**CSCE 4323 / CSCE 5173 – Formal Languages and Computability**

**Assignment 3 – Due 02/16/2024**

**Instructions:**

The focus of this assignment is on languages defined by regular expressions, methods to convert from RE to NFA, methods to convert from DFA to RE.

For questions asking for a regular expression, you should type your answers using the RE notation used in class ( for the empty string, + for union, \* for Kleene star, and round brackets as needed to specify the order of operations).

For questions asking for a DFA or NFA, you should use draw the automata using JFLAP, test it with a sequence of at least five input strings, save the automata in a “jff” file, and save images in “jpg” format to be included in the homework3.docx file.

For the questions below assume that the input alphabet is  = {a, b} or  = {0,1} based on the letters used in the question itself.

**Questions:**

1. [4 points] What is the regular expression that defines the language L = { w | w starts with an even number of a’s and ends with an odd number of b’s}?

R = (aa)\*b(bb)\*

1. [4 points] What is the regular expression that defines the language L = { w | w starts with the string 11, followed by one or more 0’s, followed by the string 11}?

R = 110(0\*)11

1. [4 points] What is the regular expression that defines the language L = { w | w contains the string “abba” with any number of a’s and b’s before or after “abba”}?

R = (a+b)\*abba(a+b)\*

1. [4 points] What is the regular expression that defines the language L = {w | w represents an even binary number that does not start with the bit 0}?

R = 1(0+1)\*0

1. [12 points] Use the method discussed in class to convert the following three regular expressions into equivalent NFAs. You do not need to simplify the NFAs to reduce the number of nodes or edges.
2. RE1 = (0+1)\*(11+00)

A screenshot of a computer

Description automatically generated

1. RE2 = (101+0)(0+111)\*

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1. RE3 = 1\*0\*1\*0\*

A screenshot of a computer

Description automatically generated

1. [12 points] Use the method discussed in class to convert the following three automata into equivalent regular expressions. You should remove GNFA nodes in numerical order (q0, q1, q2) and draw the GNFA with updated edge labels after each node is removed. You do not need to test the GNFAs.
2. A diagram of a triangle with a yellow circle and black lines

   Description automatically generated

A diagram of a diagram of a diagram

Description automatically generatedA diagram of a line of circles and a line of lines

Description automatically generatedA diagram of a circle with a yellow circle

Description automatically generatedA close-up of a wire

Description automatically generated

1. A diagram of a triangle with a yellow circle and black lines

   Description automatically generated

A diagram of a network

Description automatically generatedA diagram of a triangle with circles and lines

Description automatically generatedA diagram of a triangle

Description automatically generatedA person holding a string with numbers

Description automatically generated

c) A diagram of a circle with a yellow circle and black lines

Description automatically generated

A diagram of a line of circles

Description automatically generatedA diagram of a line of circles

Description automatically generatedA diagram of a line with circles and text

Description automatically generatedA line with a circle and a circle with a line in the middle

Description automatically generated

**Challenge Questions: (optional for undergraduates, required for graduates)**

1. [4 points] Use the method discussed in class to convert the following automata into an equivalent regular expression. You should remove GNFA nodes in numerical order (q0, q1, q2,q3) and draw the GNFA with updated edge labels after each node is removed. You do not need to test the GNFA.

A diagram of a triangle with circles and lines

Description automatically generated

1. [4 points] Use the method discussed in class to convert the following regular expression into an equivalent NFA. You do not need to simplify the NFA to reduce the number of nodes or edges.

RE = (aa + bb)\* + (ab + ba)\*

**Assignment Submission:**

Once you have answered all of the questions above, create a document called “hw3.docx” that has a copy of the questions above and copy/paste the “jpg” images you created into this document. Create a folder called “hw3” that contains all of your “jff” files and compress this folder to create “hw3.zip”. Finally, upload “hw3.zip” and “hw3.docx” into the “hw2” link in Blackboard. In order to receive full credit for each question, the “jff” files must be named correctly, and they must load and operate correctly in JFLAP. *Points will be deducted for missing or incorrectly named JFLAP files.*

The dates on your electronic submission will be used to verify that you met the due date above. All late assignments will receive reduced credit:

* 10% off if less than 1 day late,
* 20% off if less than 2 days late,
* 30% off if less than 3 days late,
* no credit if more than 3 days late.

**7. Academic Honesty Statement:**

Students are expected to submit their own work on all assignments, unless group projects have been explicitly assigned. Students are NOT allowed to distribute solutions to each other, or copy solutions from another individual or website. Students ARE allowed to use any materials on the class website, or in the textbook, or ask the instructor and/or GTAs for assistance.

Violations of the policies above will be reported to the Provost's office and may result in a ZERO on the assignment, an F in the class, or suspension from the university, depending on the severity of the violation and any history of prior violations.