CS 579 – Planning
Final Exam – Due 11:59 pm, May 12, 2004

Consider the 8-puzzle game (you can move the empty tile around, thereby changing the position of the numbers).

1	2	8
5		6
4	3	7

Start State

	1	2
3	4	5
6	7	8

Goal State

Do the following:

1. Representing the game, with the start and goal states as depicted in the above picture, as a planning problem. Use the following vocabularies:
   a. **At(X,I,J)**: the tile number X is at the I^{th} column and J^{th} row where (0,0) is the lower left corner and (3,3) is the top right corner; Use 0 for the empty tile;
   b. **Left**: the empty tile moves to the left;
   c. **Right**: the empty tile moves to the right;
   d. **Up**: the empty tile moves up;
   e. **Down**: the empty tile moves down;
   f. Additional ones if you need.

2. A frequently used heuristic function for solving this problem – as search problem – is called **the Manhattan distance** function. Let us denote this function by *h.* It is the sum of the distances of the tiles from their goal positions. The distance of a tile to its goal position is the sum of the horizontal and vertical distances. For example, the distance of the tile number 1 to its goal is 1; 4 is 2; 3 is 2; etc. The value of *h* for the start state is 1 + 1 + 2 + 2 + 2 + 3 + 2 + 2 + 1 = 15.

   Construct the search tree for this problem after 8 expansions. In your construction, us the Manhattan distance heuristic function and A* algorithm.

3. Suppose that you were told that a good way to solve the problem is to select the move that reduces the function *h* at every step. Represent this knowledge as a temporal logic formula. You might introduce *defined formulas* to make the representation easier.

   Demonstrate the use of this formula by the TLPlan system by executing the loop in the TLPlan algorithm three times.

4. Let α be the formula that you develop in question 3. Do you think that α is a good control formula in that it helps us to select the action that needs to be done at every step?

5. What is the difference between using α (question 3 & 4) and using h (question 2) in solving the problem?

The following question is not related to the above four problems.

6. Write a paragraph detailing the difficulties you meet while working on the project. How did you overcome them?