

# Assignment 1

## Regular Expressions

- Find a regular expression to describe each of the following **five** languages.

$\{\Lambda, a, abb, abbbb, \dots, ab^{2^n}, \dots\}$ .

$\{\Lambda, a, b, c, aa, bb, cc, \dots, a^n, b^n, c^n, \dots\}$ .

$\{\Lambda, a, b, ca, bc, cca, bcc, \dots, c^na, bc^n, \dots\}$ .

$\{a^{2k} \mid k \in \mathbb{N}\} \cup \{b^{2k+1} \mid k \in \mathbb{N}\}$ .

$\{a^m bc^n \mid m, n \in \mathbb{N}\}$ .

- Find a regular expression over the alphabet  $\{0, 1\}$  to describe the set of all binary numerals without leading zeros (except 0 itself). So the language is the set  $\{0, 1, 10, 11, 100, 101, 110, 111, \dots\}$ .
- Find a regular expression for each of the following languages over the alphabet  $\{a, b\}$ .
  - Strings with even length (empty string is included).
  - Strings whose length is a multiple of 3.
  - Strings in which the letter b is never tripled. This means that no word contains the substring bbb.
  - Strings with an odd number of a's and an odd number of b's.
- Describe in English phrases the languages associated with the following regular expression:
  - $a^*b(a^*ba^*b)^*a^*$
  - $((a + b)^3)^*(\Lambda + a + b)$ .
  - $(b + ab)^*(a + ab)$
- Construct a regular expression defining each of the following languages over the alphabet  $\{a, b\}$ :
  - All strings in which the total number of a's is divisible by 3 no matter how they are distributed, such as aabaabbaba.
- Describe (in English phrases) the languages associated with the following regular expressions:
  - $(a + b)^*a(A + bbbb)$
  - $(a(a + bb)^*)^*$
  - $(a(aa)^*b(bb)^*)^*$
  - $(b(bb)^*)^*(a(aa)^*b(bb)^*)^*$
  - $(b(bb)^*)^*(a(aa)^*b(bb)^*)^*(a(aa)^*)^*$
  - $((a + b)a)^*$
- Show that the following pairs of regular expressions define the same language over the alphabet  $\{a, b\}$

- $(ab)^*a$  and  $a(ba)^*$
- $(a^* + b)^*$  and  $(a + b)^*$
- $(a^* + b^*)^*$  and  $(a + b)^*$ .
- $(a^*bbb)^*a^*$  and  $a^*(bbba^*)^*$

## Finite Automata

### DFA

- Transform each of the following regular expressions into a DFA.
  - $a^*b^*$ .
  - $(a+b)^*$ .
  - $a^*+b^*$ .
- Design a DFA that accepts all strings over  $\{a, b\}$ 
  - All strings that do not end with  $aa$ .
  - All strings that contain an even number of  $b$ 's
  - All strings which do not contain the substring  $ba$

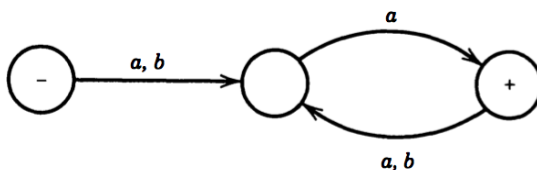
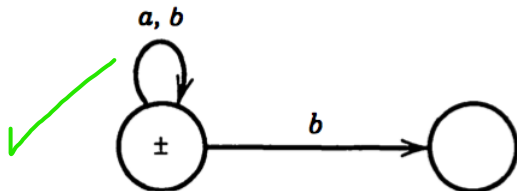
### NFA

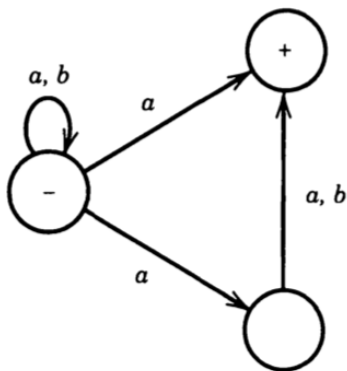
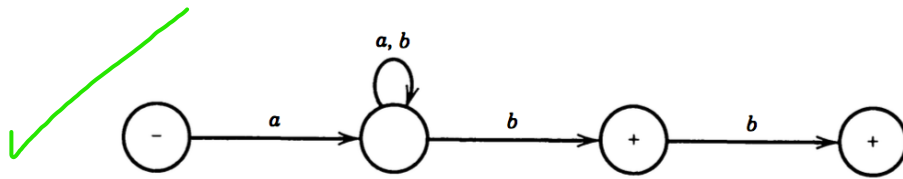
Draw NFA for each of the following languages over the alphabet  $\{a, b\}$

- All strings that contain two  $a$ 's separated by a substring whose length is a multiple of 3.
- All strings that contain an even number of  $b$ 's.
- All strings which do not contain the substring  $ba$ .

### NFA to DFA

Convert the following NFA to DFA





**Submission :**

- Deadline is Thursday 30-March @11:59PM through google form:

<https://forms.gle/EgioAcPQRYLxNKa9A>

- Write your answers in clean format, then scan your answer and upload to google form.
- The assignment is group of 2, belong to the same TA.
- Only one member of your team will submit the assignment.
- Both Team members must show up for assignment discussion.
- Cheating could get zero in the assignment.

