

CSC236 Intro. to the Theory of Computation

Lecture 12: $RE \rightarrow NFA \rightarrow DFA \rightarrow RE$ \neg pumping $\rightarrow \neg RL$

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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

FSA 12-1

review

❖ last lecture

- FSA (nondeterministic and deterministic) \equiv RE
- $NFA \rightarrow DFA \rightarrow RE \rightarrow NFA$

❖ this week:

- more on $RE \rightarrow NFA$
- application of pumping lemma in proving a language is not regular

FSA 12-2

NFA, DFA, regex

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

❖ BASE CASES

regex NFA

\emptyset

ϵ

b

FSA 12-3

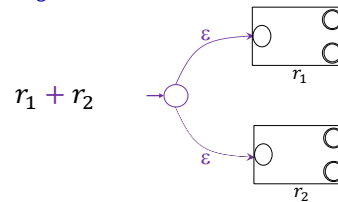
NFA, DFA, regex

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

❖ RECURSIVE CASES

regex

NFA



FSA 12-4

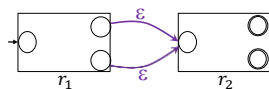
NFA, DFA, regex

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

❖ RECURSIVE CASES

regex NFA

$r_1 \cdot r_2$



FSA 12-5

NFA, DFA, regex

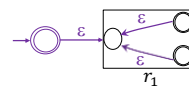
$NFA \Rightarrow DFA \Rightarrow \boxed{regex \Rightarrow NFA}$

❖ RECURSIVE CASES

regex

NFA

r_1^*

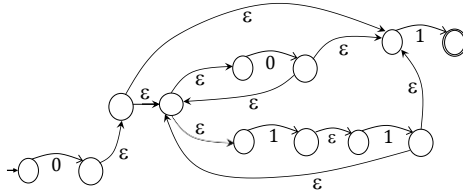


FSA 12-6

Example 104

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

❖ $0(0+11)^*1$



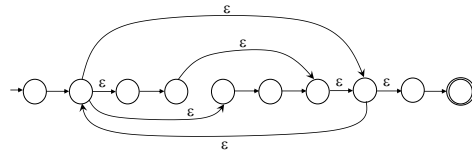
FSA 12-7

Example 105

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

❖ $0(0+11)^*1$ 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 $+$



FSA 12-8

$NFA \equiv DFA \equiv \text{regex}$

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

FSA 12-9

pumping lemma

- ❖ If L is RL , then $\exists p \geq 1$ such that $\forall \omega \in L, |\omega| \geq p, \omega = xyz$:
 - $|xy| \leq p$
 - $|y| > 0$
 - $\forall k \geq 0, xy^kz \in L$
- ❖ application of pumping lemma is in **proving non-regularity**
 - assume the language is regular, apply the pumping lemma and run to a contradiction
 - **note:**

FSA 12-10

Example 105

❖ Prove $L = \{\omega \in \Sigma^* \mid \omega = a^n b^n, n \geq 0\}$ is not regular.

FSA 12-11

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.

□

FSA 12-12