Summer 2022

Theory of Computing (CSE 221)

Lecture - 3: Conversion of DFA and NFA

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Equivalence of DFA and NFA

Every DFA is an NFA, but not every NFA is not an NFA.
But there is an equivalent DFA for every NFA.

Equivalence of DFA and NFA

- NFA's are usually easier to "program" in.

- Surprisingly, for any NFA N there is a DFA D, such that $L(D) = L(N)$, and vice versa.

- This involves the *subset construction*, an important example how an automaton B can be generically constructed from another automaton A.

- Given an NFA

$$N = (Q_N, \Sigma, \delta_N, q_0, F_N)$$

we will construct a DFA

$$D = (Q_D, \Sigma, \delta_D, \{q_0\}, F_D)$$

such that

$$L(D) = L(N)$$

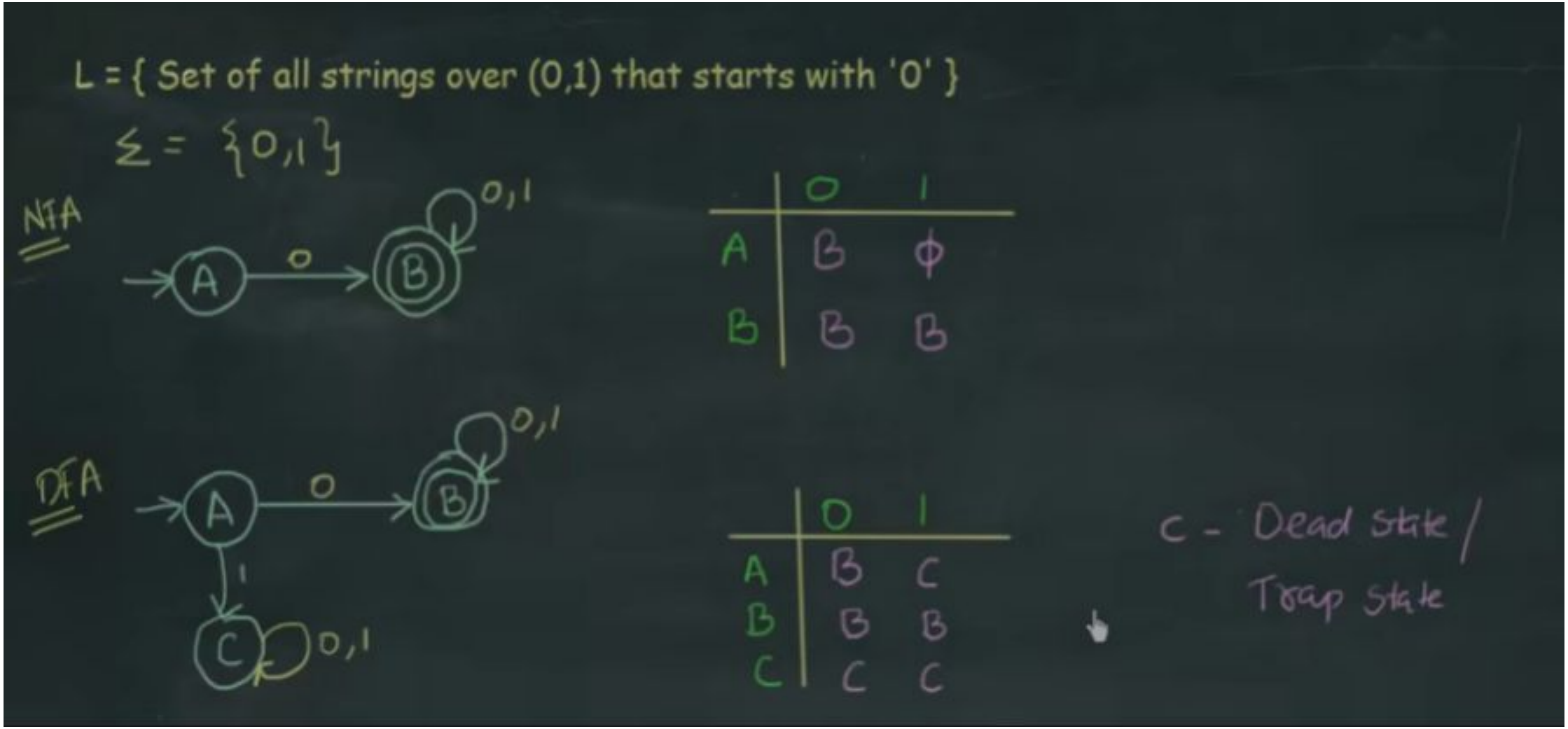
NFA to DFA Conversion

It’s a Subset Construction Method

for DFA, TF = $Q \times \Sigma \rightarrow Q$
for NFA, TF = $Q \times \Sigma \rightarrow 2^Q$

Step 1.Create an **NFA** for the Given Rule
Step 2.State Transition Table (STT) Creation the **NFA** of step 1.
Step 3.Creating DFA STT from the NFA STT

NFA to DFA Conversion



NFA to DFA Conversion

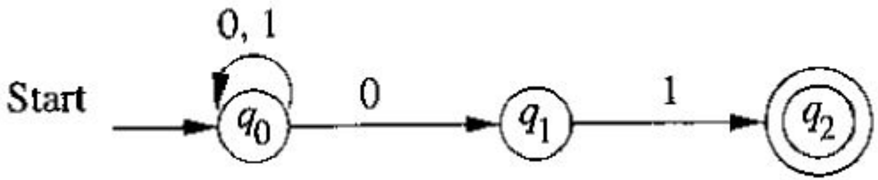


Figure 2.9: An NFA accepting all strings that end in 01

	0	1
$\emptyset$	$\emptyset$	$\emptyset$
$\rightarrow \{q_0\}$	$\{q_0, q_1\}$	$\{q_0\}$
$\{q_1\}$	$\emptyset$	$\{q_2\}$
$*\{q_2\}$	$\emptyset$	$\emptyset$
$\{q_0, q_1\}$	$\{q_0, q_1\}$	$\{q_0, q_2\}$
$*\{q_0, q_2\}$	$\{q_0, q_1\}$	$\{q_0\}$
$*\{q_1, q_2\}$	$\emptyset$	$\{q_2\}$
$*\{q_0, q_1, q_2\}$	$\{q_0, q_1\}$	$\{q_0, q_2\}$

Figure 2.12: The complete subset construction from Fig. 2.9

	0	1
A	A	A
$\rightarrow B$	E	B
C	A	D
$*D$	A	A
E	E	F
$*F$	E	B
$*G$	A	D
$*H$	E	F

Figure 2.13: Renaming the states of Fig. 2.12

NFA to DFA Conversion

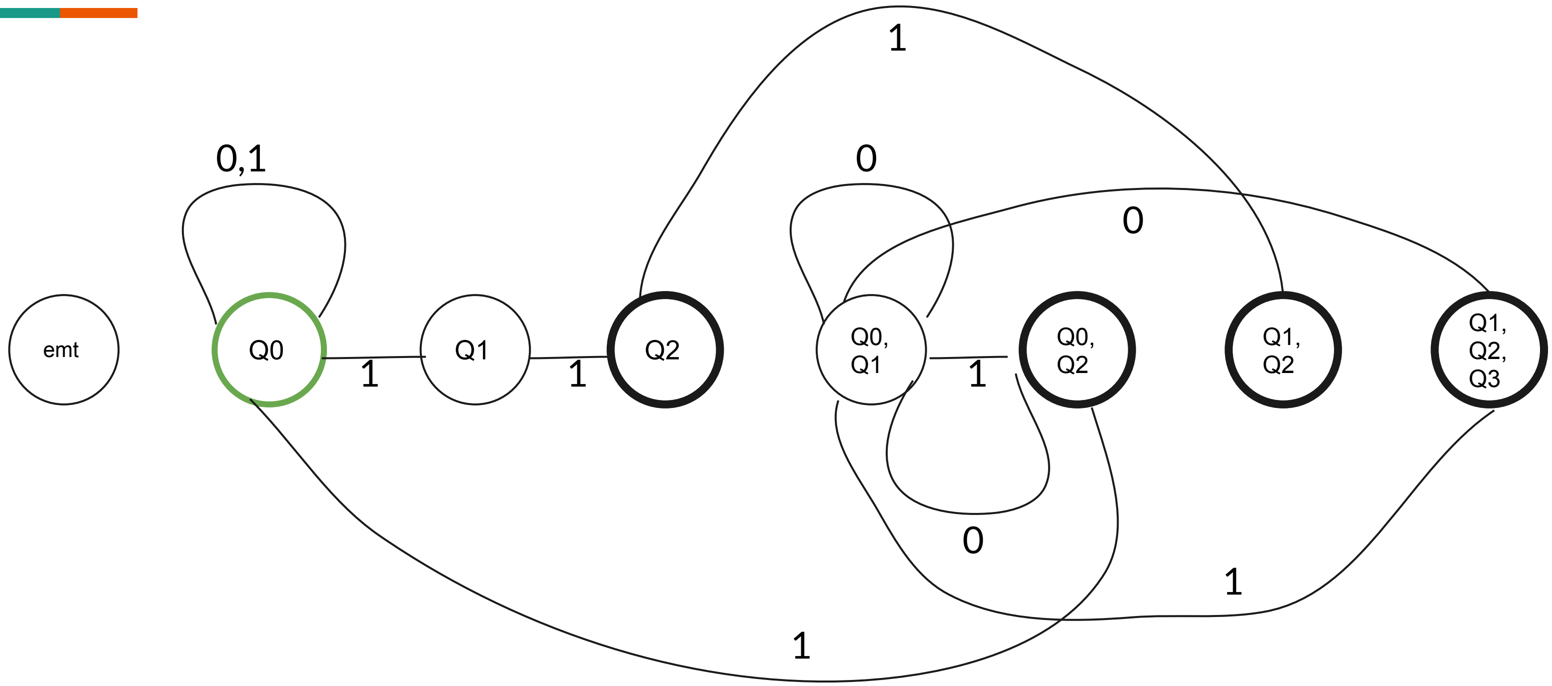


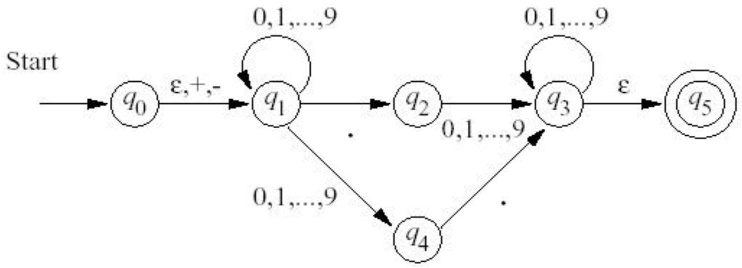
Figure 2.14: DFA of the Fig. 2.9

ϵ-NFA Example

An ϵ-NFA accepting decimal numbers consisting of:

1. An optional + or - sign
2. A string of digits
3. a decimal point
4. another string of digits

One of the strings (2) are (4) are optional



An ϵ-NFA is a quintuple $(Q, \Sigma, \delta, q_0, F)$ where δ is a function from $Q \times \Sigma \cup \{\epsilon\}$ to the powerset of Q.

Example: The ϵ-NFA from the previous slide

$$E = (\{q_0, q_1, \ldots, q_5\}, \{., +, -, 0, 1, \ldots, 9\}\ \delta, q_0, \{q_5\})$$

where the transition table for δ is

	ϵ	+,-	.	$0, \ldots, 9$
$\to q_0$	$\{q_1\}$	$\{q_1\}$	$\emptyset$	$\emptyset$
q_1	$\emptyset$	$\emptyset$	$\{q_2\}$	$\{q_1, q_4\}$
q_2	$\emptyset$	$\emptyset$	$\emptyset$	$\{q_3\}$
q_3	$\{q_5\}$	$\emptyset$	$\emptyset$	$\{q_3\}$
q_4	$\emptyset$	$\emptyset$	$\{q_3\}$	$\emptyset$
$\star q_5$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$

Thank You