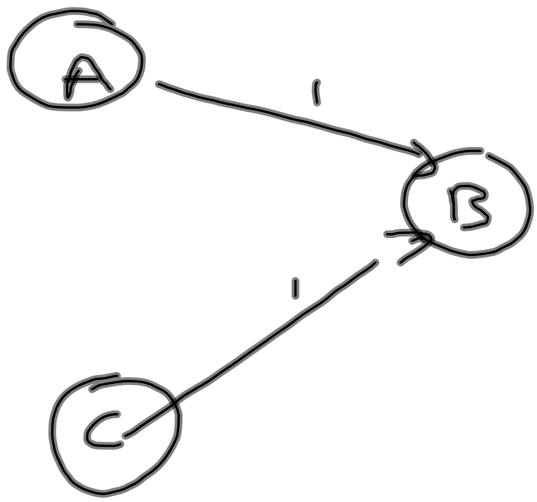
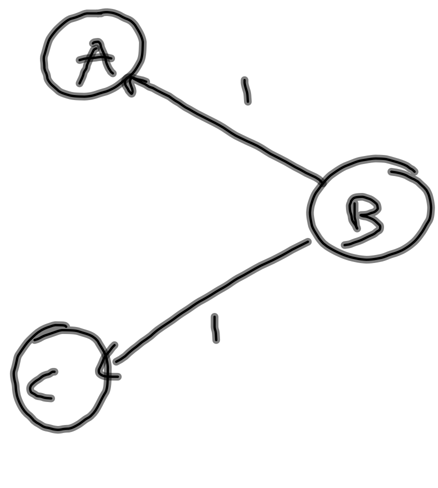

A
1
B
1
C


A
1
B
1
C

# Regular Expressions

operations

$\cup$

$\circ$

$*$

$(0 \cup 1) \circ 1^*$

0111 ✓

111 ✓

10 X

$(0 \cup 1) 1^*$

$R$ is reg. exp if $R$ is

1. $a$ for some $a \in \Sigma$
   (single symbol)
2. $\varepsilon$ - string w/ no symbols
3. $\emptyset$ - no strings
4. $(R_1 \cup R_2)$ where $R_1, R_2$ are reg. exp.
5. $(R_1 \circ R_2)$ "
6. $R_1^*$ $R_1$ is reg. exp.

$R^+ = RR^*$

Precedence order $*, \circ, \cup$

$$A \cup BC^*$$
$$A \cup (B \circ (C^*))$$

$\Sigma^*$

$L(R)$ language described by reg. exp $R$.

$\Sigma = \{0, 1\}$

$R = 0^* 1 0^* 1 0^*$

11 ✓

111 ✗

1 ✗

---

$\Sigma^* 110 \Sigma^*$

---

$(00 \cup 11)^*$

$\cancel{0101}$ $\underbrace{00}\underbrace{11}\underbrace{11}\underbrace{00}$

00 ✓ $\varepsilon$ ✓

---

$1^* \emptyset = \emptyset$

$\emptyset^* = \{\varepsilon\}$

---

$R \cup \emptyset = R$

$R \circ \{\varepsilon\} = R$

A language is regular iff some reg. exp. describes it.

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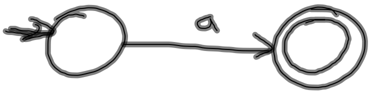
I. If a language is described by a regular expression then it is regular.

Given a regular expression $R$
Show $L(R)$ is regular ~~by~~ building an NFA to recognize it.

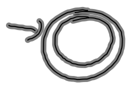
6 cases from def. of reg. expr

1. $R = a$

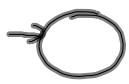



✓

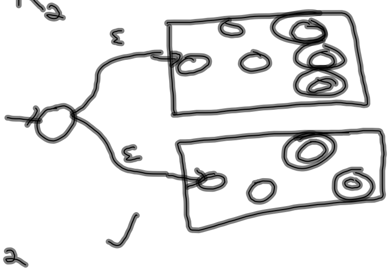
2. $R = \varepsilon$



3. $R = \emptyset$



4. $R = R_1 \cup R_2$

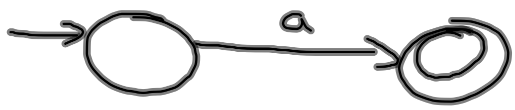



5. $R = R_1 \circ R_2$ ✓
6. $R = R_1^*$ ✓

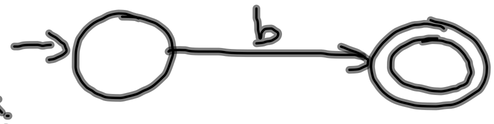
$a^*b \cup b^*$

build NFA

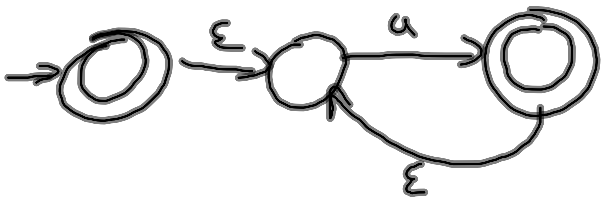
$a$:



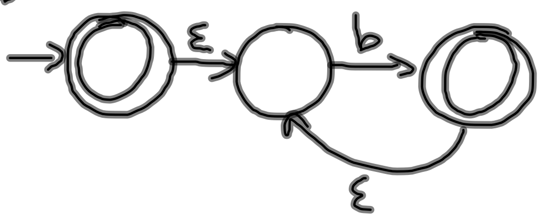

$b$:



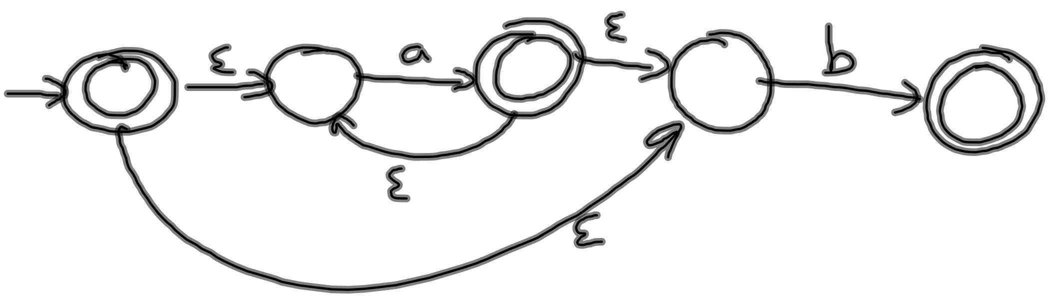

$a^*$



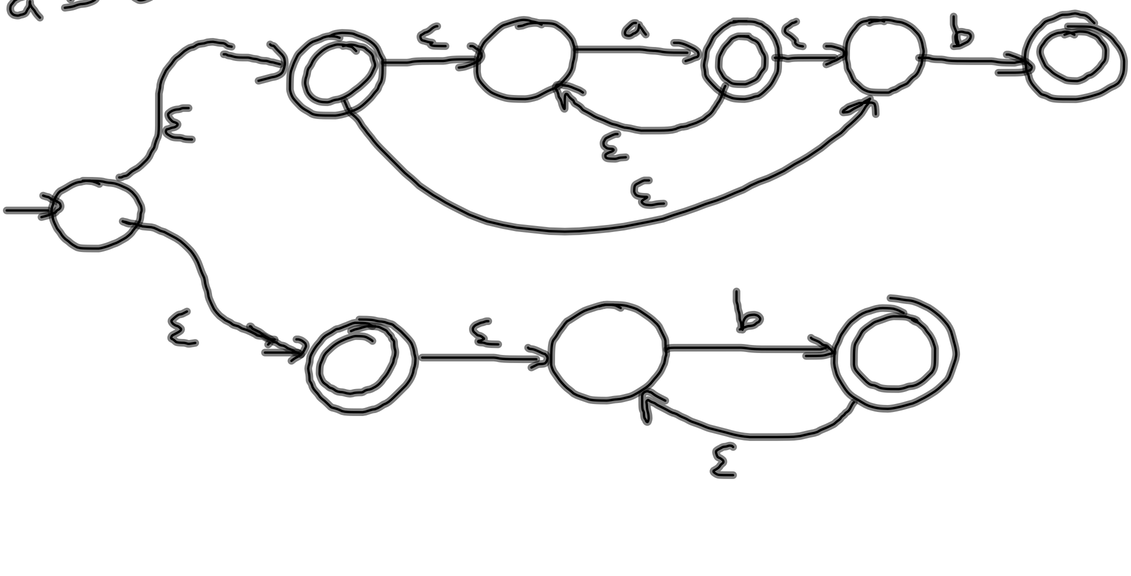

$b^*$:




$a^*b$




$a^*b \cup b^*$



(II) If a language is regular, then it is described by a regular exp.

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GNFA : generalized NFA

e.g.