assignment you will implement a solution to the 8-puzzle by state-space search, using the search engine described in the lectures, and experiment with search strategies.

2. What you must do

2.1 Implementing 8-puzzle search

In the **search2** folder in the Java download on the COM1005/2007 MOLE site is the code for the simple search engine and for Jugs problems.

Note that you may have to recompile the code for your version of Java.

- Following the instructions in section 2.9 of the lecture notes, write classes to implement a state-space search for 8-puzzle problems.
- You should not need to change the code for the search engine except perhaps to control how much it prints as a search proceeds, and to stop the search after a given number of iterations (in an 8-puzzle the search tree can become large).
- Test your implementation with **breadth-first** searches for the following initial configurations and the same goal state as above:

1		3
4	2	6
7	5	8

P1

4	1	3
7	2	5
	8	6

P2

2	3	6
1	5	8
4	7	

P3

2.2 Experimenting with Search Strategies

The search engine in the **search4** folder implements the following search strategies:

- Breadth-first
- Depth-first
- Branch-and-Bound
- A*

In this case we won't consider Depth-first and Branch-and-Bound is the same as Breadth-first because we have uniform costs. We'll compare Breadth-first with 2 variants of A*.

- Adapt your 8-puzzle classes for search4. This means that your 8-puzzle state must now include a local cost **g** (always 1 for the 8-puzzle), and an estimated remaining cost **estRemCost**, which is used by A* and must be an underestimate of the true cost.
- Code two alternative methods in your 8-puzzle state class for computing **estRemCost, assuming that the target pattern is always the same, as above.**
  - **Hamming** distance, which is the number of tiles out of place.
  - **Manhattan** distance, which is the sum of the moves each tile needs to make before it is in its correct position.

7	2	4
5	1	8
3	6	

Hamming: 7 (all out of place except 2)
Manhattan: 16 (2+0+4+3+1+2+2+2)

- In search4, the class **EpuzzGen** will generate random 8-puzzles for you. Usage:

```
EpuzzGen gen = new EpuzzGen(12345); //create 8 puzzle generator
```

The parameter ('12345' there) is a random seed which you choose. You can miss it out but if you include it you will be able to try the same set of puzzles with different strategies

```
int[][] puzz=gen.puzzGen(6); //generate a puzzle
```

The puzzle is returned at a 3 by 3 matrix. The empty tile is 0.

The parameter ('6' there) allows you some control over the degree of difficulty of the problem – i.e. how much search will be required to find the solution, on average. The higher it is, the more difficult. Don't go below 6. 12 is hard.

You can call **puzzGen** as many times as you like. Each time it will give you a new puzzle.

Only 50% of 8-puzzles have a solution, but there is a way of deciding whether a given puzzle is solvable. That check is coded into **puzzGen** so all the puzzles it generates are solvable .

- You won't need the usual printouts in a search, so there is a variant of runSearch, **runSearchE**, which does no printing and returns the efficiency of the search as a float. Failure returns 0.

The experiment is to compare the efficiency of breadth-first, A*(Hamming) and A* (Manhattan) over a number of puzzles. You are testing the hypothesis that

A is more efficient than breath-first, and the efficiency gain is greater the more difficult the problem and the closer the estimates are to the true cost.*

CAUTION: 8-puzzle search trees can be surprisingly large. You may have to wait a long time for a search to conclude.

3. What to hand in

- **Commented code**, ready to run. Give your code for 2.1 and 2.2 separately
- **Testing**: each method you write should be separately tested. **You should not run any searches until you have done this.** The tests themselves should cover every logical case and test results should be commented, e.g. **sameState**: returns true for 2 different instances with identical states, returns false for 2 instances with different states.
- **Experimental Results** which address the hypothesis above. Consider how best to present results: tables, graphs, bar charts? Discuss your results – what do they show? Could you improve on the A* estimates?

4. How to hand in

By MOLE

Deadline Monday of Week 7, 20th March, midnight.

5. Mark Scheme

Basic Implementation

8-puzzle state class	35%	of the credit for this assignment
8-puzzle search class	5%	
Solutions to P1, P2, P3	10%	

Experiments

Modifications to classes	20%
Design of Experiments	10%
Presentation of results	15%
Discussion	5%

For programming, around 60% of the credit is for the quality of the code, 20% for documentation and 20% for testing.