CSE211 – Formal Languages and Automata Theory

U1L17 – RE to e-NFA Conversion

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Agenda

- Recap of previous class
- Kleen's Theorem
- RE to NFA conversion Theorem
- RE to NFA conversion –Example
- RE to NFA conversion -Exercise

Kleen’s Theorem

It states that any regular language is accepted by an FA and conversely that any language accepted by an FA is regular.

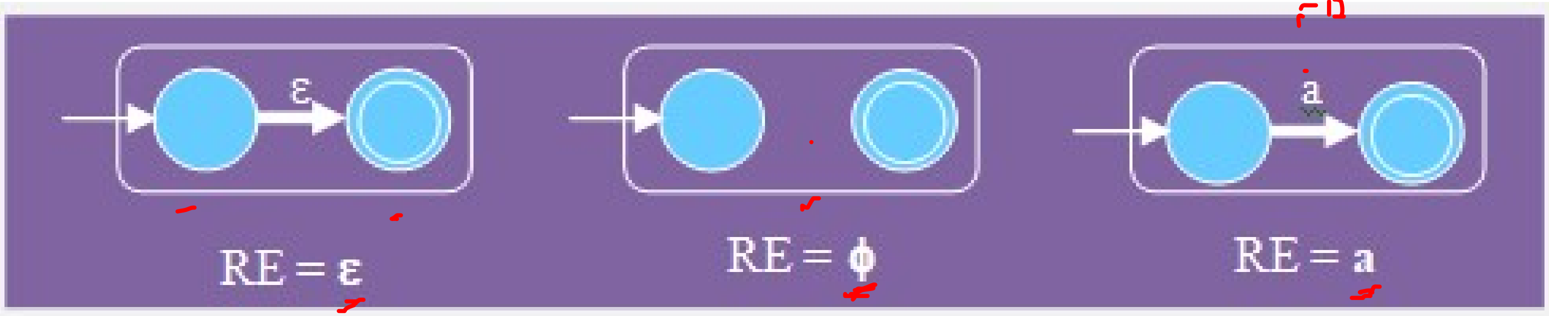
Converting RE's to Automata

- **Theorem 3.7:**

Every language defined by an RE is also defined by an FA.

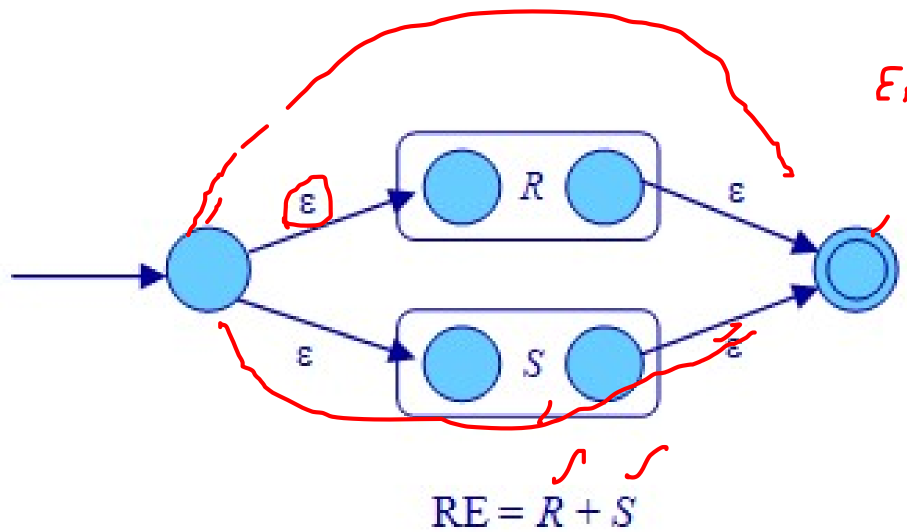
Proof.

- *Basis :*
  - There are three cases, as shown in Fig. 3.16, in which proper NFA's have been constructed to accept respectively the strings represented by the three basic RE's ε, ϕ, and **a**. It can be seen that each NFA works correctly;



Converting RE’s to Automata

- *Induction:* Three cases of the following need be considered
  - (1) RE = $R + S$;
  - (2) RE = RS;
  - (3) RE = R^*.
- Case (1) RE=R+S



$\varepsilon R \varepsilon + \varepsilon S \varepsilon$

$= R + S$

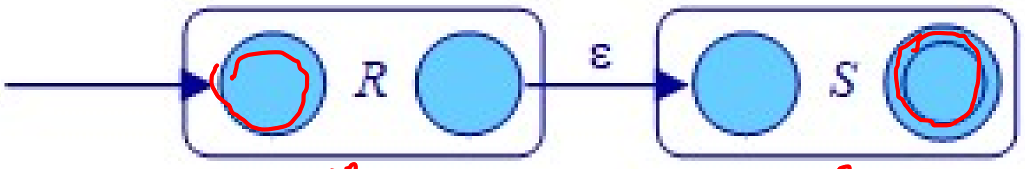
NFA for RE operation $R + S$.

Converting RE's to Automata

SASTRA DEEMED TO BE UNIVERSITY (U/S 3 OF THE UGC ACT, 1956)
THINK MERIT | THINK TRANSPARENCY | THINK SASTRA

- Case (2) RE=R+S

R ε S
⇒ RS



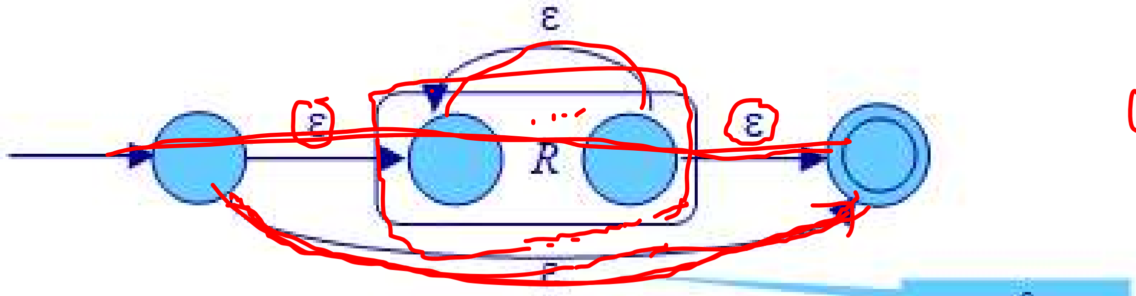
RE = RS

NFA for RE operation *RS*

$a^* = \varepsilon, a, aa, aaa...$

Case (3) RE = *R**

$(a)^*$
$(R)^*$



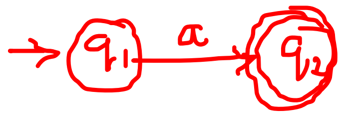
RE = R^*

NFA for RE operation *R**

RE to e-NFA: Example 1

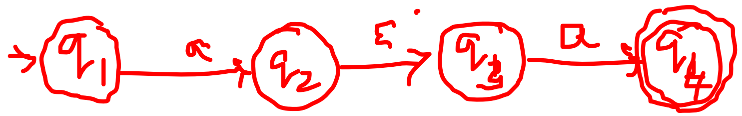
- Convert regular expression $(aa + b)^*$ into e-NFA

Step 1: e-NFA for a

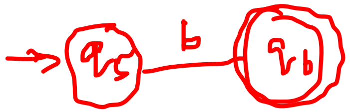


Step 2

e-NFA for aa



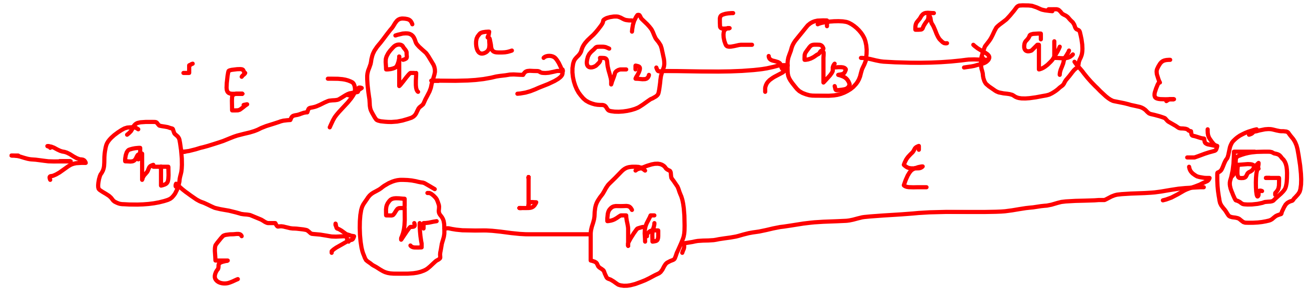
Step 3:
e-NFA for b



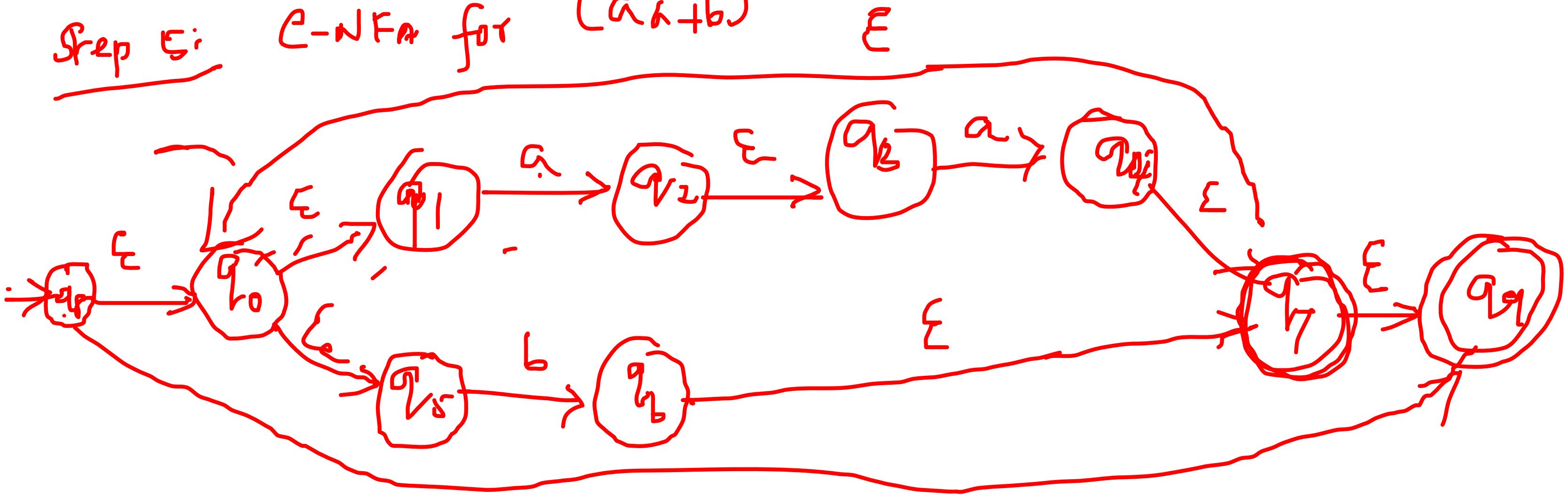
RE to e-NFA: Example 1

$(aa+b)^*$

Step 4 e-NFA for $(aa+b)$

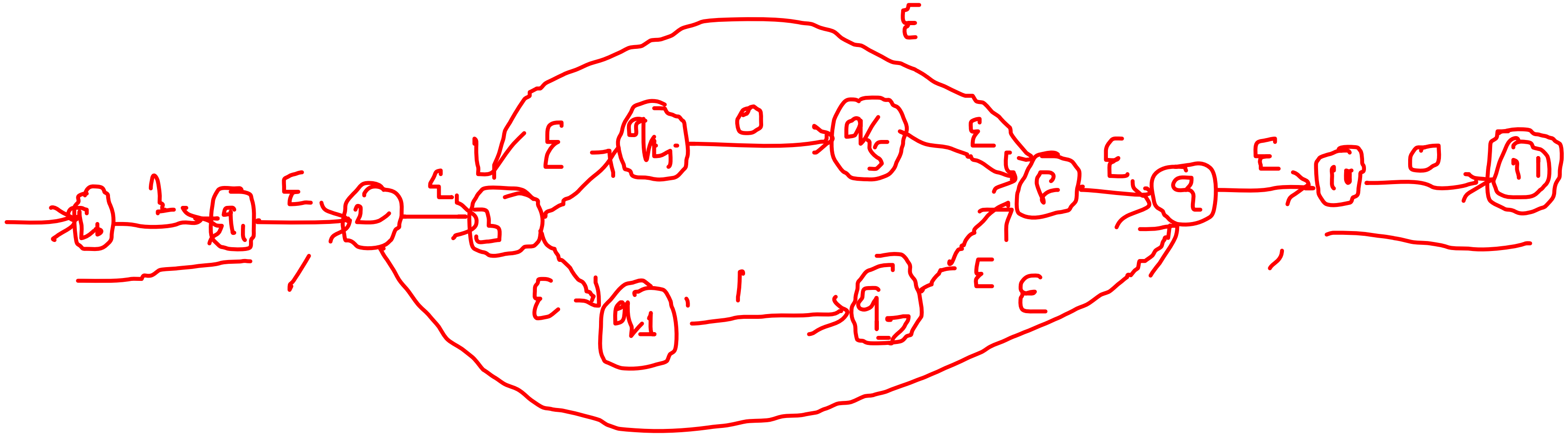


Step 5: e-NFA for $(aa+b)^*$



RE to e-NFA: Example 2

- Convert RE **1 (0 + 1)* 0** into an e-NFA.



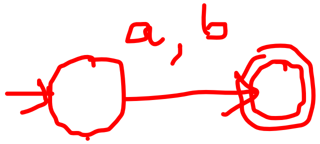
RE to e-NFA: Example 3

- Convert RE (**0** + **1**)***1**(**0** + **1**) into an e-NFA.

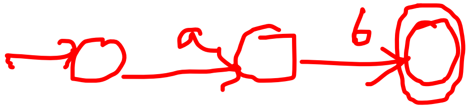
RE to NFA: Example 4

- Convert RE $(\mathbf{0} + \mathbf{1})^*\mathbf{1}(\mathbf{0} + \mathbf{1})$ into an NFA.

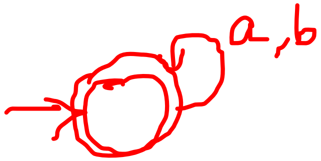
a+b ⇒



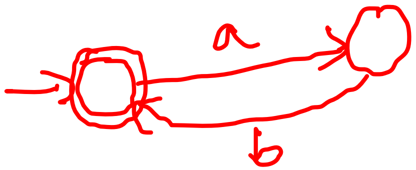
ab ⇒

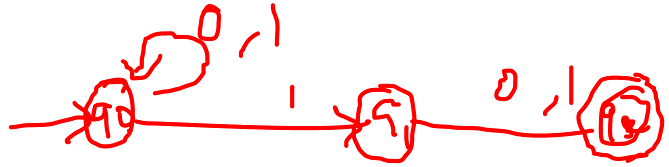


(a+b)*



(ab)*





Summary

- Kleen’s Theorem
- RE to NFA conversion Theorem, steps
- RE to NFA conversion –Example
- RE to NFA conversion -Exercise

References

- John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, *Introduction to Automata Theory*, Languages, and Computation, Pearson, 3rd Edition, 2011.
- Peter Linz, An Introduction to Formal Languages and Automata, Jones and Bartle Learning International, United Kingdom, 6th Edition, 2016.

Next Class:

Properties of RL

THANK YOU.