CS 420 Study Guide for Test 1

The test will contain three types of questions: routine, semi-creative and creative. Routine questions ask you to apply an algorithm from class. Semi-creative questions require original thought, but in a way that is similar to something you have seen before. Creative questions require you to apply known techniques in novel ways or to invent something new.

My goal is to include enough routine questions so that getting them all correct will give you a C (which is a score in the 55 to 70 range), and enough semi-creative questions so that getting them all correct in addition to the routine ones gives you a B (70 to 85). It is not always so clear what category each question is in, so I may not exactly succeed in this, but that's what I am trying for.

Here is a list of possible types of routine and semi-creative questions. Not all of these types of questions will appear on the test and there will probably be questions not of any of the types listed below, but this does give you a starting point for your studies. For each type of question, I have listed the homework problems you have had of that type.

Routine Questions

- 1. Given DFAs for A_1 and A_2 , give a DFA for $A_1 \cup A_2$. Homework 1, Exercise 3.
- 2. Given DFAs for A_1 and A_2 , give a DFA for $A_1 \cap A_2$. Homework 2, Exercise 1.
- Given a DFA for A, give a DFA for A. Homework 1, Exercise 2.
- 4. Given NFAs for A_1 and A_2 , give an NFA for $A_1 \cup A_2$. Homework 2, Exercise 5.
- 5. Given NFAs for A_1 and A_2 , give an NFA for A_1A_2 . Homework 2, Exercise 6.
- 6. Given an NFA for A_1 , give an NFA for A^* . Homework 2, Exercise 7.
- Convert an NFA to an equivalent DFA. Homework 2, Exercises 3, 4b.
- Convert a regular expression into an NFA. Homework 3, Exercise 1.
- Convert an NFA into a regular expression. Homework 3, Exercise 2.

- Give a leftmost derivation/parse tree for a string in a context-free grammar. Homework 5, Exercise 2
- 11. Given CFGs for A_1 and A_2 , give a CFG that generates $A_1 \cup A_2$. Homework 5, Exercise 4.
- 12. Given CFGs for A_1 and A_2 , give a CFG that generates $A_1 \circ A_2$. Homework 5, Exercise 5.
- 13. Given a CFG for A_1 , give a CFG that generates A_1^* .
- 14. Convert a regular expression into a context-free grammar. Homework 5, Exercise 6.
- 15. Convert a DFA into a context-free (right regular) grammar. Homework 5, Exercise 8.
- 16. Convert a right regular grammar into an NFA. Homework 5, Exercise 9.
- 17. Convert a context-free grammar into Chomsky Normal Form. Homework 6, Exercise 1.
- Give an accepting computation for a PDA on a string. Homework 6, Exercises 3, 4b.
- Convert a context-free grammar into a PDA. Homework 7, Exercise 1.
- 20. Convert a PDA into a context-free grammar. Homework 7, Exercise 2.

Semi-Creative Questions

- 1. Give a DFA for a language. Homework 1, Exercise 1.
- Give an NFA for a language. Homework 2, Exercises 2, 4a; Homework 3, Exercise 4a.
- 3. Give a regular expression for a language. Homework 5, Exercise 1.
- 4. Show that a language is regular. (This is harder than the last three types, because you are not told which method to use.)
- Use the Pumping Lemma to show that a language is not regular. Homework 3, Exercise 5; Homework 4, Exercise 1.

- 6. Use closure properties to prove that a language is or is not regular. Homework 4, Exercises 3,b,c.
- 7. Show that a language has the Pumping Property for regular languages. Homework 4, Exercise 3a.
- 8. Give the minimum pumping length for a regular language. Homework 4, Exercise 2.
- Give a context-free (or right regular) grammar for a language. Homework 4, Exercise 4; Homework 5, Exercises 2,3,7.
- 10. Determine what language a context-free grammar generates. (This kind of problem is possible, but unlikely.)
- 11. Determine what language a PDA recognizes.
- 12. Show that a context-free grammar is ambiguous.
- 13. Give a PDA for a language. Homework 6, Exercises 4a, 5.
- Use closure properties of context-free languages to show that a language is or is not context-free. Problem 2.18b.
- 15. Show that a language is context-free.
- 16. Use the Pumping Lemma to show that a language is not context-free. Homework 7, Exercise 3.
- 17. Show that a language has the Pumping Property for context-free languages.
- 18. Give the minimum pumping length for a context-free language. Homework 7, Exercise 4.
- 19. Classify each of the following languages as being i) regular, ii) context-free but not regular or iii) not context-free. Explain your answers. (This is a harder version of previous questions in that you are not told what the classification of each language is.)

Creative Questions

By their nature creative questions are hard to categorize. There are many possibilities. Here are just four.

1. Show that the regular languages are closed under some operation. Problem 1.31.

- 2. Show that every NFA is equivalent to one in some special form. Homework 3, Exercise 4b.
- 3. Show that some variation of the definition of NFA is equivalent to the original one.
- Show that the context-free languages are or are not closed under some operation. Problem 2.18a.