Theory of Computation, CSCI 438, Spring 2022
Essay questions for exam 1, Feb. 14

Answer the following with as many, or as few, words as is needed to thoroughly answer the question. You may use your notes, text or the Internet to answer these questions. You may not discuss these questions with any other students.

1. Describe at least three situations where regular expressions are useful. (5 pts.)

    1. Validating input
    2. Formatting output (the parameters of scanf provides one example) or data coming from somewhere, to be used somewhere else
    3. Searches/filtering within MSExplorer, Google, grep, and many other tools
    4. Recognizing tokens by a lexical analyzer
    5. Defining tokens
    6. Shortens particular code segments by replacing multiple if-else statements with the utilization of regular expressions

2. One of your classmates doesn't understand the pumping lemma. Explain the pumping lemma to this student without using the formulas. (5 pts.)

    The pumping lemma can be used to prove that a language is not regular. It does this by exploiting the fact that any regular language can be described by a DFA with a finite number of states. This means that for infinite languages, any long string in the language, must visit some state at least twice. (This is based on the Pigeonhole Principle – where the pigeons are the characters in the string and the boxes are the states of the DFA. Since the string is long, there will be more characters of the string than there will be states, so two characters will need to cause the DFA to enter the same state twice.)

    Since, when traversing the string, one state is visited at least twice, a similar string where the state was only visited once must also be in the language. Also, a similar string but where the state is visited more than twice must be in the language. This process of identifying strings which are similar to the original but where a portion of the string is removed or repeated, is known as "pumping the string". If a long string in the language can't be pumped for any breakdown of the string, the language must not have been regular.

3. Your classmate is so excited about the pumping lemma that he wants to use the fact that a sufficiently long string can be pumped to prove that the language is regular. Respond to this student explaining why the pumping lemma cannot be used this way. (Don't just say it can't, tell them why.) (5 pts.)

Many non-regular languages contain strings that can be pumped. Being able to pump a single string, or even many strings, doesn't say anything about the whole language.

4. Say that you are given a pattern, expressed as a regular expression, and told to write a function which is passed a string and returns true if the string is a member of the language described by the regular expression and false otherwise. Describe how you could use your knowledge of deterministic finite automaton in order to implement this function. Write pseudo code for the function. (5 pts.)

Every regular expression can be converted to an NFA and every NFA can be converted to a DFA. Using the DFA, code the following:

```
bool parseString (String w) {
        currentState = startState
        foreach  (char c in w) {
                currentState = DFA_transition(currentState, c)
        }
        if currentState is in Final, accept; otherwise reject
```