COT 4210 Quiz #2 Part A: Context Free Grammars 2/23/2021

Regular Start Time: 1:45 pm (EST)
Regular End Time: 2:15 pm (EST)
Regular Late Time: 2:25 pm (EST)

1) (9 pts) Below is the formal description of a DFA which describes a language L. Use the algorithm shown in class to convert a DFA to an equivalent context free grammar to produce a CFG that accepts L.

Q = {a, b, c, d} $\Sigma = \{0, 1\}$ $q_0 = a$ F = {b, d}

δ State\Character	0	1
a	b	d
b	a	c
c	d	b
d	c	a

Clearly designate your CFG formally, listing each of the components in the formal designation. Please make your variable names easy to follow such that the correspondence to the DFA is clear.

2) (9 pts) The following grammar over the alphabet {a, b} below is in the process of being converted into Chomsky Normal Form. A new start symbol, S' has been added. The next step is to remove all epsilon rules. Show the resulting grammar when all epsilon rules have been removed. To save time, feel free to copy and paste all of the old rules and then just add the new rules at the end. (Note: the variables in the grammar currently are S', S, T, U, V

S' → S
S → aS | Sb | TUV
T → TT | TU | VT | ε
U → bUb | bVVa | bVUVb
V → aab | bVa | ε

3) (7 pts) Design a context grammar over the alphabet { (,) } representing the set of strings of matching parentheses. Use the usual notion of matching parentheses, namely, each open parenthesis has a matching close parenthesis and inside of each pair of matching parentheses any valid set of matching parentheses are allows. Examples of strings in the language are: (), ()(), (()), (()()(())) and ε. Examples of strings that aren't matching parentheses are: ())(, ((), and ()()())(). In the first example, the prefix of the first three characters has more close parentheses than open parentheses. In the second example, the full string has more open parentheses than close parentheses and in the last example, the prefix of the first seven characters has more close parentheses than open parentheses. Clearly designate your CFG formally, listing each of the components in the formal designation.

COT 4210 Quiz #2 Part B: Push Down Automata and Pumping Lemma for CFGs

2/23/2021

Regular Start Time: 2:15 pm (EST)
Regular End Time: 3:00 pm (EST)
Regular Late Time: 3:10 pm (EST)

1) (12 pts) Consider designing a PDA to accept the following language of strings over the alphabet {0, 1}:

L = { w | w is a palindrome **with length 1 or greater**, with leading 0s allowed, whose binary value is divisible by 3 }

Note that with this definition, some strings in L are 11, 0110, and 10101. Examples of strings not in L are 110, 101, and 1001001. 110 is not in the language because 110 is not a palindrome. Both 101 and 1001001 are palindromes, but their numerical values in binary, 5 and 73, respectively, are not divisible by 3. **Your PDA should NOT accept ε.**

The design of this PDA is likely to require 9 states. Describe the conceptual meaning of each of the 9 states. In each description, explain both the property of the string read in so far as well as the meaning of the stack contents.

2) (10 pts) Use the pumping lemma for context free languages to prove that the following language over the alphabet {a, b} is NOT context free:

$$L = \{a^n b^{2^n} \mid n \in Z^+\}$$

Note: Recall that the set Z^+ is the set of positive integers.

3) (3 pts) Olivia Rodrigo's hit song Driver's License is about the singer getting her license to do this. (Note: it's really about something else, but at this point, hopefully you know how to answer these questions!)