

CSE596 Lecture Friday, Aug. 30, 2019.

String And Language "Border" Examples.

The empty string is denoted by ϵ (or λ , or $''$)

The length of ϵ is zero: $|\epsilon| = 0$.

For any string x , $\epsilon \cdot x = x \cdot \epsilon = x$.

Concatenation is not commutative: $a \cdot b \neq b \cdot a$.

The empty set \emptyset is a language, i.e. Set<string>

Its cardinality $|\emptyset|$ is zero.

We want $L(N) = \{ \epsilon, ab, ba, abab, abba, baba, \dots \}$

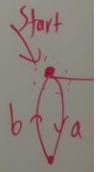
How about baab? No followed by

Def: $Q, \Sigma, s,$

An NFA $_{\epsilon}$

has δ

instruct

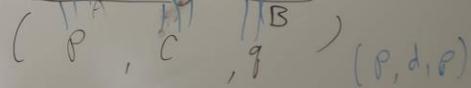


0 or more
0 or more

Defⁿ: An NFA is a 5-tuple $N = (Q, \Sigma, \delta, s, F)$ where

Q, Σ, s, F are as in a DFA and $\delta \subseteq (Q \times \Sigma) \times Q$.

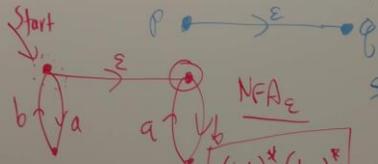
Typical tuple:



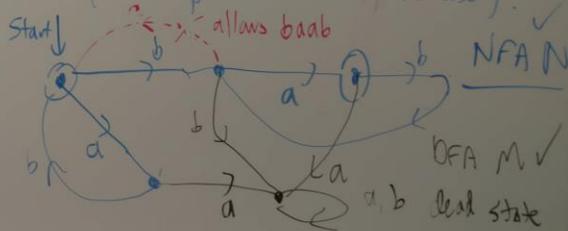
An NFA $_{\epsilon}$ (NFA with ϵ -transitions)

has $\delta \subseteq Q \times (\Sigma \cup \{ \epsilon \}) \times Q$ instead, which means it also has instructions (p, ϵ, q) which do not process a character.

(Can do $p \xrightarrow{\epsilon} q$ but it has no use).



$(ab)^x \cdot (ba)^y$



or $''$)

$\neq b \cdot a$.

i.e. Set<string>

$\{ ab, abba, baba, \dots \}$

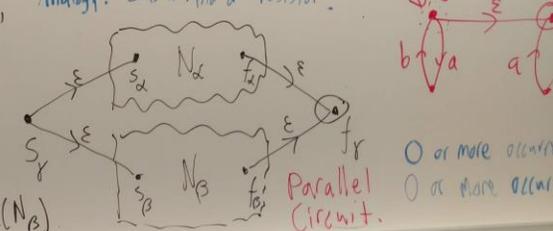
? No followed by

- 0 or more occurrences of ab
- 0 or more occurrences of ba.

Inductive Defⁿ of Regular Expressions $\alpha, \beta, \gamma, \dots$ over any alphabet Σ . Defⁿ: An and theorem that for every regexp α there is an NFA N_α st. $L(N_\alpha) = L(\alpha)$. Q, Σ, s, F are a

Base Cases
 $L(\emptyset) = \emptyset$ \emptyset is a regexp. $N_\emptyset = \overset{s}{\circ} \xrightarrow{\text{complete resistance}} \circ \overset{f}{\circ}$
 $L(\epsilon) = \{\epsilon\}$ ϵ is a regexp. $N_\epsilon = \overset{s}{\circ} \xrightarrow{\epsilon \text{ zero-resistance}} \circ \overset{f}{\circ}$
 For any char $c \in \Sigma$, c is a regexp. $N_c = \overset{s}{\circ} \xrightarrow{c} \circ \overset{f}{\circ}$
 $L(c) = \{c\}$

Induction Cases: Given any regexps α and β ,
 $\gamma = (\alpha + \beta)$ is a regexp build $N_\gamma =$
 $L(\gamma) = L(\alpha) \cup L(\beta)$
 Given the NFAs N_α, N_β for α and β ,
 Then $L(N_\gamma) = L(N_\alpha) \cup L(N_\beta)$



An NFA_ϵ (NFA) has $S \subseteq Q$ instructions (A) Start s ϵ p a b v a a
 \circ or more occur
 \circ or more occur

The Wed. 9/4 lecture will pick up the definition of regular expressions and the rest of the proof of how to convert them to NFAs after first defining:

- Computations that process a string x from a state p to a state q .
- The concatenation of two languages and the Kleene star of a language.