Grad. Comp. Exam: Artificial Intelligence (Fall 2011) Student ID: ____________________

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

1. (25 pts) On inference rules:
   (a) Discuss the concept of *sound*.
   (b) Discuss the concept of *complete*.
   (c) Consider the *modus ponens* inference rule (given $(A \Rightarrow B) \wedge B$, B is inferred), explain whether it is *sound* and *complete*.
   (d) When we use the *resolution* inference rule for proving a logical sentence S, explain why when we acheive an empty clause, S is inferred to be true.

2. (25 pts) On decision tree learning:

   (a) Consider learning a boolean function with n boolean attributes/variables, explain how many possible boolean functions can be represented by (different) decision trees. [Hint: you might want to start with $n = 2$.]

   (b) Explain in what situation that the decision tree learning algorithm could have no remaining attributes to use and the examples in a leaf are still not of the same target class.

3. (25 pts) Consider a ***modified*** version of tic-tac-toe where one can only win if you get three pieces along a diagonal or along an edge of the board (not along the middle rows or columns). Assume that by now you ('x') have already placed a piece in the center and the opponent ('o') has placed a piece in the N-W (northwest or upper left) corner, and it is again your turn.

   (a) Show each step of an alpha-beta pruning to decide what to do next based on a maximum traversal of depth 4 (describe the heuristic you select for node ordering, and the evaluation function that you use)

   (b) Assume at ply 3 you placed a piece in the N (north or top center) cell of the board, in ply 4 the opponent placed a piece in the S-W (southwest or lower left) corner and in ply 5 you place a piece in the W (west or middle left) cell. Show each step of mini-max your opponent will use for deciding what to do next. Does he have a 'draw' strategy?

```
o x _
x x _
o _ _
```

4. (25 pts) On Planning:

   (a) What are the 3 main parts of a planning problem when modelled with STRIPS operators?
   situation calculus?

   (b) Model the Sussman anomaly problem using STRIPS operators:
   The Susman anomaly problem asks you to move the block objects A, B, and C found in the initial configuration:

   ```
   C
   A   B
   -------------Table
   ```

   to the final configuration:

   ```
   A
   B
   C
   -------------Table
   ```

   when the possible operations allow moving one block at a time, from the current position to another position on the table or on top of another block.