EECS 391: Introduction to AI (Spring 2015) Written Homework 2 (Max Points: 130)

Assigned Tuesday February 10, due midnight Thursday February 19. Write your answers neatly and remember to show all relevant work. If turning in on paper, staple your answer sheets together and write your name and Case ID on the front page. If a pair of you did this assignment together, both your names and IDs should appear on the front page. You may only turn in an assignment as a pair if both of you have contributed equally to it.

1. Gradient ascent search is prone to local optima just like hill climbing. Describe how you might adapt simulated annealing to gradient ascent search to reduce this problem. (15 points)

2. Derive a condition on the class of functions $f$ for which the Newton-Raphson method guarantees improvement at each step, i.e., each iteration of Newton-Raphson strictly decreases the function value. (15 points)

3. Prove that a positive linear transformation of leaf values, where a leaf with value $x$ gets a new value $ax+b$, $a > 0$, leaves the choice of moves unchanged in a game tree. (10 points)

4. Question 5.8 parts (a)-(c), p197, from the Russell and Norvig textbook. (“Consider the two-player game…””) (20 points)

5. Prove the following assertions: (a) $\alpha$ is valid iff $\text{TRUE} \models \alpha$. (b) For any $\alpha$, $\text{FALSE} \not\models \alpha$. (10 points)

6. Prove the deduction theorem in propositional logic. (10 points)

7. Suppose a propositional language has only four symbols A, B, C and D. How many models are there for the following sentences? (10 points)
   (a) $(A \land B) \lor (B \land C)$
   (b) $A \lor B$
   (c) $A \leftrightarrow B \leftrightarrow C$

8. From the following assertions:
   “If the Unicorn is magical, then it is immortal, but if it is not magical, it is a mortal mammal. If the Unicorn is either immortal or a mammal, then it is horned. The Unicorn is mythical if it is horned.”
   Can you prove that the Unicorn is (a) magical, (b) mythical, (c) horned? (15 points)

9. Any propositional logic sentence is logically equivalent to the assertion that each possible world in which it would be false is not the case. From this observation, prove that any sentence in propositional logic can be written in CNF. (15 points)

10. Is a random 5CNF formula more likely to be satisfiable than a random 4CNF formula, both consisting of $m$ clauses over $n$ symbols? Explain your answer. (10 points)