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sec. 036

CIIC4030/ICOM4036: Programming Languages

University of Puerto Rico at Mayaguez

Assignment 1

1. Describe the languages denoted by the following regular expressions
   (a) $\mathbf{a}(\mathbf{a}|\mathbf{b})^*\mathbf{a}$
   (b) $\mathbf{a}^*\mathbf{b}\mathbf{a}^*\mathbf{b}\mathbf{a}^*\mathbf{b}\mathbf{a}^*$
2. Construct a Deterministic Finite Automation (DFA) for each of the languages described in Problem 1.
3. Write regular definitions for the following languages
   (a) All strings of lowercase letters that contain the five vowels in order.
   (b) All strings of **a's** and **b's** that do not contain the substring **abb**
4. Consider the following context-free grammar

$$S \rightarrow SS+ \mid SS* \mid \mathbf{a}$$

   (a) Show how the string **aa+a*** can be generated by this grammar
   (b) What language does this grammar generate? Explain.
5. Construct a recursive-descent parser for the following grammar

$$S \rightarrow S(\,S)\,S \mid \epsilon$$

1. Describe the languages denoted by the following regular expressions

   (a) $\mathbf{a(a|b)^*a}$

   (b) $\mathbf{a^*ba^*ba^*ba^*}$

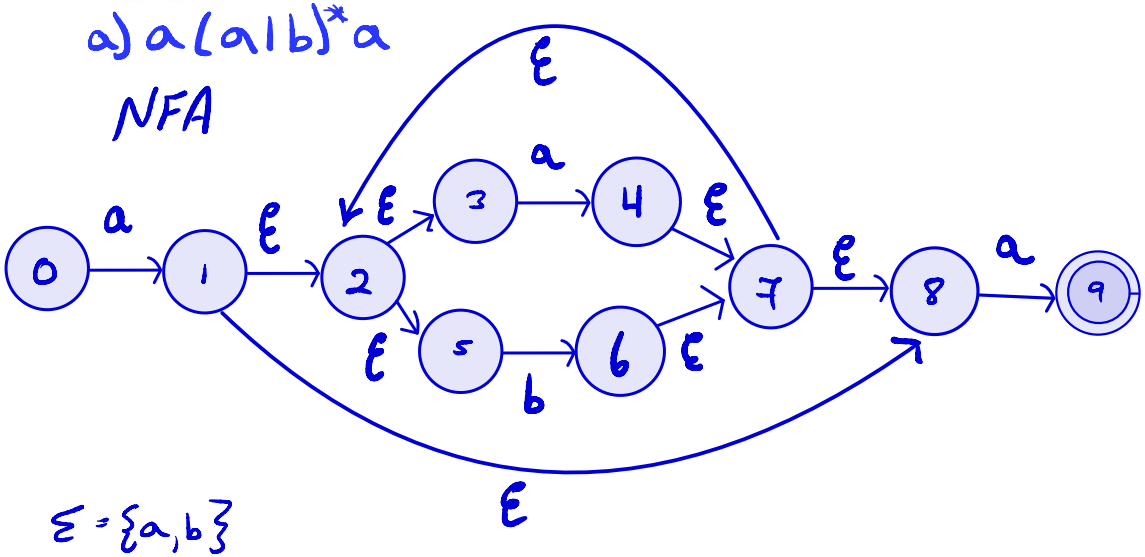
a) In the first language we can see that the language should start with "a". Also should end with "a". In the center there may be any repetitions of "a" or "b".

b) In the second language we can see that the language starts with repetitions of a, followed by a mandatory b. Then other repetition of a's and a mandatory b once again. The next sequence is the same than the last one. Finally ends with a repetition of a. In summary, 3 mandatory b and 4 infinite repetitions of a starting with a, then b until ending with an a.

2. Construct a Deterministic Finite Automation (DFA) for each of the languages described in Problem 1.

a) $a(a|b)^*a$

NFA



$\Sigma = \{a, b\}$

ε-closure(0) = {0} = A

move(A,a) = {1}
ε-closure(move(A,a)) = {1,2,3,5,8} = B
move(A,b) = {0}
ε-closure(move(A,b)) = {0} = A

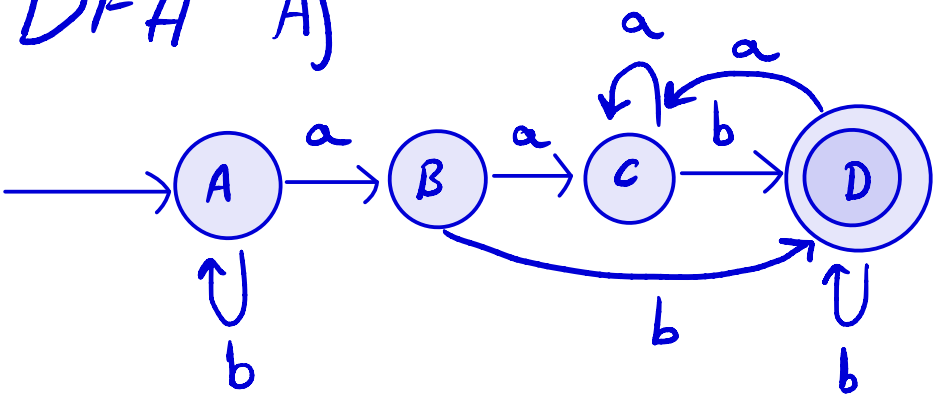
move(B,a) = {4}
ε-closure(move(B,a)) = {2,3,4,5,7,8} = C
move(B,b) = {6}
ε-closure(move(B,b)) = {2,3,5,6,7,8} = D

move(C,a) = {4,9}
ε-closure(move(C,a)) = {2,3,4,5,7,8} = C
move(C,b) = {6}
ε-closure(move(C,b)) = {2,3,5,6,7,8} = D

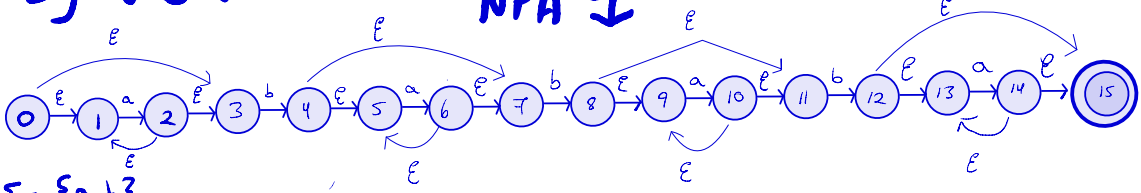
move(D,a) = {4,9}
ε-closure(move(D,a)) = {2,3,4,5,7,8} = C
move(D,b) = {6}
ε-closure(move(D,b)) = {2,3,5,6,7,8} = D

states	a	b
A	B	A
B	C	D
C	C	D
D	C	D

DFA A)



b) $a^*ba^*ba^*ba^*$ NFA 1



$\Sigma = \{a, b\}$

$\varepsilon\text{-closure}(0) = \{0,1,3\} = A$

States	A	B
A	B	C
B	B	C
C	C	D
D	D	E
E	E	E

move(A,a) = {2}
ε-closure(move(A,a)) = {1,2,3} B

move(A,b) = {4}
ε-closure(move(A,b)) = {4,5,7} C

move(B,a) = {2}
ε-closure(move(B,a)) = {1,2,3} B

move(B,b) = {4}
ε-closure(move(B,b)) = {4,5,7} C

move(C,a) = {6}
ε-closure(move(C,a)) = {4,5,7,} C

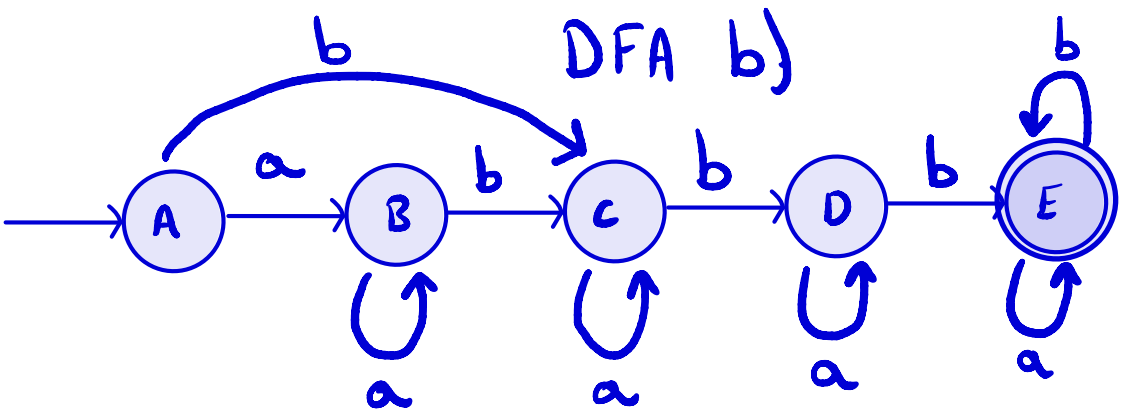
move(C,b) = {8}
ε-closure(move(C,b)) = {9,10,11} D

move(D,a) = {10}
ε-closure(move(D,a)) = {9,10,11} D

move(D,b) = {12}
ε-closure(move(D,b)) = {12,13,15} E

move(E,a) = {14}
ε-closure(move(E,a)) = {12,13,15} E

move(E,b) = {12}
ε-closure(move(E,b)) = {12,13,15} E


DFA b)
b
a
b
b
b
b
A
B
C
D
E
a
a
a
a

3. Write regular definitions for the following languages

(a) All strings of lowercase letters that contain the five vowels in order.

(b) All strings of **a's** and **b's** that do not contain the substring **abb**

a) Lowercase alphabet without vowels

$L = \{b\,c\,d\,f\,g\,h\,j\,k\,l\,m\,n\,p\,q\,r\,s\,t\,w\,x\,y\,z\}$

$a(L|a)^*(L|e)^*e(L|i)^*i(L|o)^*o(L|u)^*u$

b) $b^*(a|b)aba^*$

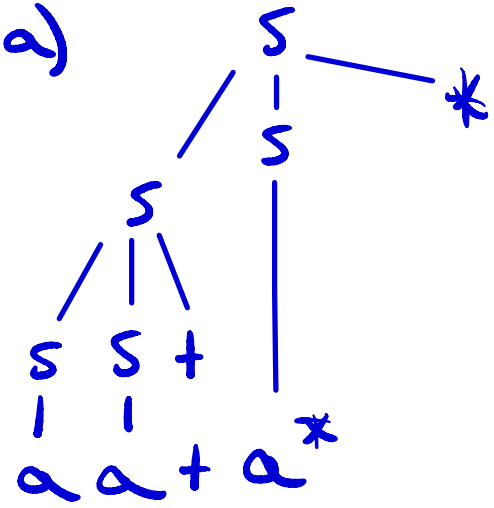
4. Consider the following context-free grammar

$$S \to SS+ \mid SS* \mid \mathbf{a}$$

(a) Show how the string **aa+a*** can be generated by this grammar

(b) What language does this grammar generate? Explain.

a)



b) This grammar generate a language of strings and operators + and * to represent maths symbols.

5. Construct a recursive-descent parser for the following grammar

$$S \rightarrow S(\,S)\,S \mid \epsilon$$

void S(){

if(