Final Examination, CSE477-Ling549, Fall 1998

Please return your examination to Room 555 Moore or to the front desk in IRCS by DEC 18.

Problem 1: 10 points

Let Let $\sum = \{a, b\}$. A palindrome over $\sum = \{a, b\}$ can be defined as a string w that reads the same forward and backward or by the following definition.

(a) e, the null string, is a palindrome.

(b) If $a \epsilon \sum$ then the string a is a palindrome.

(c) If x is a palindrome and $a \epsilon \sum$ then the string axa is a palindrome.

(d) Nothing is a palindrome unless it follows from (a) through (c).

Show by *induction* that the two definitions are equivalent.

Problem 2: 20 points

Show that the language L,

$L = \{ww | w \epsilon \{0, 1\}^*\}$

is not a regular (finite state) language. Use the pumping lemma for finite state languages. Hint: Try the string $w = 0^p 10^p 1$, for some appropriate p.

The language L is also not a context-free language. Try to show this by using the pumping lemma for context-free languages. Again you need to choose a specific string. Will the string w mentioned above work in this case? If so, show that it will work. If not, suggest some other string that will work.

Problem 3: 10 points

For each language corresponding to the regular expressions below give two strings that are in the language and two strings that are not in the language.

(a) a^*b^*

(b) $a^* + b^*$

(c) $(a + ba + bb)(a + b)^*$

Problem 4: 15 points

(a) Give a context-free grammar for the language for the language

$L = \{a^i b^j c^k | i, j, k \geq 0 \; and \; either \; i = j \; or \; j = k\}$

(b) Is the grammar for L ambiguous? If yes then give an ambiguous string in the language, otherwise show why the grammar is unambiguous.

(c) Give an informal description of a pushdown automaton that recognizes L.

Problem 5: 15 points

A string x is a *prefix* of a string y if there is a string z such that $y = xz$. Further, if $x \neq y$ then x

is a *proper prefix* of y. Let L be a regular (finite state) language. Show that the language

$L_{noprefix} = \{w | w \epsilon\, L \; and \; no \; proper \; prefix \; of \; w \; is \; in \; L\}$

is also a regular language.

Problem 6: 30 points

Here is a list of sentence types illustrated by the following examples.

1. Harry likes potatoes.
2. Potatoes Harry likes.
3. Mary thinks Harry left yesterday.
4. Bill invited Harry for the party.
5. Who did Bill invite for the party?
6. Who do you think Bill invited for the party?
7. John seems to be happy.
8. John tried to swim.

Construct a Lexicalized Tree-Adjoining Grammar (LTAG) and a Categorial grammar (CG) that will be adequate to describe these sentence structures. For the CG, show the basic categories, reductions and the derivations for the sentences listed above. You should only show the critical parts of the derivations. For the LTAG, show the elementary trees and the 'derivation' trees for the sentences listed above.

Please do not write too much. If you show the basic structures and derivations clearly, I will be able to make the right inferences.