CSE 460 1. Midterm

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I. Question (20 points)

Suppose you're trying to solve the following puzzle. The puzzle involves numbers from 100 to 999. You're given two numbers called S and G. You're also given a set of numbers called bad. A move consists of transforming one number into another by adding 1 to one of its digits or subtracting 1 from one of its digits; for instance, a move can take you from 678 to 679; or from 234 to 134. Moves are subject to the following constraints:

- You cannot add to the digit 9 or subtract from the digit 0. That is to say, no carries are allowed and the digits must remain in the range from 0 to 9.
- You cannot make a move which transforms your current number into one of the numbers in the bad set.
- You cannot change the same digit twice in two successive moves.

Since the numbers have only 3 digits, there are at most 6 possible moves at the start. And since all moves except the first are preceded by another move which uses one of the digits, after the start there are at most 4 possible moves per turn. You solve the puzzle by getting from to in the fewest possible moves. Your task is to use A* search to find a solution to the puzzle.

(a) Briefly list the information needed in the state description in order to apply A* to this problem.
(b) Find a heuristic for use with A* search in this problem which is admissible. Explain clearly why your heuristic is admissible.
(c) Give a domain-independent description of what f, g, and h values represent in A* search in general.
(d) Use your heuristic to carry out an A* search to find a solution when G = 567, S = 777, and bad = {666, 667}.

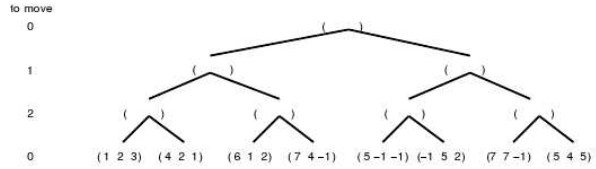
II. Question (20 points)

Decide if each of the following is true or false. Explain why?

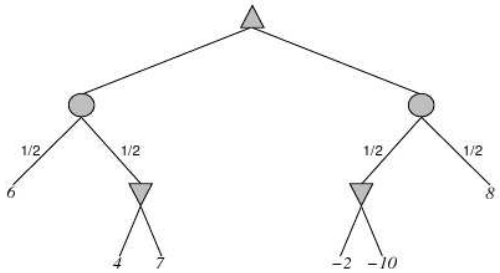
(a) Breadth-first is an optimal search algorithm.
(b) Simple reflex agents cope well with inaccessible environments.
(c) Minimax and alpha-beta can sometimes return different results.
(d) It is possible to write an exact evaluation function for chess.
(e) Assume that a king can move one square in any direction on a chessboard (8 directions in all). Manhattan distance is then an admissible heuristic for the problem of moving the king from square A to square B.
(f) It is possible to build a knowledge-based agent that is a pure reflex agent.
(g) A rational agent outperforms all nonrational agents because it knows the actual outcome of its actions.
(h) h(n) = 0 is an admissible heuristic for 8-puzzle.
(i) A perfectly rational backgammon agent never loses.
(j) Search algorithms cannot be applied in completely unobservable environments.

III. Question (24 points)

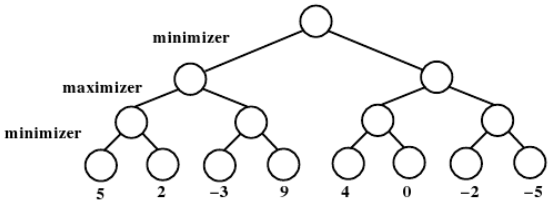
(a) Draw the smallest possible game tree on which alpha-beta will prune at least one leaf node. Make sure to label the leaves with values, and circle the leaf (or leaves) that will be pruned.
(b) Copy and complete the following game tree by filling in the backed-up value triples for all remaining nodes:



(c) Copy and complete the following game tree by filling in the values for all remaining nodes:



(d) Apply the minimax algorithm to the game tree below, where it is the minimizers turn to play. Report the estimated values of the intermediate nodes and indicate the proper move of the minimizer.

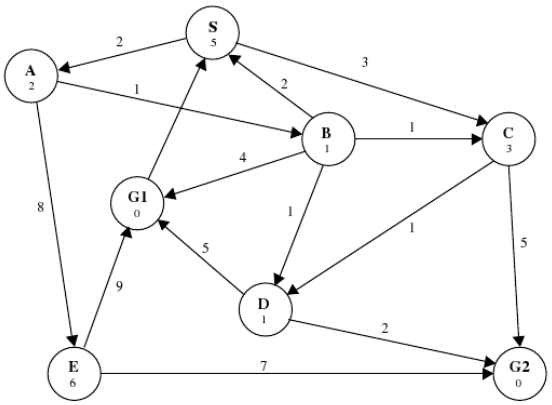


Indicate, by crossing out, one (1) unnecessary call to the static board evaluator. Explain why this call to the board evaluator is unnecessary.

IV. Question (20 points)

Consider the search space below, where S is the start node and G1 and G2 satisfy the goal test. Arcs are labeled with the cost of traversing them and the estimated cost to a goal

is reported inside nodes. For each of the following search strategies, indicate which goal state is reached (if any) and list, in order, all the states popped off of the OPEN list. When all else is equal, nodes should be removed from OPEN in alphabetical order.



(a) Iterative Deepening
(b) A^*
(c) Hill climbing
(d) Breadth-first
(e) Depth-first

V. Question (16 points)

Consider the following fitness function:

$$fitness = 5a + 3bcd + 2e \tag{1}$$

where a-e are all Boolean-valued parameters. Compute the fitness of each of the members of the initial population below.

a	b	c	d	e
1	1	0	1	1
0	1	1	0	1
1	1	0	0	0
1	0	1	1	1
1	0	0	0	0

Assuming the first two of members of the population are selected for reproduction, and the cross-over point is that between the b and the c, show the resulting children.