

Make a regex for these languages:

$$\{a^n b a\} \quad a^* b a$$

$$\{a^n b a \mid n > 0\} \quad a a^* b a$$

$$\{a^n b a \mid n \leq 2\} \quad (\epsilon + a + a^2) b a$$

$$\{x \in \{a,b\}^* \mid x \text{ ends with } b\} \quad (a+b)^* b$$

$$\{ \dots \mid x \text{ starts with } a, \text{ ends with } ba \} \quad a(a+b)^* b a$$

$$\{x \mid x \text{ contains } ba\} \quad (a+b)^* b a (a+b)^*$$

$$\{x \mid x \text{ contains 3 consecutive } a\text{'s}\} \quad (a+b)^* a a a (a+b)^*$$

$$\{x \mid x \text{ contains exactly 3 } a\text{'s}\} \quad b^* a b^* a b^* a b^*$$

$$\{x \mid x \text{ contains at least 3 } a\text{'s}\} \quad (a+b)^* a (a+b)^* a (a+b)^* a (a+b)^*$$

$$\{a^n \mid n \text{ is even}\} \quad (aa)^*$$

$$\{x \in \{a,b\}^* \mid |x| \text{ is even}\} \quad ((a+b)(a+b))^* \\ \text{or } (aa+ab+ba+bb)^*$$

$$\{x \in \{a,b\}^* \mid \# \text{ of } a\text{'s is even}\}$$

~~$$b^* (a b^* a)^* b^*$$~~

$$b^*(b^*ab^*ab^*)^*$$

Which languages can be generated by Regex?

We can convert regex to NFA.

(So a regex always generates a regular language)

We convert regex to NFA piece by piece:

Atoms:

a single letter: $a \rightarrow \text{circle} \xrightarrow{a} \text{double circle}$

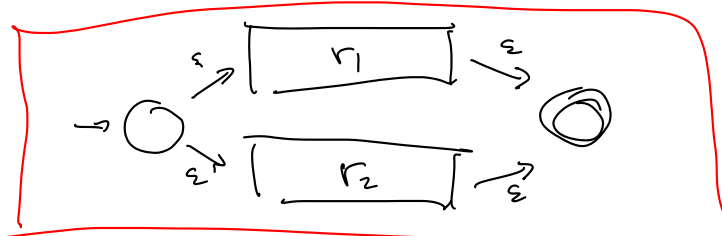
ϵ : $\rightarrow \text{double circle}$

$\emptyset$: $\rightarrow \text{circle}$

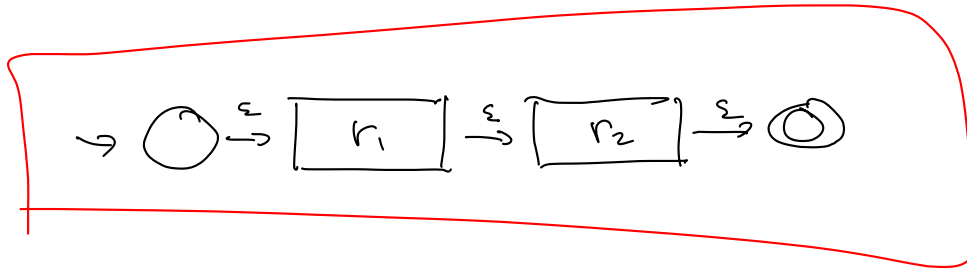
Operations:

$+$: If we have NFAs for r_1 & r_2

An NFA for $r_1 + r_2$

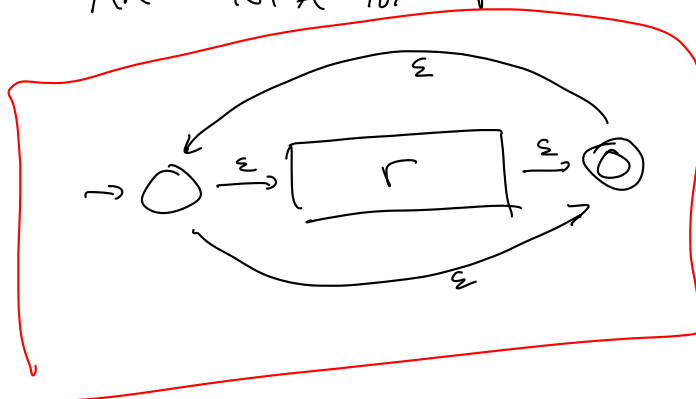


Concatenation: If we have NFAs for r_1 & r_2 ,
An NFA for $r_1 r_2$

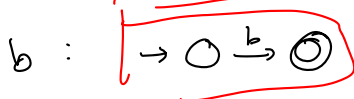


* If we have a NFA for r ,

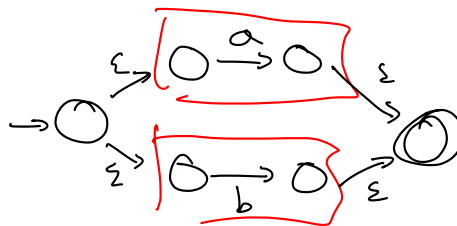
An NFA for r^*



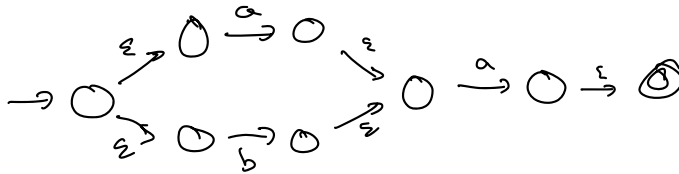
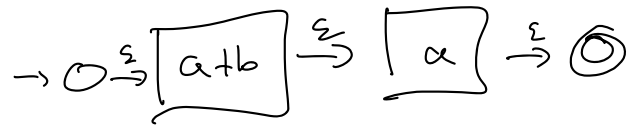
Make an NFA for $a+b$



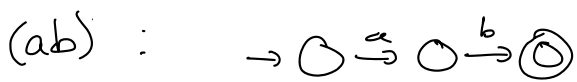
∞ $a+b$:



$(a+b)a$ concatenation



$a(ab)^*(a+b)$



$a(ab)^*(a+b)$:

