CompSci 162  Unit 1 Diagnostic Exam 2  Spring 2023

DO NOT OPEN EXAM UNTIL INSTRUCTED TO DO SO
SILENCE AND STORE ALL ELECTRONICS

This is a diagnostic exam intended to help you evaluate your readiness for the real exam.

The following rules apply to you, whether you think they do or not. Read and understand them; failure to abide by these rules, or directions given by course staff during the exam, may result in disciplinary action, including but not limited to a failing grade in the class.

• This exam is solely for students enrolled in this lecture. Anyone not enrolled in this lecture may not take an exam.

• You may not open the exam or begin writing until the instructor has explicitly given you permission to do so.

• Keep your UCI ID readily accessible during the test. Proctors may request to see it.

• This exam is closed book, closed notes, and is individual effort. Once course staff begin passing out exams, you may not communicate with anyone other than proctors for any reason, nor may you have electronics, including calculators watches and phones, available to you during the test for any reason. YOU DO NOT NEED A CALCULATOR!

• If you leave your seat during the test for any reason, your instructor may collect it and deem you to have turned it in. Do not ask proctors for an exemption to this, they are not authorized to grant such.

• If you are still seated at 10:35, you may not leave your seat until explicitly dismissed by the instructor. Leaving after 10:35 and before being dismissed may result in a grade penalty.

• If you believe a question is ambiguous, write at least two reasonable interpretations and indicate clearly which one you will be using. Then answer your question with that assumption. Unless your interpretation makes the problem much more trivial than intended, we will grade your response as if one of us had made that clarification.

• The purpose of the real exam is to evaluate how well you understand the material presented in the course. It is an academic integrity violation to do anything that subverts the goals of this assessment including, but not limited to, not doing your own work or submitting that of anyone else.

• We will only grade responses marked in the space provided for each question.
1. (3 points) Give a regular expression for strings over the alphabet \{a, b\} where the substring \textit{ab} occurs strictly more often than \textit{ba}.

2. (3 points) Draw an NFA for the language consisting of strings over the alphabet \(\Sigma = \{a, b\}\) where, for the first \(k\) symbols when reading the string, for any natural number \(k\), the absolute value of the difference of the number of \(a\)s seen so far and the number of \(b\)s seen so far is at most two. The order does not matter other than that. For example, if I have seen eight characters so far, I might have seen three \(a\) and five \(b\), in any order, other than I could not have seen more than two more of one than the other. For example, \textit{abbabbab} would be okay, as would \textit{aabbbbab}, but \textit{aaabbbbb} would not.

Unnecessarily complex diagrams for this question may cause a loss of points on the real exam. For best results, make use of non-determinism.

3. (2 points) Suppose I have an NFA \(N\). I define a string as being “super duper accepted by \(N\)” if there are two or more accept states that \(N\) can be in when the string is done being processed. Show that the set of “super duper accepted by \(N\)” strings is a regular language.

\textbf{Caution:} Assuming anything about the NFA other than what is listed here or in the definition may cause you to lose credit from your answer.

\textit{Note: this is arguably the hardest question on this exam. Take a deep breath and give it a try. I wouldn’t put it here if I didn’t think you can do it. Think about what we have covered so far in this unit – there is something we discussed. I believe in you!}

Also, consider coming back to this after answering the pumping lemma question on the next page.
Write your answer to question 1 between here and the dotted line below.

Write your answer to question 2 between here and the dotted line below.

Write your answer to question 3 between here and the bottom of the page.
Nothing you write on this page will be graded. The next page in this booklet contains a spot to answer these questions. You may use this page as scratch paper if you would like, and room to do so exists.

4. (2 points) Recall the pumping lemma for regular languages:

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

- $|xy| \leq p$
- $|y| > 0$
- for each $i \geq 0$, $xy^iz \in L$

Consider the language $L_4 = \{w \in \{a,b\}^* ||w|_a > |w|_b\}$ is not regular. That is, $L_4$ consists of all strings over $\Sigma = \{a,b\}$ where there are strictly more instances of the letter $a$ than of the letter $b$.

Use the pumping lemma for regular languages to show that $L_4$ is not regular.

This question will count towards both your quiz 1 score and the portion of your final exam for “Showing a language is not regular by use of the pumping lemma.”

And remember to answer this on the answer page, not on here! Use this page for scratch paper.
Write your answer to question 4 on this page. You will probably not need anywhere near the entirety of it.