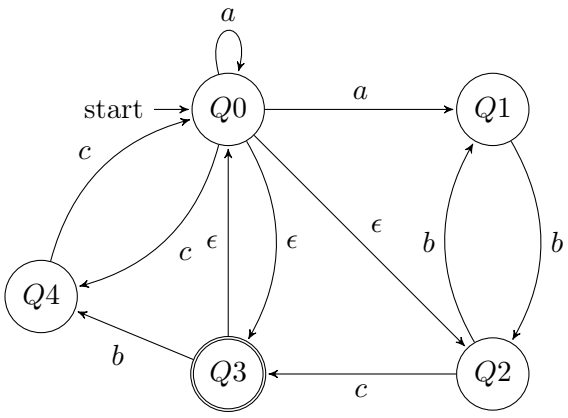
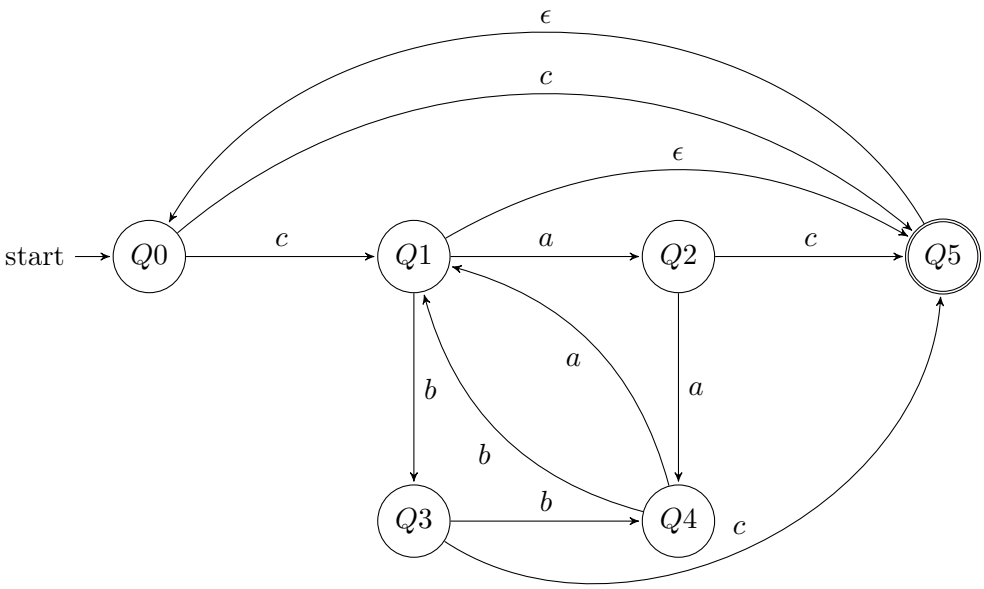
Language and Logic Assignment 1

- Please submit your solutions in a .pdf file in addition to commented code and executable files with instructions regarding execution.
- Submit each file separately in uncompressed format.
- The deadline for submissions is 14 April 2019.
- Only typed solutions will be accepted. You can however submit scans or images of the automata. Please show the steps when solving the questions.
- *Reports that do not comply with the aforementioned requirements will not be considered.*

Question 1.

Give equivalent DFAs and Regular Expressions with the minimum number of operators for the following NFAs (25points)





Question 2.

Write regular expressions over $\Sigma = \{a, b, c\}$ for (20points)

1.Strings with:

1. Starting or ending with a number of a's divisible by 2 and
2. can be split into disjoint substrings of length 5 such that each of such a substring has 3 b's and 2 c's

2.Strings with at least 2 a's separated by a substring with the following properties:

1. contains at least 1 occurrence of each of a, b, c and
2. has length that is a multiple of 2

Note: The properties refer to the substring and not the whole word.

3.Integer literals in java consist of a set of digits that can be categorized based on their prefix and suffix.

1. When a literal is prefixed with "0" it corresponds to an octal int
2. When a literal is prefixed with "0b" or "0B", it corresponds to an binary int
3. When a literal is prefixed with "0x" or "0X", it corresponds to a hexadecimal int
4. When no prefix exists, it is considered a decimal int
5. If any of the above cases is suffixed with an "L", then the integer is considered a long instead.

- Write a regular expression or a set of regular expressions capable to recognize the type and numerical base of integers in java
- Give the equivalent NFA

Question 3.

1.Prove whether the following languages are regular or not over $\Sigma = \{a, b, c\}$ (10points)

$(ab)^n(ba)^m \ \ n \geq m \geq 0$

$c^{2k}ab^2c^{2n} \ \ n \geq 0, k > 1$

Question 4.

Enhanced Dictionary design and implementation (30points)

A word dictionary can be implemented using an automaton.

1. Explain how a deterministic automaton that can store any set of English words can be built.

   Give an automaton that contains: {logic, logical, local, locally, paradox, paradoxes}.

2. Explain how the above designed automaton can be extended with automatic completion and grammatical checking capabilities.

Implement your solution (both the automaton and auto-completion and grammatical checking) in a programming language of your choice, it should be able to:

1. Load an external dictionary given as a raw text file.
2. Search for a word in the dictionary.
3. Provide automatic completion by increasing depth.
4. Be able to grammatically check a sentence based on the automaton.

Note: you can use the words file provided with the assignment to validate your programs.

Question 5.

Let Σ_1 and Σ_2 be two arbitrary alphabets, and f be a function that maps every symbol of Σ_1 to an element in Σ_2, i.e., $f : \Sigma_1 \to \Sigma_2$. Let L_1 be a regular language, $f^*(s_1 s_2 \ldots) = f(s_1)f(s_2)\ldots$ where $s_1 s_2$..... is a string, and $f^*(L_1) = \bigcup_{w \in L_1} f^*(w)$. The function $F(L_2)$ is defined as follows:

$$F(L_2) = \{w \in \Sigma_1^* \mid f^*(w) \in L_2\}$$

Show that if L_2 is regular, then $F(L_2)$ is regular as well. (15 points)