CSci 4511
Final

Name: ____________________________________

Student ID: _________________________

Instructions: The time limit is 120 minutes. Please write your answers in the space below. If you need more space, write on the back of the paper. The exam is open book and notes. You may use electronic devices to ONLY look at either an e-book version or electronic notes. You may not use the internet, program/run code or any other outside resources. (If you are typing on your keyboard/input device for anything other than ctrl-F to find words in the e-book or notes, this is probably not acceptable.) For all questions you must **show work**.

Problem (1) [20 points] Suppose you have two planning actions. This question pertains to how you could combine two actions into one larger action. For example if there were an action MakeCereal and EatCereal, then the combined action would be MakeAndEatCereal. For this specific problem, assume that you are trying to combine action A and action B, where you are doing action A first.

(1) List all conditions (and support each condition with a sentence justifying your logic) that must be true between A and B for it to be possible to combine the actions.
(2) List the rules for finding the pre-condition of this combined action.
(3) List the rules for finding the effects of this combined actions.

Problem (2) [15 points] When using resolution (in first order logic) the rigorous way is to try and combine all possible pairs of sentences. In class we described an approximate method that only tries to compare sentences with the sentence we are checking for entailment negated (i.e. the "proof by contradiction" sentence). In other works when deciding $KB \models \alpha$, on the first round we would only combine sentences with $\neg\alpha$. Then on the second round we would only combine sentences with the result of the first round (and so on). What other algorithm that we discussed in class is this process most similar to? Justify your answer and show with a small example.

Problem (3) [20 points] (1) Convert this sentence into first-order logic: "Every dog barks at a cat".
(2) Convert the following sentence from first-order logic to propositional logic:
"$\forall x(\forall y A(x) \wedge B(x, y)) \Rightarrow (\exists y C(x, y))$ ". Assume that there are two objects: {R, T}.

Problem (4) [20 points] Use forward chaining on the following sentences to determine whether "$\exists x\ F(x)$" is entailed:

$\forall x \exists y\ A(x) \wedge B(x, y) \Rightarrow C(y)$

$\forall x, y\ \neg A(x) \vee \neg C(x) \vee D(x)$

$\forall x, y\ C(x) \wedge \neg C(y) \Rightarrow F(x)$

$\forall x\ A(x)$

$\exists x, y\ B(x, y)$

$\neg D(Cow)$

Problem (5) [10 points] Use alpha-beta pruning to prune this graph. Assume the tree is searched left to right. Clearly indicate which parts of the tree do not need to be searched (show work to receive full credit). What is the best action of the root node?

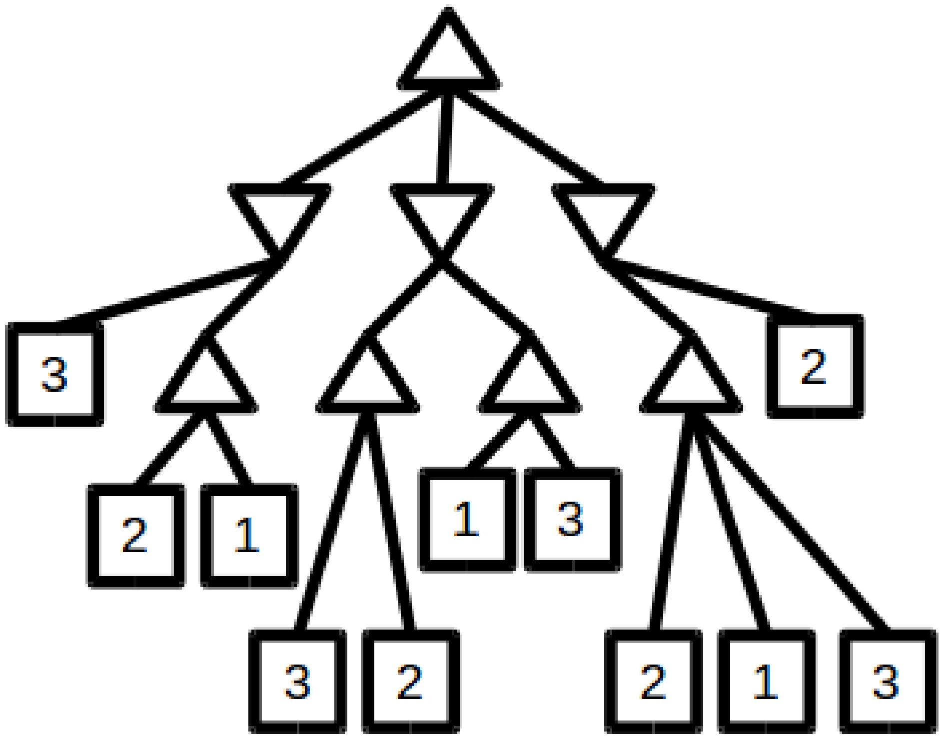
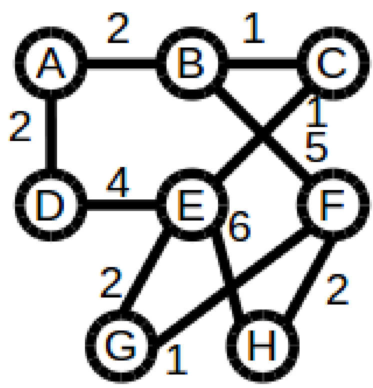


Figure 1: Tree for alpha-beta pruning. Triangles pointing up are maximization nodes and triangles pointing down and minimization nodes.

Problem (6) [15 points] Run A* search on the following graph and tell what the shortest path is from A to H. Show your work at every step through this graph. Is this heuristic admissible? Is this heuristic consistent? Justify your answers.



Heuristics:

A:	7	E:	5
B:	4	F:	1
C:	6	G:	3
D:	5	H:	1

Figure 2: A* search graph. Costs between states are shown on the edges in the graph. Heuristics for each are on the right.