CS343: Midterm Exam

March 12, 2009

NAME:_____

1. (25 points) Consider the following search problem. Assume a state is represented as an integer, that the initial state is the number 1, and that the two successors of a state n are the states $2n$ and $2n+1$ (in this order). For example, the successors of 1 are 2 and 3, the successors of 2 are 4 and 5, the successors of 3 are 6 and 7, etc. Assume the goal state is the number 12.

   Consider the following heuristics for evaluating the state n where the goal state is g

   - $h1(n) = |n - g|$ (the absolute value of the difference)
   - $h2(n) = (g - n)$ if $n \leq g$ and $h2(n) = \infty$ otherwise $(n > g)$

   Below and on the following blank page, show the search trees generated for each of the following strategies for the initial state 1 and the goal state 12, numbering the nodes in the order expanded. Assume goal states are detected as soon as they are generated instead of waiting until they are expanded.

   (a) Depth-first search

   (b) Breadth-first search

   (c) Best-first with heuristic h1

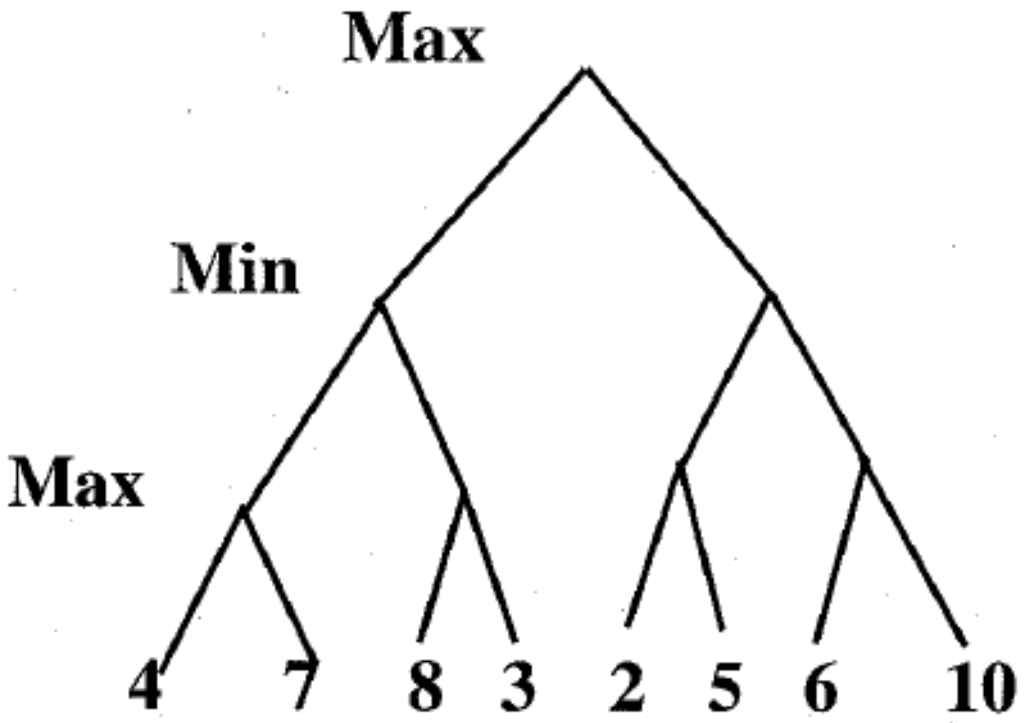
   (d) Best-first with heuristic h2

   (e) Hill-climbing with heuristic h1

   If any of these strategies get lost on an infinite path and never find the goal, simply show the search tree for a few steps and then say "FAILS."

Search Trees for Problem 1

2. (15 points) Consider the following simple game tree showing the utility (or heuristic evaluation) of each of the leaves. Assume alpha-beta search is used to pick the best move for Max at the top level and that siblings are explored in left to right order. Circle each leaf node that is actually evaluated and show each updated bound and exact value established for the utility of any intermediate nodes. Number each step in order. What is the best move for Max (left or right)?



3. (16 points) Represent the following in first-order logic. Make sure to use a reasonable set of primitive predicates that capture the basic concepts. Explain any predicates and their arguments that are not obvious.

Every company layed-off at least two employees and at least one of them hated their boss.

There is a town in a state that borders Texas in which all residents were killed by someone who sells an illegal drug. (Note: Assume each person may have been killed by a different drug dealer but that they all sell the same illegal drug)

4. (23 points) Given the following KB in first order logic

   "For every test in a CS course, at least one person fails."
   $\forall x \forall y(\text{CScourse}(x) \wedge \text{Test}(y,x) \Rightarrow \exists z\ \text{Fail}(z, y))$

   "Everyone passes an easy test in a course."
   $\forall y((\exists x\ \text{Test}(y,x)) \wedge \text{Easy}(y) \Rightarrow \forall z\ \text{Pass}(z,y))$

   "No one can both pass and fail the same test."
   $\neg \exists x \exists y(\text{Pass}(x,y) \wedge \text{Fail}(x,y))$

   "Class1 had an easy test."
   Test(Exam1,Class1)
   Easy(Exam1)

   Use resolution to prove:

   "Class1 is not a CS course."
   $\neg$CScourse(Class1)

   Show the conversion to clause form and clearly indicate each resolution used in the proof. The straightforward proof contains 6 resolutions.

5. (21 points) Provide short answers (1-3 sentences) for each of the following questions:

What are the four primary criteria used to evaluate search algorithms (i.e. fundamental properties that you should ask about any method)?

What is the worst aspect of breadth-first search compared to other uninformed search strategies? Be specific.

Describe the evaluation function used to sort the queue in A* search? Be specific and define any terms that you use.

(Extra credit) What was Alan Turing's favorite Disney movie?

What is the worst case time complexity of all known algorithms for determining whether or not a sentence in propositional logic is a tautology. Assume the sentence contains n propositional symbols.

What is the primary advantage of backward chaining over forward chaining for most inference problems. Be specific.

Explain what is meant by the statement that resolution theorem proving in first-order logic is *semi-decidable*.

Name and clearly define the unusual form of negation used in Prolog.