CPSC 420-500 Homework #1 (08 Fall)
Due 10/02/08, 12:45pm (submit, in class)

Handwritten or printed hardcopy must be submitted

1 Uninformed Search

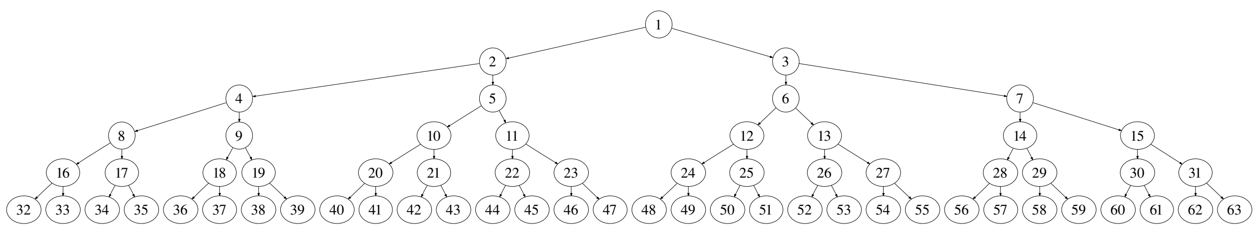

Figure 1: **Search Trees.**

Consider the search tree in Figure 2. Assume that the exploration of the children of a particular node proceeds from the left to the right for all search methods in this section.

Question 1 (4 pts): If node 21 and 12 were the goals, (1) would depth-first search give an optimal solution? (2) Explain why.

Question 2 (4 pts): In which case does the time complexity in depth-first search equal that of breadth-first search? (multiple choice)

1. goal is 12
2. goal is 41
3. goal is 47.
4. goal is 63.

Question 3 (4 pts): In which case is the time complexity in depth-first search greater than that of breadth-first search? (multiple choice)

1. goal is 12
2. goal is 41
3. goal is 47.
4. goal is 63.

Question 4 (4 pts): In which case is depth-limited search suboptimal? (Note: depth = number of moves from root to reach the current node; depth limit: do not expand any further if current depth = depth limit). (multiple choice)

1. goals are 12 and 27, and depth limit is 3.
2. goals are 20 and 12, and depth limit is 5.
3. goals are 20 and 50, and depth limit is 5.
4. goals are 44 and 14, and depth limit is 4.

Question 5 (4 pts): Explain what limitation in breadth-first search is overcome by iterative deepening search.

2 Informed Search

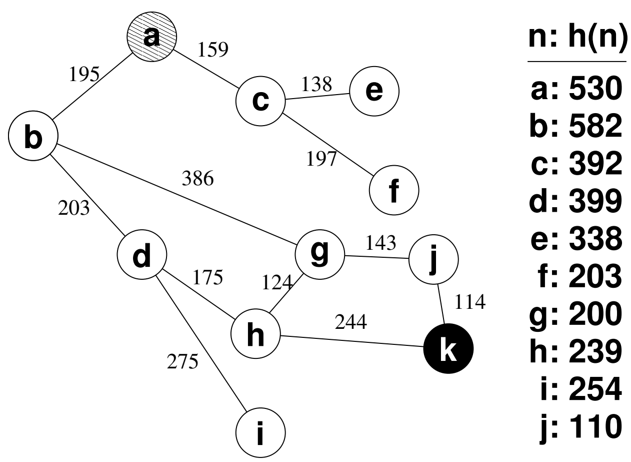

Figure 2: **Informed Search.**

Question 6 (12 pts): Manually conduct greedy best-first search on the above graph, with initial node **a** and goal node **k**. Actual cost from node to node are shown as edge labels. The heuristic function value for each node is shown on the right. Show:

1. Node list content at each step
2. Node visit order
3. Solution path
4. Cost of the final solution.

Note: Assume that you are not allowed to go back immediately to where you came from. For example, if you went from **a** to **c** to **f**, then you cannot expand **f** into **c**.

Question 7 (14 pts): (1) Repeat the problem right above with A* search. (2) In addition, show the $f(n)$ value for all nodes expanded. (3)Which one gives a shorter solution: Greedy best-first or A*? **Note:** Note that the same node can appear in the node list with a different $f(n)$ value, depending on the path taken.

Question 8 (4 pts): Why is IDA* more efficient in space than A*? Explain in terms of the particular exploration strategy.

Question 9 (4 pts): Why is a dominant heuristic better than a dominated heuristic?

Question 10 (8 pts): Explain why A* is optimal. Explain in terms of an arbitrary node n on the path to an optimal goal G_1, and a separate suboptimal goal G_2.

3 Game Playing

3.1 Minmax Search

Question 11 (4 pts): Using the following figure 3, use minmax search to assign utility values for each internal node (i.e., non-leaf node) and indicate which path is the optimal solution for the MAX node at the root of the tree. Assume you explore the successors from left to right.

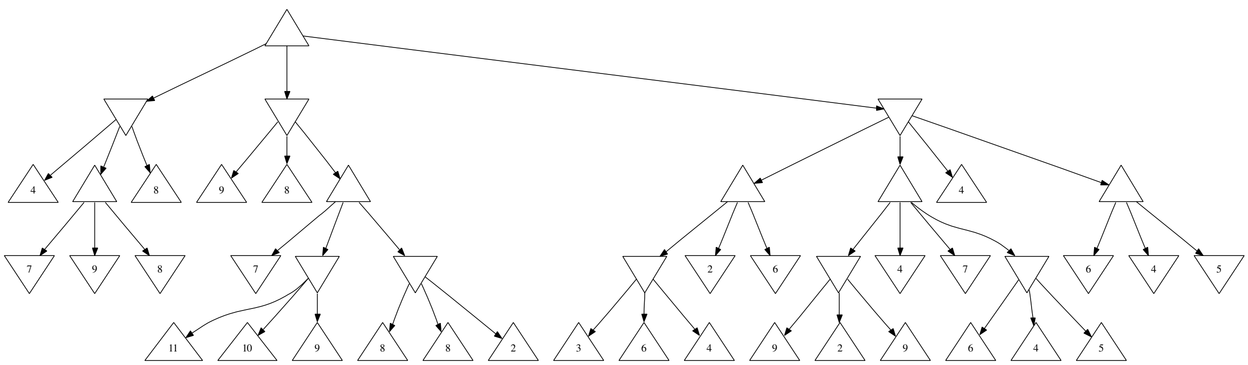

Figure 3: **Game Tree.** Solve using minmax search.

3.2 $\alpha - \beta$ pruning

Question 12 (10 pts): Using the following figure 4, use $\alpha - \beta$ pruning to (1) assign utility values for each internal node (i.e., non-leaf node) and indicate which path is the optimal solution for the MAX node at the root of the tree. (2) For each node, indicate the final α and β values. (Note that initial values at the root are $\alpha = -\infty, \beta = \infty$.) (3) For each cut that happens, draw a line to cross out that subtree.

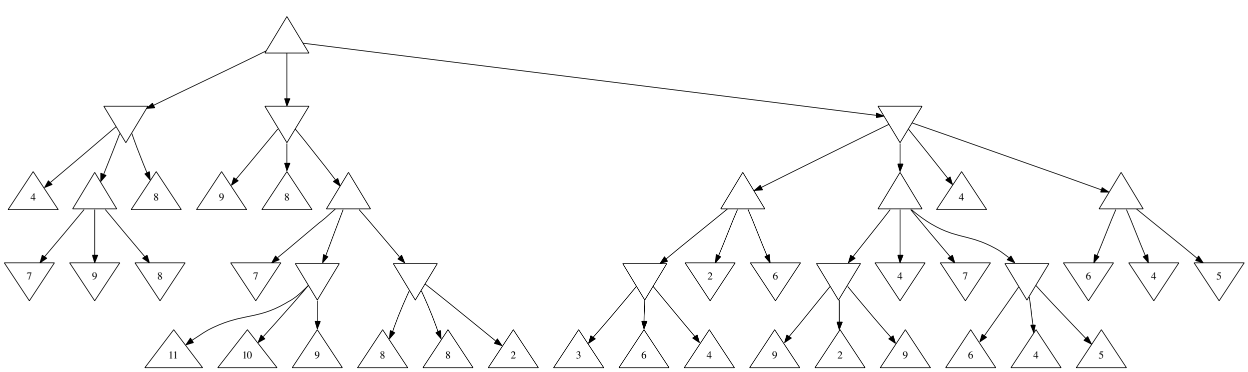

Figure 4: **Game Tree.** Solve using $\alpha - \beta$ pruning. This tree is the same as figure 3.

4 Propositional Logic

4.1 Normal forms

In all of the problems in this section, show each step of the derivation and indicate which axioms (or other rules) you used: For example, *distributive law, by definition, etc.*

Question 13 (4 pts): Convert $\neg(P \rightarrow \neg S) \vee (\neg(S \rightarrow (Q \rightarrow R)))$ into conjunctive normal form.

Question 14 (4 pts): Convert $\neg T \rightarrow (R \wedge (\neg(P \wedge Q) \rightarrow \neg S))$ into disjunctive normal form.

Question 15 (4 pts): Convert $(R \wedge S) \rightarrow (\neg(\neg P \vee T) \rightarrow \neg Q)$ into horn normal form. After that, show the equivalent expression with a single implication ($\rightarrow$) and some conjunctions ($\wedge$) where all literals are positive literals.

4.2 Theorem proving

Question 16 (12 pts): Given:

1. $A \vee \neg B$
2. $\neg A \vee C$
3. $C \rightarrow D$
4. $(C \wedge A \wedge D) \rightarrow E$

show that $B \rightarrow E$ is a logical consequence of the above using **resolution**.

Hint: first, transform the problem into a set of clauses, and the follow the resolution steps.