CS321 Introduction to Theory of Computation
Assignment No. 3, Due: Noon, Friday February 16, 2024

1. Suppose that a bank only permits passwords that are strings from the alphabets $\sum = \{a, b.c, d, 1, 2, 3, 4, \#, \$, \&\}$. The passwords follow the rules

   (a) The length can be 5 or 6.

   (b) The first alphabet must be from $\{a, b, c, d\}$.

   (c) The last two alphabets must be from $\{1, 2, 3, 4\}$

   (d) Exactly one alphabet is from $\{\#, \$, \&\}$

   Give a regular expression for this language.

2. Find an NFA that accepts the language $L = L(ab^*a^*) \cup L((ab)^*ba)$.

3. Suppose an NFA is defined by

   $\delta(q_0, a) = \{q_0, q_1\}$.
   $\delta(q_1, b) = \{q_1, q_2\}$
   $\delta(q_2, a) = \{q_2\}$
   $\delta(q_0, \lambda) = \{q_2\}$

   with initial state q_0 and final state q_2. Find the regular expression for the language accepted by this NFA.

4. Construct a DFA that accepts the language generated by the grammar

$$S \to abS|A$$

$$A \to baB$$

$$B \to aA|bb$$

5. Construct right- and left-linear grammar for the language

$$L = \{a^n b^m : n \geq 2, m \geq 3\}.$$

1. Suppose that a bank only permits passwords that are strings from the alphabets $\Sigma = \{a, b.c, d, 1, 2, 3, 4, \#, \$, \&\}$. The passwords follow the rules

   (a) The length can be 5 or 6.

   (b) The first alphabet must be from $\{a, \overset{A}{b}, c, d\}$. B

   (c) The last two alphabets must be from $\{1, 2, 3, 4\}$

   (d) Exactly one alphabet is from $\{\#, \$, \&\}$

   Give a regular expression for this language.

We assume that

length is 5 or 6

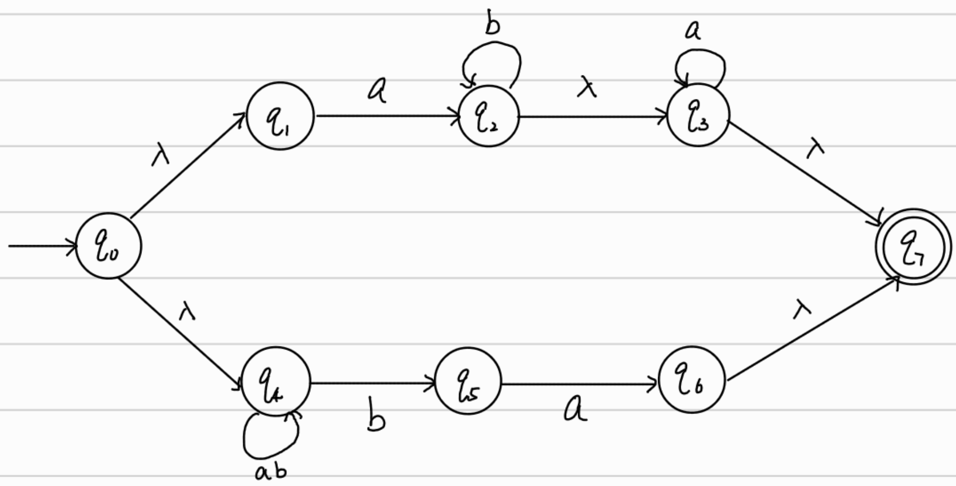
$L = a + b + c + d$

$N = 1 + 2 + 3 + 4$

$S = \# + \$ + \&$

$$RE = L((S)((L+N) + (L+N)(L+N))NN$$
$$+ L((L+N)((S) + (S)(L+N))NN$$
$$+ L(((L+N)(L+N))(S))NN$$
$$= L(((S)((L+N)+(L+N)(L+N))) + ((L+N)((S)+(S)(L+N))) + (((L+N)(L+N))(S))NN$$

2. Find an NFA that accepts the language $L = L(ab^*a^*) \cup L((ab)^*ba)$.

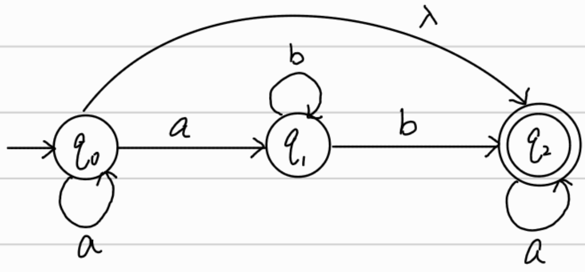


3. Suppose an NFA is defined by

$\delta(q_0, a) = \{q_0, q_1\}$.
$\delta(q_1, b) = \{q_1, q_2\}$
$\delta(q_2, a) = \{q_2\}$
$\delta(q_0, \lambda) = \{q_2\}$

with initial state q_0 and final state q_2. Find the regular expression for the language accepted by this NFA.

The equivalent NFA is:



$$RE = a((ab^*b)+\lambda)a^*$$

4. Construct a DFA that accepts the language generated by the grammar

$$S \to abS|A$$

$$A \to baB$$

$$B \to aA|bb$$

$S \to abS|A$

$S \to abA \quad S \to A$

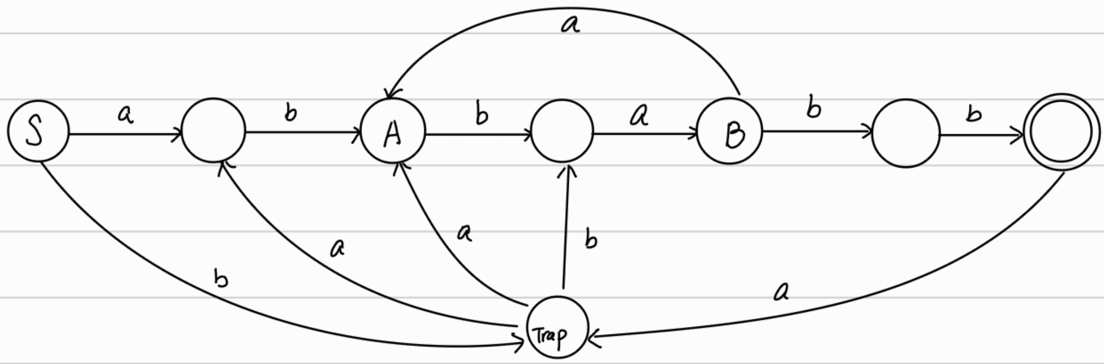
$S \to abbaB \quad A \to baB$

$S \to abbaaA \quad B \to aA$

$S \to abbaabaB \quad A \to baB$

$S \to abbaababb \quad B \to bb$

The DFA of given grammar can be shown:



So we can kown that the DFA that accepts the language generated by the grammar $S \to abS|A$, $A \to baB$ $B \to aA|bb$.

5. Construct right- and left-linear grammar for the language

$$L = \{a^n b^m : n \geq 2, m \geq 3\}.$$

$L = \{a^n b^m \mid n \geq 2, m \geq 3\}$

$RE = aaa^* bbbb^*$

R:

$S \rightarrow aaA$
$A \rightarrow aA$
$A \rightarrow bbbB$
$B \rightarrow bB$
$B \rightarrow \lambda$

$S \xrightarrow{1} aaA \xrightarrow{2} aaaA \xrightarrow{3} aaabbbB \xrightarrow{4} aaabbbbB \xrightarrow{5} aaabbbb$

L:

$S \rightarrow Bb$
$B \rightarrow Abbb$
$A \rightarrow Aa$
$A \rightarrow Aaa$
$A \rightarrow \lambda$

$S \xrightarrow{1} Bb \xrightarrow{2} Abbbb \xrightarrow{3} Aabbbb \xrightarrow{4} Aaaabbbb \xrightarrow{5} aaabbbb.$