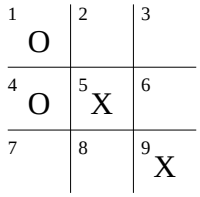
Student ID: _____

Graduate Comprehensive Exam: Artificial Intelligence (Fall 2000)

Answer all questions on the exam. You may use the back for additional space. Total: 100 points. Good Luck.

1. (30 pts) Tic-tac-toe



   (a) Describe an evaluation function for a state/position in tic-tac-toe.

   (b) Player X moves next. Draw a three-ply game tree (two moves for X and one for O), moves are considered in the order of the square number (indicated in the upper left corner of each square).

   (c) Use your evaluation function and perform alpha-beta pruning on the game tree. Indicate which nodes (if any) in the game tree need not be explored, and what is the next "best" move for Player X.

2. (40 pts) For the following 8-puzzle problem:

Initial Configuration

8	1	5
2		7
4	6	3

Final Configuration

1	2	3
8		4
7	6	5

   (a) Describe and explain an admissible heuristic for the problem.

   (b) Describe a cost function from the start state to the current state during a search for the problem.

   (c) Using your answers above, perform the following search algorithms up to the first five **visited** states and indicate their order of visitation.

      i. uniform-cost (branch and bound) search

      ii. A*

   (d) How many possible states are there in this problem? Explain.

   (e) What is the maximum branching factor for a state-space search in this problem? Explain.

3. (30 pts) Given the following operators:

   - $Move(x, y, z)$ [Move block x from block y to block z]
     - Precondition: $On(x, y), Clear(x), Clear(z)$
     - Effect: $On(x, z), Clear(y), \neg On(x, y), \neg Clear(z)$
   - $MoveToTable(x, y)$ [Move block x from block y to Table]
     - Precondition: $On(x, y), Clear(x)$
     - Effect: $On(x, Table), Clear(y), \neg On(x, y)$
   - $MoveFromTable(x, z)$ [Move block x from Table to block z]
     - Precondition: $On(x, Table), Clear(x), Clear(z)$
     - Effect: $On(x, z), \neg On(x, Table), \neg Clear(z)$

   and this initial condition:

$$On(A, C), On(C, Table), On(D, B), On(B, Table), Clear(A), Clear(D)$$

   develop a plan to reach this goal:

$$On(A, B), On(B, C)$$

   (a) show your steps in detail how to develop a plan

   (b) show the final plan