CS472 Foundations of Artificial Intelligence
Fall 2002
Assignment 2

Due Friday, October 11 at the beginning of class.

Solutions must be typed, although equations, graphs, tables, etc., can be drawn in by hand.

1. **(10 pts.)** Exercise 4.2 parts b) and c) from Russell & Norvig.
2. **(5 pts.)** Exercise 4.8 from Russell & Norvig.
3. **(10 pts.)** Consider the pure Random Walk procedure for 2-SAT as discussed in class. Now, instead of flipping the truth assignment of a randomly selected letter in an unsatisfied clause, consider simultaneously flipping the truth assignment of all letters in the unsatisfied clause. Is the procedure still guaranteed to find a satisfying assignment in $O(n^2)$ flips with probability going 1? (n is the number of variables in the formula.) Explain your answer.
4. **α-β Pruning (25 pts)**

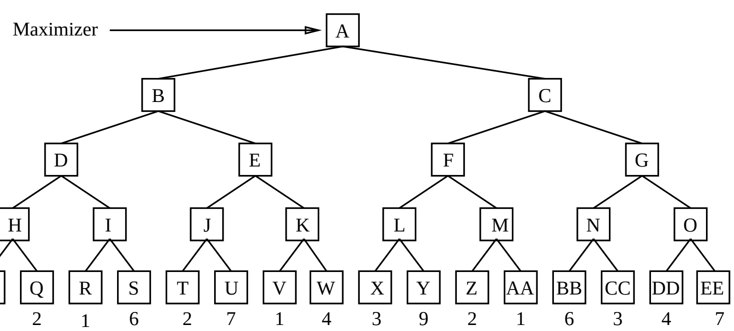

Figure 1: Game Tree for Alpha-beta Pruning

These questions refer to the game tree in Figure 1.

   (a) **(5 pts.)** What is the solution? That is, which move should be made next and what is the expected value of that move?

   (b) **(5 pts.)** Using alpha-beta pruning (and standard left-to-right evaluation of nodes), how many of the leaves get evaluated? Indicate all parts of the tree that are cut off. Indicate the winning path or paths. Strike out all static evaluation values that do not need to be computed.

   (c) **(5 pts.)** How does the answer to (b) change if right-to-left evaluation of nodes is used?

   (d) **(5 pts.)** What do the answers to (b) and (c) imply about the benefit of choosing the right evaluation order for alpha-beta search? State a heuristic which can guide the search for the best evaluation-order; this may be domain-independent or specific to a particular game like chess. What would be the savings if the "perfect" evaluation order were used?

   (e) **(5 pts.)** Explain why searches in game-playing programs generally go forward from the current position instead of backward from the goal.

5. **(15 pts.)** Exercise 5.1 from Russell & Norvig.

6. **(15 pts.)** Exercise 5.8 parts a) and c) from Russell & Norvig.

7. **Adversarial search (10 pts.)** Consider minimax game tree search. Let's define an "exhaustive search" (ES) player as a player that can perform a minimax search on the full game tree.

   Assume that the opponent of the ES player cannot search the full search tree; instead it uses a depth-limited minimax search with a heuristic board evaluation function.

   The goal of both players is to win, independent of how many moves that may take.

   (a) **(5 pts.)** If the ES player can identify a winning move at the top of the game tree, would the ES player ever have a reason for making a different move from the one identified by minimax? Explain your answer.

   (b) **(5 pts.)** Now assume that the best possible move found by ES based on a complete minimax search would lead to a draw. In this situation, would ES ever want to choose a different move than the one identified by minimax? Explain your answer.

8. **Problem Hardness (10 pts.)**

   (a) **(5 pts.)** Consider randomly generated 3-SAT instances with the ratio of clauses to variables equal to 10. What can you say about the difficulty of solving such instances. Compare with the difficulty of solving randomly generated instances at the ratio of 4.3.

   (b) **(5 pts.)** Consider a SAT instance encoding a problem in VLSI design. Assume the ratio of clauses to variables of that instance is 10. What can you say about the hardness of the instance?