CptS 317: Automata and Formal Languages

Spring 2021

Final Exam (Take Home)

Assigned: May 3, 10 AM

Due by: May 5, 11:59 PM

Instructions:

1. Make sure that your exam has 2 pages (including this cover page). The exam questions begin on the second page.
2. There are 10 questions in this exam; Questions Q3, Q8, and Q9 have multiple parts. The point each question carries is shown in parenthesis. The points add up to 100. Read each question carefully before you begin writing your solution.
3. The exam is take-home. Your solution in PDF format is to be submitted on Canvas. You may either type-up your solution to produce a PDF document, or hand-write your solution and scan to get a PDF document. Both options are fine. If you hand-write, make sure to write legibly.
4. The exam is due **Wednesday May 5, 2021 by 11:59 PM Pacific**.
5. **Academic Integrity:** note that the same WSU Standards of Conduct for Students, particularly the section on Academic Integrity, apply to this take-home exam as any in-class exam. See the section on Academic Integrity in the syllabus of the course for further information and for consequences of violating the University's standard of conduct.

1. (8 pts) Now that you have completed this course and experienced what it had to cover, suppose you were asked to develop a crisp and informative "course description" for it for use for future semesters. The course description is to consist of a brief paragraph (roughly 3 to 5 sentences) followed by a list of topics. What would your course description be?
2. (8 pts) Consider the 7 homeworks that were assigned this semester. Choose any three of the homeworks you worked on, and for each the three homeworks you chose,
   (i) list the topics the homework covered, and (ii) describe one or two most important things you learnt from solving the problems in that homework.
3. (12 pts) Let L and M be two languages. The XOR operator $\oplus$ between two languages is defined as follows:

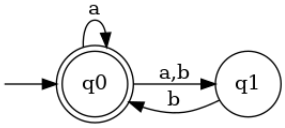
   $$L \oplus M = \{w | w \text{ is either in } L \text{ or } M \text{ but not in both } \}$$

   Is the XOR operation closed for the class of:

   a) regular languages?
   b) context free languages?

   Answer each part with a yes/no, followed by a brief justification.
4. (10 pts) Write a context free grammar generating the language $\{0^{3a}1^{2b}0^{2b}1^{a} : a > 0, b > 0\}$. Please check your solution by actually generating an example word from your grammar.
5. (10 pts) Provide a PDA to accept the language described in problem 4.
6. (10 pts) Provide an implementation-level description (or state diagram) of a Turing machine that accepts the language $\{0^n 2^n : n \geq 0\}$.
7. (14 pts) Given a CFG G and a variable A, consider the problem of testing whether A is **usable**. We say A is usable if it appears in some derivation of some string $w \in G$. Formulate this problem as a language and show that it is decidable.
8. (10 pts)

   a) Convert the following NFA into an equivalent DFA:

   b) Provide an English language description of the language accepted by the above NFA.
9. (10 pts) Answer True or False for each of the following:

   a) $2^{2^n} = O(2^{2^n})$
   b) $n = o(log(n))$
   c) $1 = o(1/n)$
   d) The Halting Problem belongs to the class P of problems.
   e) Every context-free language is a member of P.
10. (8 pts) Suppose you were invited to participate at an Oxford-style debate a student body at a major research university organized on the following topic:

    > "Introduction to Theory of Computation" should be a required course for all Computer Science students seeking a Bachelors degree.

    Write a brief paragraph arguing for or against this debate question. You will be graded on this not for the side you pick, but rather for the quality of the argument you make (i.e., the points you make in your argument).