Concepts of Programming Languages, CSCI 305, Fall 2021
Homework, complete by Sept. 17

Regular Expressions

In addition to the two problems below, do exercises 2.1 a & f and 2.9 a from the text (pages 105-107)

1. Give a regular expression for the even integers 0, 2, 4, 6, …. (Don't allow extra leading 0's, such as 012, and you don't need to worry about putting digits into groups of 3).

   0 | 2 | 4 | 6 | 8 | [(1 | 2 | 3 | … | 9) (0 | 1 | 2 | … | 9)* (0 | 2 | 4 | 6 | 8)]

2. all strings except 11 or 111.

   ε | (0 | 1)* 0 (0 | 1)* | 1 | 11111*

Exercise 2.1, a.
Strings in C. These are delimited by double quotes ("), and may not contain newline characters. They may contain double-quote or back-slash characters if and only if those characters are "escaped" by a preceding backslash. You may find it helpful to introduce shorthand notation to represent any characters that is *not* a member of a small specified set.

Example legal strings: "hello!", "she said \"hello!\"", "\"""",
"this is weird \"\\\""
Example illegal strings: "hello!"", """hello!""

Regular expressions as productions:
string → " (legalChar | legalPair)* "
legalChar → any chararacter except newline, " or \
legalPair → \" | \\

Exercise 2.1, f.
Financial quantities in American notation. These have a leading dollar sign ($), an optional string of asterisks (*-used on checks to discourage fraud), a non-empty string of decimal digits, and an optional fractional part consisting of a decimal point (.) and two decimal digits. The string of digits to the left of the decimal point may consist of a single zero (0). Otherwise, it must not start with a zero. If there are more than three digits to the left of the decimal point, groups of three (counting from the right) must be separated by commas (,). Example: $**2, 345.67. (Feel free to use "productions" to define abbreviations, so long as the language remains regular.)

Example legal strings: $0 , $0.00 , $***29,000,123.23
Example illegal strings: "***$, $$,   29,34.13

Regular expressions as productions:
financialQuantity $\rightarrow$ \$ $\circ$ $*^*$ $\circ$ dollars $\circ$ fraction

dollars $\rightarrow$ 0 |
nonZeroDigit cluster* |
nonZeroDigit digit cluster* |
nonZeroDigit digit digit cluster*
nonZeroDigit $\rightarrow$ 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
digit $\rightarrow$ 0 | nonZeroDigit
cluster $\rightarrow$, digit digit digit
fraction $\rightarrow$ ε | (. digit digit)

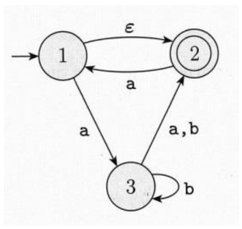
Exercise 2.9

Part a.
Describe in English the language defined by the regular expression a* (ba*ba*)*. Your description should be a high-level characterization-one that would still make sense if we were using a different regular expression for the same language.

Any string of a's and b's containing an even number, possibly 0, of b's.

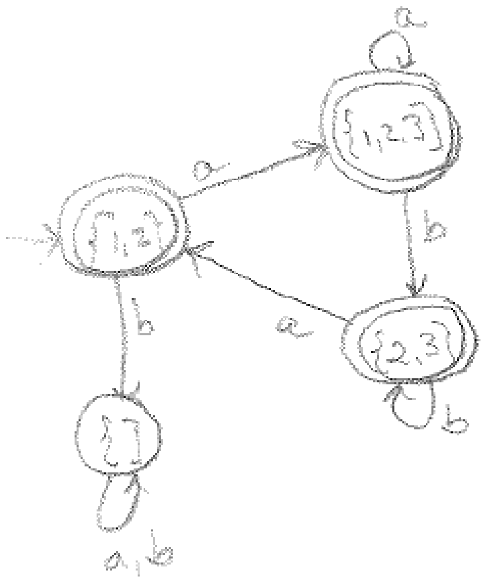
DFA and NFA

7. Consider the NFA below. Give some example strings that are in the NFA and some which are not in the NFA.



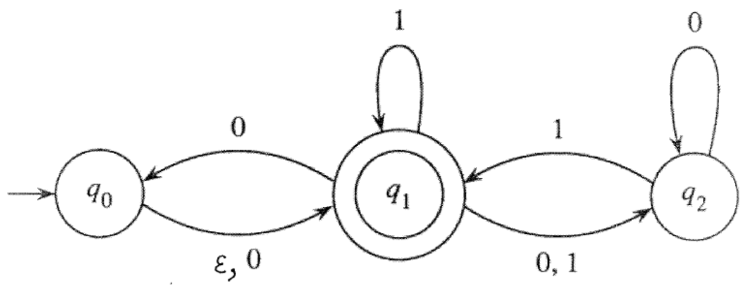
Strings which are in the NFA	Strings which are not in the NFA
ε	b
a*	b (a|b)*
ab*a	
ab*b	
ab*ba*	

8. Convert the NFA to an equivalent DFA using the algorithm given in class and discussed in the text.



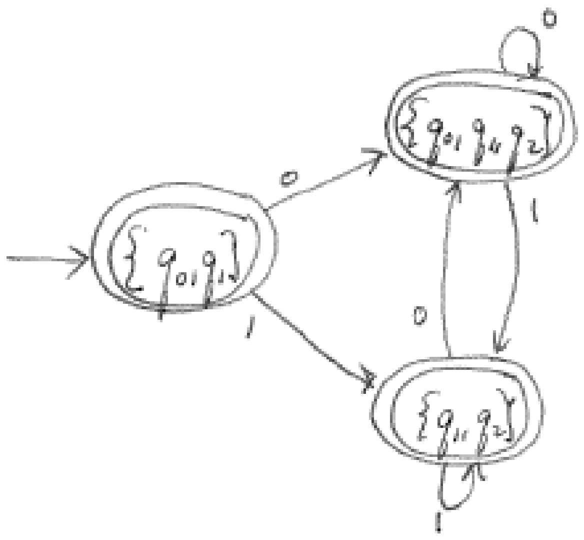
Check that each of the strings that were in the NFA, are also in the DFA, and each of the strings that were not in the NFA, are also not in the DFA.

9. Consider the NFA below. Give some example strings that are in the NFA and some which are not in the NFA.



Strings which are in the NFA	Strings which are not in the NFA
ε	
0	
1	
(0 | 1)*	

10. Convert the NFA to an equivalent DFA using the algorithm given in class and discussed in the text.



Check that each of the strings that were in the NFA, are also in the DFA, and each of the strings that were not in the NFA, are also not in the DFA.