Automata, Computability and Formal Languages — Spring 2020
CS 3350 — L. Longpré

Sample midterm 2 exam questions

1. Give an example of each of the following. In all questions, the alphabet is $\{a, b\}$. If no example exists, answer "impossible". No justification needed.

   (a) A pushdown automaton for the language $a + \varepsilon$.

   (b) A context-free grammar with 2 variables, two terminals, two rules and one start variable.

   (c) An ambiguous context-free grammar for the language $a + \varepsilon$.

   (d) A parse tree for the string *abbba* generated by the CFG: $S \to aSa \mid SS \mid b$.

   (e) An ambiguous string generated by the CFG: $S \to aSa \mid SS \mid b$.

   (f) A pushdown automaton that accepts everything except ε

   (g) Two different languages that are not regular

2. (a) Build a context-free grammar for the language $\{a^n b^{2n} \mid n \geq 2\}$.

   (b) Build a parse tree for the string *aaabbbbbb* according to your grammar.

3. The following context-free grammar has some ε production rules, but cannot generate ε. Use the algorithm we saw in class to build an equivalent context-free grammar without ε production rules.

$$\begin{array}{lcl} S & \to & aXYa \\ X & \to & aX \mid Xa \mid b \mid Y \mid Z \\ Y & \to & YbY \mid bZ \mid X \mid \varepsilon \\ Z & \to & bb \mid XXa \end{array}$$

4. Complete the statement of the pumping lemma for regular languages.

   If A is a regular language, then there is a number p (the pumping length) where if s is any string in A of length at least p, then s may be divided into three pieces, $s = xyz$, satisfying the following conditions:

   (a) for each $i \geq 0$, ...

   (b) $|y|$ ...

   (c) $|xy|$ ...

5. Questions like assignments 5, 6 and 7.