MedTech
MEDITERRANEAN INSTITUTE OF TECHNOLOGY

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Exercise 1. Lexical Analysis: Token Specification

Provide a regular expression over $\Sigma = \{a, b, ..., z, 0, 1, 2, ..., 9\}$, for each one of the following specifications:

1. A **keyword** could be "for", "while", "if", "else", "elseif" or "forall".
2. An **Integer** is a non-empty sequence of digits which not starts by "0".
3. An **EInteger** is a non-empty sequence of digits which not starts by "0" and is even.
4. An **Identifier** is a non-empty sequence of characters which not starts by a digit and should not provide a keyword.
5. A **FunctionName** is a non-empty sequence of an odd number of characters which not starts by a digit.

Exercise 2. Lexical Analysis: Implementation

Consider the following DFA1 = $< Q = \{Q0, Q1\}, Sigma = \{a, b\}, Delta, I = \{Q0\}, F = \{Q0\} >$
Delta(Q0,a)={Q1}, Delta(Q0,b)={Q0}
Delta(Q1,a)={Q0}, Delta(Q1,b)={Q1}

1. Using the Arden's lemma, compute the language recognized by this DFA1.

Consider the following $NFA1 =< Q = \{Q0, Q1, Q2\}, Sigma = \{a, b\}, Delta, I = \{Q0\}, F = \{Q2\} >$
Delta(Q0,a)={Q0,Q1}, Delta(Q0,b)={Q0}
Delta(Q1,b)={Q2}, Delta(Q2,a)={Q2}, Delta(Q2,b)={Q2}

2. Convert the NFA1 to a DFA.

Exercise 3. Syntax Analysis: Introduction
Consider the following grammar G_1:

$$\begin{array}{lcl} \text{S} & \rightarrow & \text{NTS} \mid \text{NT} \\ \text{N} & \rightarrow & 1 \mid 2 \\ \text{T} & \rightarrow & \text{A} \mid \text{BC} \\ \text{A} & \rightarrow & \text{ac} \mid \text{Ta} \\ \text{B} & \rightarrow & \text{b} \mid \text{Tb} \end{array}$$

1. Provide the set of the terminals and the set of the non-terminals of the grammar G_1.

2. List the productions of the grammar G_1.

3. Derive the following string: "1a2b" and provide the derivation tree and the productions' sequence.

4. Derive the following string: "2abba" and provide the derivation tree and the productions' sequence.

5. Write a regular expression that recognizes the same language as G_1. Use the character "|" for the union.

Problem. Using Lexical Analysis to resolve common problems
An industrial company has to develop the software for its coffee machine, which provides three kinds of preparations that are coffee, cappuccino, and cheesecake. The prices of the goods are respectively 1 dinar, 1.5 dinar, and 3 dinars. This machine accepts only three types of coins: 0.5 dinar, 1 dinar, and 2 dinars.

Since this machine keeps the change, the developers have to provide a solution to deliver the right items when the user inserts the coins. Therefore, when the consumer inserts coins and reaches the exact price of an item, the coffee machine will give such the item. To resolve this problem, the developers will handle the sequence of coins as an input sequence of characters. As a result, the items delivered by the machine are considered tokens.

For example, if the consumer inserts two coins of 0.5 dinars, the coffee machine will give a coffee. The machine will not provide a cappuccino only unless the consumer inserts a coin of 0.5 followed by 1 dinar.

1. For which sequence of coins, the coffee machine will provide a cheesecake?

2. Which alphabet Σ will be used by the developers?

3. Provide the regular expression related to the token "coffee".

4. Provide the regular expression related to the token "cappuccino".

5. Give the regular expression related to the token "cheesecake".

6. Write the regular expression related to the token "CCa" when the machine gives a coffee and a cappuccino.

7. Provide the regular expression related to the token "CCC" when the machine gives a coffee and cheesecake.

8. Give the DFA related to the coffee machine.

9. Give the table which describes the DFA of the previous question

The senior developer has defined the following algorithm. He has also provided a function called "`dispenseItem`" which takes as input a state of the automaton and gives the identified tokens related to a final state. The function "`getCoin`" returns 1, 2, and 3 when the customer introduces 0.5, 1, and 2 dinars, respectively.

```
1 CoffeeMachine (table, initState, finalStates){
2  while (true){
    state <- initState;
4   Cv <- getCoin();
    genToken (table, state, finalStates);
6  }}
```

10. Complete the solution by generating the algorithm of the procedure "genToken".

11. Provide the mandatory modification when we remove the statement "while (true)" of the above algorithm.