CSC236 *Intro. to* the Theory of Computation

Lecture 12: RE→NFA→DFA→RE
¬ pumping → ¬ RL

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Course page:
http://www.cdf.toronto.edu/~csc236h/fall/index.html

Section page:
http://www.cdf.toronto.edu/~csc236h/fall/amir_lectures.html

review

- last lecture
  - FSA (nondeterministic and deterministic)≡ RE
    - NFA→DFA→RE→NFA
- this week:
  - more on RE→NFA
  - application of pumping lemma in proving a language is not regular

$NFA, DFA, regex$

- $NFA \Rightarrow DFA \Rightarrow regex \Rightarrow NFA$

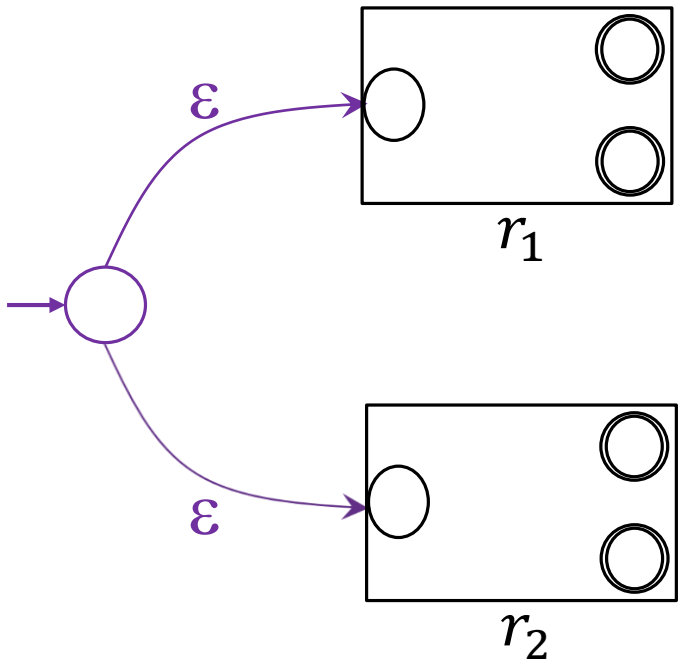
- *BASE CASES*

$regex$	NFA
$\emptyset$	
ε	
b	

$NFA, DFA, regex$

$NFA \Rightarrow DFA \Rightarrow \boxed{regex \Rightarrow NFA}$

- *RECURSIVE CASES*

$regex$	NFA
$r_1 + r_2$	

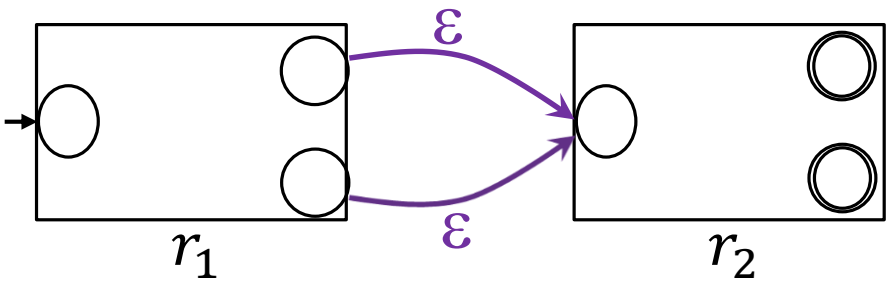
$NFA, DFA, regex$

$NFA \Rightarrow DFA \Rightarrow \boxed{regex \Rightarrow NFA}$

- *RECURSIVE CASES*

$regex$ NFA

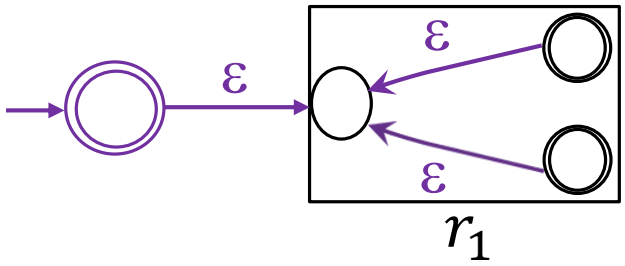
$r_1 . r_2$



$NFA, DFA, regex$

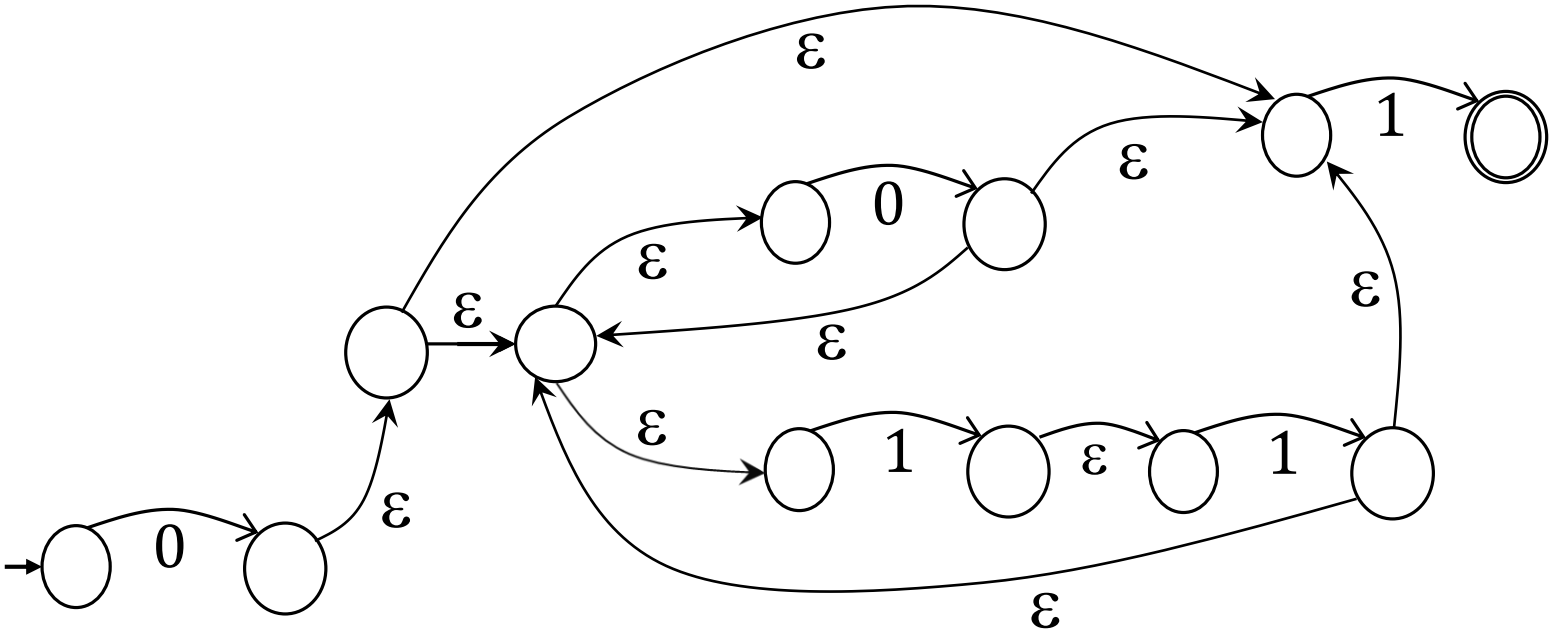
$NFA \Rightarrow DFA \Rightarrow \boxed{regex \Rightarrow NFA}$

- *RECURSIVE CASES*

$regex$	NFA
$r_1{}^*$	

Example 104

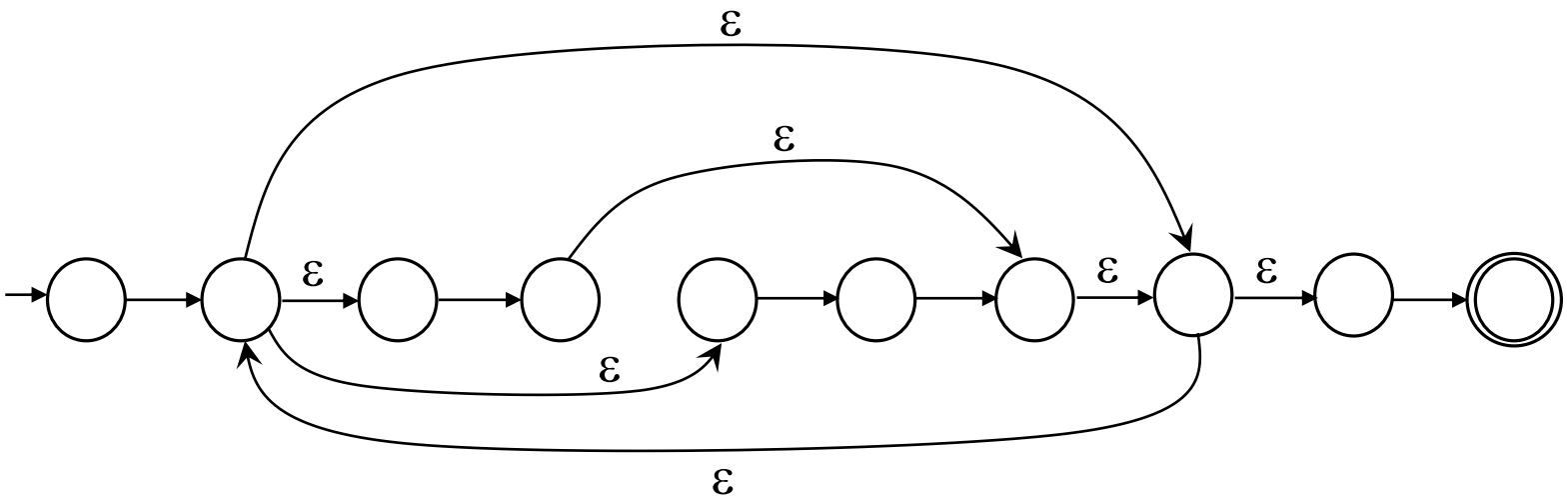
- 0 (0 + 1 1)* 1



Example 105

- 0 (0 + 1 1) * 1 revisited (2nd algorithm)

  - make a transition from each symbol of alphabet to the next state
  - make an ε-transition from each brace to the next state
  - make 3 ε-transitions for each *
  - make 2 ε-transitions for each +



$NFA \equiv DFA \equiv regex$

- $NFA \Rightarrow DFA \Rightarrow \boxed{regex \Rightarrow NFA}$
  - nicely done!
- $NFA \Rightarrow \boxed{DFA \Rightarrow regex} \Rightarrow NFA$
  -
  -
- $\boxed{NFA \Rightarrow DFA} \Rightarrow regex \Rightarrow NFA$
  -
  -
- analogy:
  -

pumping lemma

- If $\boldsymbol{L}$ is RL, then $\exists \boldsymbol{p} \geq \mathbf{1}$ such that $\forall \omega \in \boldsymbol{L}, |\omega| \geq p, \omega = x\boldsymbol{y}z$:
  - $|xy| \leq p$
  - $|y| > 0$
  - $\forall k \geq 0, x\boldsymbol{y}^{\boldsymbol{k}}z \in \boldsymbol{L}$

- application of pumping lemma is in proving non-regularity
  - assume the language is regular, apply the pumping lemma and run to a contradiction
  - **note:**

Example 105

- Prove $L = \{\omega \in \Sigma^* | \omega = a^n b^n \;\; n \geq 0\}$ is not regular.

final notes

- you have enhanced your analytical skills, in particular in
  - systematic reasoning, proofs, program correctness, and simple computational models
- next?
  - CSC263: more algorithm analysis & data structures
  - CSC373: more algorithms complexities and paradigms
  - …
  - CSC448: more formal languages and automata
- if I can be of any help, drop me a line or stop by BA4222.

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