Midterm 1- Standard 10

Due Date ..... TODO
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Collaborators ..... **None**

Contents

1 Instructions

- The solutions may be typed or handwritten, using proper mathematical notation. If you handwrite your solutions, you must embed them as an image in the template and orient your image so we do not have to rotate our screens to grade it.
- You should submit your work through the **class Canvas page** only. Please submit one PDF file, compiled using this LaTeX template.
- You may not need a full page for your solutions; pagebreaks are there to help Gradescope automatically find where each problem is. Even if you do not attempt every problem, please submit this document with no fewer pages than the blank template (or Gradescope has issues with it).
- You **may not collaborate with other students**. **Copying from any source is an Honor Code violation. Furthermore, all submissions must be in your own words and reflect your understanding of the material.** If there is any confusion about this policy, it is your responsibility to clarify before the due date.
- Posting to **any** service including, but not limited to Chegg, Discord, Reddit, StackExchange, etc., for help on an assignment is a violation of the Honor Code.
- You **must** virtually sign the Honor Code (see Section 2). Failure to do so will result in your assignment not being graded.

2 Honor Code (Make Sure to Virtually Sign)

- My submission is in my own words and reflects my understanding of the material.
- Any collaborations and external sources have been clearly cited in this document.
- I have not posted to external services including, but not limited to Chegg, Reddit, StackExchange, etc.
- I have neither copied nor provided others solutions they can copy.

(I agree to the above, Alex Ojemann). □

3 Standard 10- Classify Languages as Regular or Non-Regular

3.1 Problem 1

Problem 1. For each language, classify as regular or non-regular. Give justification.

For the justification, when showing a language is regular you can demonstrate using the usual constructions (DFA,NFA,regexp) and do not need to prove that your construction works.

You could also use closure properties and known regular languages. To justify the claim that a language is non-regular, you can use e.g. the pumping lemma or closure properties.

Recall that you may use any languages in the book, problem sets, or in-class exercises, which we have shown to be regular or non-regular. For example, here are some common non-regular languages: $\{a^n b^n : n \geq 0\}$, $\{a^n b^m : n \geq m\}$, $\{a^n b a^n : n \geq 0\}$.

(a) $L = \{xay : x, y \in \{a, b\}^*, |x| = |y|\}$

Proof. Assume L is regular

k given $(k \geq 0)$

Let x_0 and y_0 represent the x and y given in this problem to avoid confusion with the x and y used in the pumping lemma

$x = \epsilon, y = \{a, b\}^k, z = a\{a, b\}^k$

$y = uvw, |v| > 0, v = \{a, b\}^{|v|}$

take i = 2:

$xuv^i wz = xuvvwz = \{a, b\}^{k+|v|} a\{a, b\}^k$

The length of x_0 is now not equal to the length of y_0 so this string is not in the language so this language is non-regular by the pumping lemma □

(b) $L = \{xya : x, y \in \{a, b\}^*, |x| = |y|\}$

Proof. Assume L is regular

k given $(k \geq 0)$

Let x_0 and y_0 represent the x and y given in this problem to avoid confusion with the x and y used in the pumping lemma

$x = \{a, b\}^k, y = \{a, b\}^k, z = a$

$y = uvw, |v| > 0, v = \{a, b\}^{|v|}$

take i = 2:

$xuv^iwz = xuvvwz = \{a, b\}^k\{a, b\}^{k+|v|}a$

The length of x_0 is now not equal to the length of y_0 so this string is not in the language so this language is non-regular by the pumping lemma $\square$