

AUTOMATA THEORY AND FORMAL LANGUAGES

2015-16

UNIT 5 PART 1 REGULAR LANGUAGES

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Regular languages. Bibliography

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OUTLINE

PART 1:

- **Finite Automata and Type-3 Grammars**
 - **Finite Automata associated to a Type-3 grammar ($G_3 \rightarrow FA$)**
 - **Type-3 Grammar associated to a FA ($FA \rightarrow G_3$)**

PART 2:

- **Regular expressions and Regular Languages**

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From FA to Type-3 grammar

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1 From FA \rightarrow G3:

Given the FA, $A = (\Sigma, Q, q_0, f, F)$, there is a right-linear grammar that fulfills

$$L(G3RL) = L(A)$$

That it is to say, the language generated by the grammar is the same that the recognized by the automaton

Following: How to obtain the grammar $G = \{\Sigma_T, \Sigma_N, S, P\}$

from the FA $= (Q, \Sigma, q_0, f, F)$

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From FA to Type-3 grammar

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1 From FA \rightarrow G3:

Process:

- $\Sigma_T = \Sigma$; $\Sigma_N = Q$, $S = q_0$
- $P = \{ \dots \}$
 1. Transition $f(p, a) = q \rightarrow$ if q' is not a final state $\rightarrow p ::= aq$
 2. $q \in F$ and $f(p, a) = q \rightarrow p ::= a$ and $p ::= aq$
 3. $p_0 \in F \rightarrow p_0 ::= \lambda$
 4. If $f(p, \lambda) = q \rightarrow p ::= q$
 5. $q \in F$ and $f(p, \lambda) = q \rightarrow p ::= q$ and $q ::= \lambda$

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From FA to Type-3 grammar

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1 From FA \rightarrow G3: Example

Given the FA described by the following table, calculate the right-linear G3 grammar that generates the language described by it. Verify that both languages are the same.

	0	1
$\rightarrow A$	A	C
B	A	C
*C	C	B

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From Type-3 grammar to FA

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2 From G3 → FA:

Given a right-linear G3, $G = (\Sigma_T, \Sigma_N, S, P)$, there is a FA, A, that fulfills: $L(G3LD) = L(A)$

Process:

- $\Sigma = \Sigma_T$
- $Q = \Sigma_N \cup \{F\}$, with $F \notin \Sigma_N$
- $q_0 = S$
- $F = \{F\}$
- f:
 - If $A ::= aB \rightarrow f(A,a) = B$

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From Type-3 grammar to FA

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2 From G3 → FA : Example

Given the following right-linear G3 right-linear grammar, calculate the equivalent FA.

$G = (\{d,c\}, \{A,S,T\}, A, \{A ::= cS, S ::= d/cS/dT, T ::= dT/d\})$

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From Type-3 grammar to FA

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- ◆ We have seen the procedure to obtain a FA that accepts the language described by a G3 left-linear grammar, however, this procedure does not always lead to an DFA, typically:

$G_3 \rightarrow \text{NFA} \rightarrow \text{DFA}$

- ◆ **Exercise 1:** Given the left-linear grammar: $G = (\{0,1\}, \{S,U\}, S, \{S ::= U0, U ::= U0 \mid S1 \mid 0\})$ Calculate the corresponding DFA.

- ◆ **Exercise 2:** Given the left-linear grammar: $G = (\{0,1\}, \{S,U\}, S, \{S ::= U0, U ::= U0 \mid S1 \mid 0\})$

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From Type-3 grammar to FA

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Given the left-regular grammar G3: $G = (\Sigma_T, \Sigma_N, S, P)$

From it, we build the FA: $A = (\Sigma_T, \Sigma_N \cup \{p, q\}, f, p, \{S\})$

where: $p, q \notin \Sigma_T$ and/or Σ_N

Q

f is defined by:

$$1) f(U, t) = V \text{ si } V ::= U t \in P$$

$$2) f(p, t) = V \text{ si } V ::= t \in P$$

$$3) f(U, t) = q \quad \forall t \in \Sigma_T / V ::= U t \notin P$$

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From Type-3 grammar to FA

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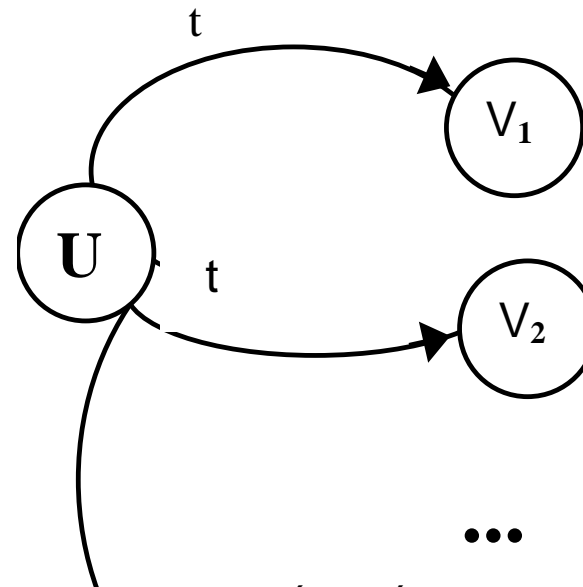
- ◆ This definition does not ensure a deterministic FA since it is possible:

$V_1 ::= Ut$

$V_2 ::= Ut$

...

$V_3 ::= Ut$



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From Type-3 grammar to FA

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Given the G3 left-linear grammar:

$$G = (\{0,1\}, \{S,U,V\}, S, P)$$
$$\text{Where } P = \{S ::= U0 / V1$$
$$U ::= S1 / 1$$
$$V ::= S0 / 0\}$$

Calculate the minimum DFA that recognizes the language generated by G.

Steps: 1) Calculate the FA (Determinist in this case)

2) Minimize it.

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Additional Issues

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And if we want to obtain a FA from a left-linear G3?

G3 left-linear \rightarrow G3 right-linear \rightarrow FA

And if we want to obtain a left-linear G3 from a FA?

FA \rightarrow G3 right-linear \rightarrow G3 left-linear

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