CPSC 420-500 Homework #1
Due 10/8/07, in Class
Handwritten or printed hardcopy must be submitted

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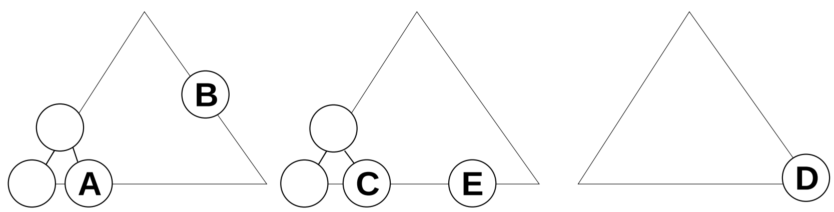
September 30, 2007

1 Uninformed Search



(a) Tree 1 (b) Tree 2 (c) Tree 3

Figure 1: **Search Trees.**

Consider the three search trees in Figure 1. Suppose the branching factor is b and the tree is full. Nodes A, B, C, D, and E the *goal nodes* in the trees. Assume that nodes A, C, D, and E are at depth n; and A and C are the k-th node from the left at that depth, where $k < b$, i.e., they are children of the left-most node at depth $n - 1$. Node B is at depth m $(< n)$. Node D is the last node to the right at depth n. Depth n is the last level of all the trees. Further assume that the exploration of each depth level proceeds from the left to the right.

Question 1 (4 pts): Which one shows a case where both depth-first and breadth-first have identical **time** complexity? (Tree 1, 2, or 3)

Question 2 (4 pts): Which one shows a case where depth-first can be complete but non-optimal? (Tree 1, 2, or 3) Explain why.

Question 3 (8 pts): Assume $b = 4$, $k = 3$, $m = 4$, and $n = 20$. What is the number of nodes visited in case of Tree 2 for depth-first (and breadth-first)?

Question 4 (4 pts): Assume $b = 4$, $k = 3$, $m = 4$, and $n = 20$. In which case does depth-first outperform breadth-first in terms of time complexity (= nodes visited)? (Tree 1, 2, or 3)

Question 5 (4 pts): Answer the following questions (5–6) regarding iterative-deepening search (IDS). In what sense is iterative-deepening search similar to depth-first and to breadth-first? Answer in terms of (some of) the four evaluation criteria.

Question 6 (4 pts): If space is adequate, is IDS still a good choice compared to breadth-first search (Yes/No)? Explain why.

2 Informed Search

Answer the following questions regarding informed search strategies.

Question 1 (4 pts): Why does A* have an exponential space requirement (in case the heuristic function is not very good)? Compare with breadth-first search, and explain in relation to the concept of f-contour.

Question 2 (4 pts): Why is IDA* more efficient in space than A*? Explain in terms of the particular exploration strategy.

Question 3 (4 pts): What is the potential disadvantage of IDA* compared to A* if space is adequate?

Question 4 (4 pts): What is the difference between greedy search and A* search?

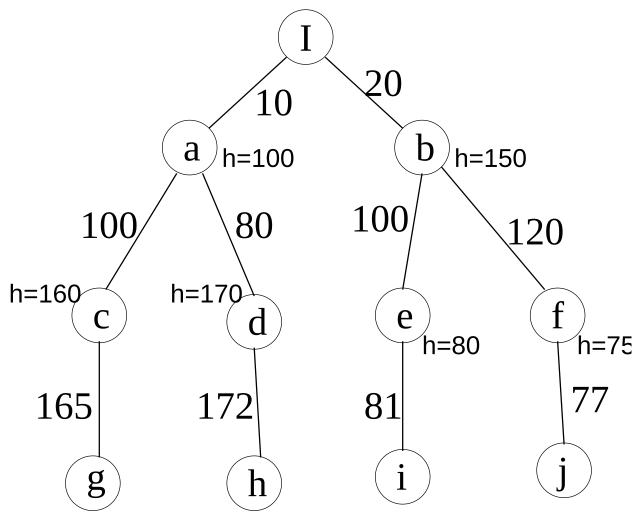


Figure 2: **Search tree.** An example search tree is shown with path cost on each edge and heuristic function value next to each node. The leaf nodes are goal states.

Question 5 (6 pts): Given the search tree in figure 2, calculate the $f(n)$ value for each node (a to j).

Question 6 (12 pts): Given the search tree in figure 2, list the node **visit order** and the **goal state** reached for the two search methods: (1) greedy search, and (3) A*.

3 Game Playing

3.1 Minmax Search

Question 1 (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.

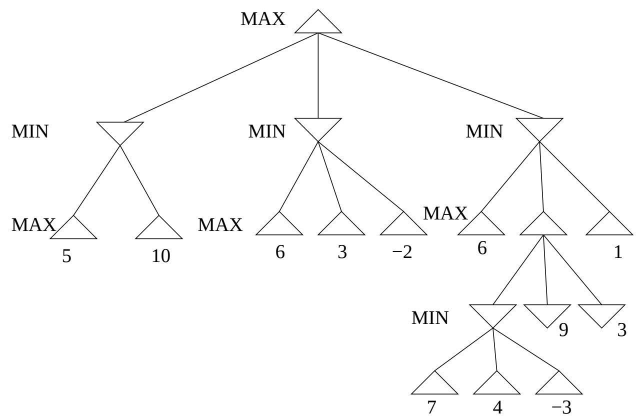


Figure 3: **Game Tree.** Solve using minmax search.

3.2 $\alpha - \beta$ pruning

Question 1 (4 pts): Using the following figure 4, use $\alpha - \beta$ pruning 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.

Question 2 (4 pts): For each node, indicate the final utility values.

Question 3 (6 pts): For each cut that happens, draw a line to cross out that subtree.

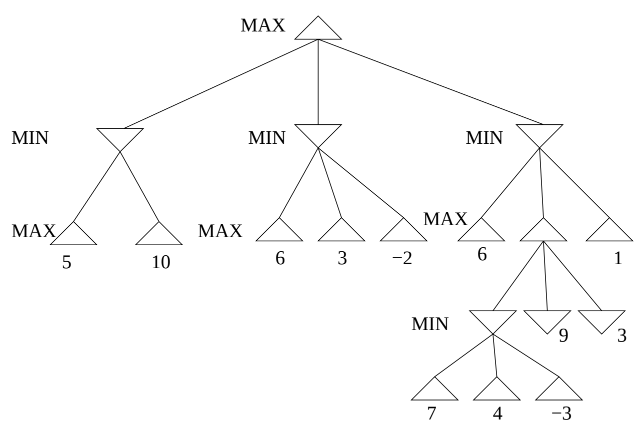


Figure 4: **Game Tree.** Solve using $\alpha - \beta$ pruning. This tree is the same as figure 3.

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 1 (2 pts): Convert $A \vee (B \wedge \neg C)$ into conjunctive normal form.

Question 2 (4 pts): Convert $A \vee (B \wedge \neg C) \vee (B \wedge E)$ into conjunctive normal form.

Question 3 (2 pts): Convert $(A \rightarrow B) \rightarrow (C \vee D)$ into disjunctive normal form.

4.2 Theorem proving

Question 1 (12 pts): Using resolution, show that $G \vee A$ is a logical consequence of the following:

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

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