

Midterm

CSC 242

March 2008

Write your **NAME** legibly on the bluebook. Work all problems. You may use two double-sided pages of notes. Please hand your notes in with your bluebook. The best strategy is not to spend more than the indicated time on any question (minutes = points).

1. FOPC: 15 Min.

Put the following assertions into FOPC formulae, convert to clause form, and use resolution to answer the question “Who (if anyone) is amiable?”. Make sure you show what converts to what, what resolves to what, etc. so the process is clear, not just the answer.

Use the predicate notation $L(x, y)$, $A(x)$, $K(x, y, z)$ for “ x Loves y , x is Amiable, and x, y, z all know each other”. Use constants T for Tim and Z for Zelda, variables u, v, w, x, y, z as necessary.

In the following statements, the labels A and B should *not* be part of your FOPC axiomatization! They are just here in the English to keep the meaning clear.

A. *For every person A there is another person B such that if A loves B then B is amiable.*

B. *There is no person A such that: it is false that both: a) Tim loves A and b) Tim, A, and Zelda all know each other.*

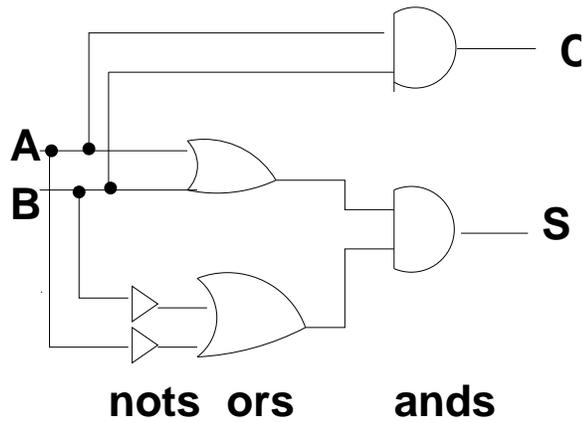
2. FOPC Quickies: 5 Min.

A. If the object of a proof is to derive some logic sentence S, what is a good and practical reason that I have to negate S and derive the null clause in a resolution proof? Why not just resolve until I produce what I’m looking for, namely S?

B. We’re warned to negate the conclusion *before* putting it into clause form, not *after*. That must mean that negation (\neg) does not commute with “clausification” ($C(\cdot)$), or that for some FOPC sentence S , $\neg(C(S)) \neq C(\neg S)$. Give such a sentence S and demonstrate the results of doing negation and clausification in the “correct” and “wrong” order.

2. Propositional Calculus 10 Min.

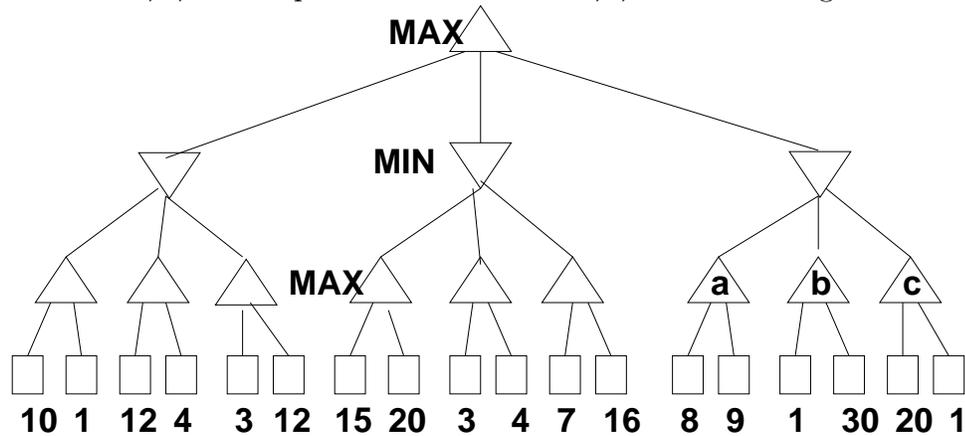
I claim the following (really badly drawn) circuit takes binary inputs A and B and computes C the carry bit and S the sum bit in the binary sum of A and B. Prove it (hint: using truth tables).



3: $\alpha - \beta$ Pruning: 15 Min.

A. Redraw this game tree. Its leaves have, or would have if they were ever evaluated, static evaluation values as shown. As usual, search the tree depth-first from left to right and illustrate where alpha and beta cutoffs occur by making X's over the affected arcs (extra if you show which are alpha and which are beta).

B. Suppose nodes labeled **a,b,c** are expanded in the order **b,c,a**. What changes?



4. CSP: 15 Min.

Consider Sudoku, played on a 9x9 grid probably containing some digits in some grid squares in its initial state. The rules of the game are: "Fill in the grid so that every row, every column, and every 3x3 box contains the digits 1 through 9."

A. Formalize Sudoku as a Constraint Satisfaction Problem.

B. I don't think anyone knows how many ways there are to fill the grid if it is initially totally empty. But what can you say about an upper bound on the number of such solutions (i.e. what is your best answer for X in the statement "there are no more than X solutions.", and why?).

C. What would be your favored method of solving the Sudoku CSP, and why? (Recall we have candidates like minimax, various flavors of informed and uninformed state-space search, various flavors of iterative improvement with various heuristics, genetic algorithms, random guessing, simulated annealing, constraint propagation,). (Hint: some ideas are clearly worse than others but for me, here, there's no single 'right' answer, so don't be afraid to pick a likely method and convince me it's good.)

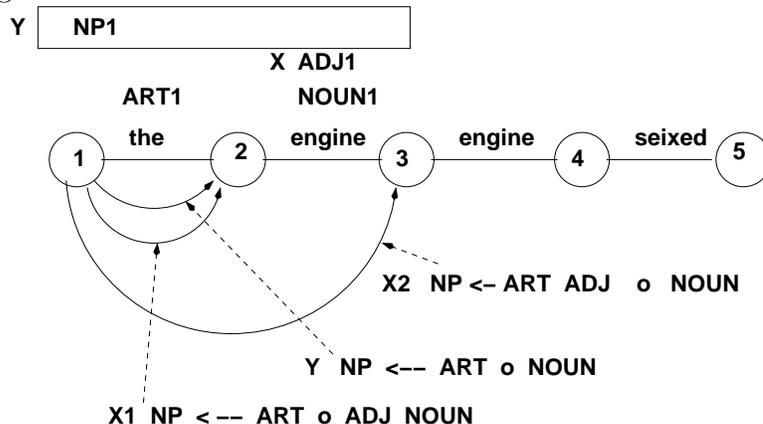
5. NLU: 15 Min.

A: Chart Parsing

You have the following CFG and associated lexicon:

S \leftarrow NP VP	ARTs: the
NP \leftarrow ART NOUN	NOUNs: engine, block
NP \leftarrow ART ADJ NOUN	ADJs: engine, new
VP \leftarrow ITVERB	ITVERBs: seized

A bottom-up left-corner chart parser is given the legal (probably nonsense) sentence “the engine engine seized.” After processing the first two words it looks like this:



Here interpreting “engine” as NOUN1 resulted in completing active arc Y to give the NP1 constituent labelled Y. Interpreting “engine” as an adjective ADJ1 at X extends arc X1 to X2.

Next, the parser reads the word “engine” again. Update the chart appropriately.

B. Augmentations

Now suppose you add the word “engines” to NOUNs in the lexicon of Part A above, and also add “seizes” to the ITVERBs list.

Augment the grammar (into a definite clause grammar) with a (singular, plural) distinction so that it does not generate, for instance, “the new engines seizes.”