## CS-171, Intro to A.I. — Quiz#2 — Fall Quarter, 2015 — 20 minutes

YOUR NAME: ________________________________________________

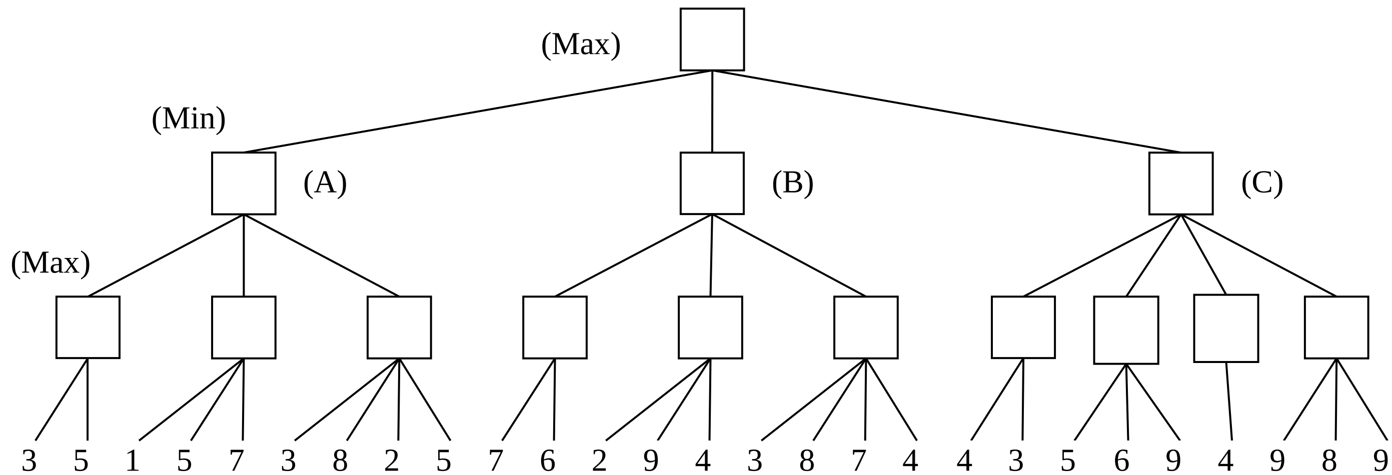
YOUR ID: ______________ ID TO RIGHT: _______________ ROW: __________ SEAT: __________

**1. (35 pts total, -5 pts for each error, but not negative) MINI-MAX SEARCH IN GAME TREES.** The game tree below illustrates a position reached in the game. Process the tree left-to-right. It is **Max**'s turn to move. At each leaf node is the estimated score returned by the heuristic static evaluator.

**1.a. Fill in each blank square with the proper mini-max search value.**

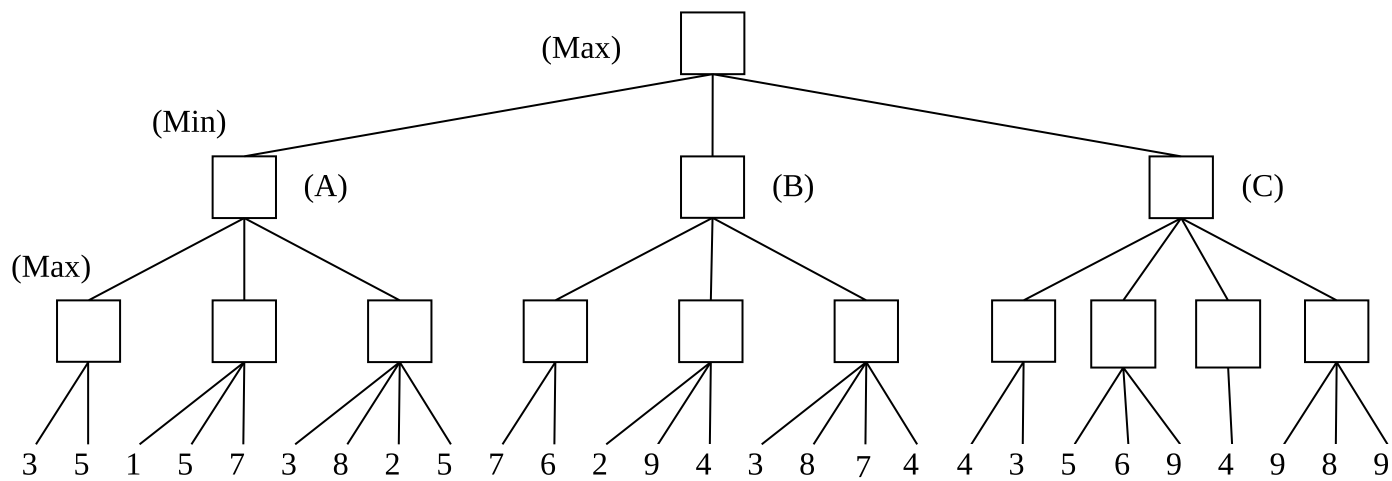
**1.b. What is the best move for Max?** (write A, B, or C) ________

**1.c. What score does Max expect to achieve?** ______________




**2. (35 pts total, -5 for each error, but not negative) ALPHA-BETA PRUNING.** Process the tree left-to-right. This is the same tree as above (1.a). You do not need to indicate the branch node values again.

**<u>Cross out</u> each leaf node that will be pruned by Alpha-Beta Pruning. Do not just draw pruning lines.**

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**3. (30 pts total, -5 for each error, but not negative) RESOLUTION THEOREM PROVING.** You are engaged in Knowledge Engineering for the Wumpus Cave. You have interviewed an expert on the Wumpus Cave who told you, among other things, "A stench in square (1,2) is equivalent to a wumpus in square (1,1) or (2,2) or (1,3). A stench in square (2,1) is equivalent to a wumpus in square (1,1) or (2,2) or (3,1)." You translated this into propositional logic as

$(S12 \Leftrightarrow W11 \vee W22 \vee W13)$ $(S21 \Leftrightarrow W11 \vee W22 \vee W31)$

and then into Conjunctive Normal Form (CNF) as

$(\neg S12 \vee W11 \vee W22 \vee W13) \wedge (S12 \vee \neg W11) \wedge (S12 \vee \neg W22) \wedge (S12 \vee \neg W13)$

$(\neg S21 \vee W11 \vee W22 \vee W31) \wedge (S21 \vee \neg W11) \wedge (S21 \vee \neg W22) \wedge (S21 \vee \neg W31)$

Now it is time for the first "live" test of your system. An agent has been lowered down into the Wumpus cave, and reports back by radio, "Square (1,1) has no wumpus and no stench. Square (1,2) has a stench. Square (2,1) has no stench." You translate this knowledge into CNF as "$(\neg W11) \wedge (\neg S11) \wedge (S12) \wedge (\neg S21)$" and add it to your knowledge base.

Next the agent asks by radio, "Is it true that square (1,3) has a wumpus?" You translate this query into propositional logic as the goal sentence "(W13)." You form the negated goal as "($\neg$ W13)." Now your knowledge base plus the negated goal, expressed in clausal form, is:

| | | | | |
|---|---|---|---|---|
| ($\neg$S12 W11 W22 W13) | | ($\neg$S21 W11 W22 W31) | | |
| (S12 $\neg$W11) | (S12 $\neg$W22) | (S12 $\neg$W13) | | |
| (S21 $\neg$W11) | (S21 $\neg$W22) | (S21 $\neg$W31) | | |
| ($\neg$W11) | ($\neg$S11) | (S12) | ($\neg$S21) | ($\neg$ W13) |

**Run resolution on this knowledge base until you produce the null clause, "( )", thereby proving that the goal sentence is true. The shortest proof I know of is only five lines long. It is OK to use more lines, if your proof is correct.**

**Repeatedly choose two clauses, write one clause in the first blank space on a line, and the other clause in the second. Apply resolution to them. Write the resulting clause in the third blank space, and insert it into the knowledge base.**

*Think about what you are trying to prove, and find a proof that mirrors how you think. You know S12 and ($S12 \Rightarrow W11 \vee W22 \vee W13$). You know ($\neg$W11). It is easy to prove ($\neg$W22), so (W13) is the only possibility left. Your negated goal is ($\neg$W13). You seek ( ). Think about it.*

Resolve ________________________ and ________________________ to give __________________

Resolve ________________________ and ________________________ to give __________________

Resolve ________________________ and ________________________ to give __________________

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Resolve ________________________ and ________________________ to give __________________

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