CSE332 Theory of Computation
Homework 1

Instructor: Mijung Kim

Due: Tuesday, October 11, 2022 at 11:59pm on Blackboard

General Information

This homework is worth 10% of your final grade. It has 10 problems worth 130 points in total.
We take cheating very seriously. Please revisit and be well-noted with Syllabus and CSE Cheating Policy on Blackboard.
If you have any questions, please actively use Pizza at `http://piazza.com/unist.ac.kr/fall2022/cse332` or TA's Office Hours.

Submission Guidelines

Your homework must be typed in `LaTeX` and compiled into a PDF. This PDF file should be submitted on Blackboard. Please note that **no late submission will be accepted**.

`LaTeX` Guidelines

We recommend to use `Overleaf` for editing and compiling your `.tex` files. For a reference, we provided the original `tex` files that we used to write this homework. Those files are included in the attached `hw.zip` file. At `overleaf.com`, go to `New Project` > `Upload Project` and upload the attached zip file. In the created project, you can get the PDF file by compiling `hw1.tex`. If you have difficulties in using `LaTeX`, please ask TAs for help on Piazza or during their Office Hours.

Problems

Problem 1 (10pts) Prove that $(uv)^R = v^R u^R$ for all $u, v \in \Sigma^+$. (Hint: Use induction on the length of v.)
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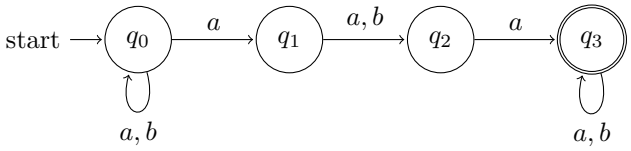
Problem 2 (10pts) Consider the following language: $L = \{w \in \{0,1\}^* \mid w \text{ ends with } 1001.\}$.

1. (5pts) Design a DFA that accepts L.
2. (5pts) Design an NFA that accepts L.

Problem 3 (10pts) Design an NFA to recognize the strings that represent real numbers. Assume $\Sigma = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, .\}$. For example, the NFA should accept strings such as "1.0", "12.156", and ".01", but must reject strings such as "0.5.1", "12.", and "3".

Problem 4 (20pts) Use subset construction to convert the following NFA to a DFA:



Problem 5 (10pts) Design an ϵ-NFA that accepts the following language:

$$L = \{a^m b^n c^o \mid m, n, o \geq 0\}$$

Problem 6 (20pts) Consider the following transition table of an ϵ-NFA:

	ϵ	a	b	c
p	$\emptyset$	$\{p\}$	$\{q\}$	$\{r\}$
q	$\{p\}$	$\{q\}$	$\{r\}$	$\emptyset$
r	$\{q\}$	$\{r\}$	$\emptyset$	$\{p\}$

where p is the initial state and r is the final state.

1. (10pts) Compute the ϵ-closure(EClosure) of each state.
2. (10pts) Convert the automaton to a DFA.

Problem 7 (15pts, 5pts each) Find regular expressions for the following languages.

1. $L = \{\omega \in \{a, b, c\}^* \mid \omega$ has no more than three a's$\}$
2. $L = \{\omega \in \{0, 1\}^* \mid \omega$ begins and ends with 0 and contains at least one 1$\}$
3. $L = \{\omega \in \{0, 1\}^* \mid \omega$ does not contain 111$\}$

Problem 8 (20pts) Consider a DFA represented by a transition table:

	0	1
$\rightarrow q_1$	q_2	q_1
q_2	q_3	q_1
$*q_3$	q_3	q_2

Give all the regular expressions $R_{ij}^{(0)}$,$R_{ij}^{(1)}$,$R_{ij}^{(2)}$. Try to simplify the expressions as much as possible. Think of state q_i as if it were the state with number i.

Problem 9 (10pts) Convert the following regular expressions to finite automata (ϵ-NFA): $ab^*aa + bba^*ab$

Problem 10 (10pts) Find a ϵ-NFA that accepts language $L(ab^*a^*) \cap L(a^*b^*a)$.