EECS 510 INTRO TO THE THEORY OF COMPUTATION

TUES AUGUST 23 2022

LECTURE 00

2.2 NON-DETERMINISTIC FINITE AUTOMATA

DEFN A NONDETERMINISTIC FINITE AUTOMATA (NFA) IS A 5-TUPLE $(Q, \Sigma, \delta, q_0, F)$

LIKE ITS DFA COUNTERPART WITH ONE EXCEPTION THAT THE TRANSITION FUNCTION

$$\delta : Q \times \Sigma \longrightarrow P(Q)$$

THE TRANSITION FUNCTION δ MAPS A STATE & A SYMBOL INTO THE POWER SET OF Q.

Q - FINITE SET OF STATES

Σ - ALPHABET

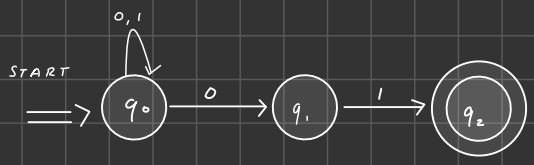
δ - TRANSITION FUNCTION

δ(STATE, SYMBOL) = SET OF STATES

$\delta : Q \times \Sigma \longrightarrow P(Q)$

$q_0 \in Q$ INITIAL/STARTING STATE

$F \subseteq Q$ SET OF FINAL/ACCEPTING STATES



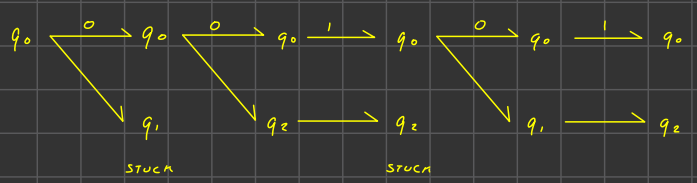
TRANSITION TABLE

	0	1
q_0	q_1	q_0
q_1	q_1	q_2
$*q_2$	q_2	q_2

NFA ACCEPTS INPUTS ENDING IN 01

ABSTRACT MACHINES THAT PROCESS STRING

- DIFFERENCE BETWEEN DFA & NFA IS CHOICE/PARALLELISM



2.4 THE TRANSITION TABLE FOR NFA

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

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EXTENDING TRANISITION FUNCTION δ

BASE CASE $\hat{\delta}(q, \varepsilon) = \{q\} \quad \forall \; q \in Q$

INDUCTIVE CASE FOR A STRING $w = xq$

$q :=$ LAST CHAR OF w

SUPPOSE $\delta(q, x) := \{p_1, \ldots p_k\}$

AND LET $\bigcup_{i=1}^{n} \delta(p_i, q) := \{R_1, \ldots, R_m\}$

EX 2.4 RUN THE STRING 00101 THROUGH NFA

1 $\hat{\delta}(q_0, \varepsilon) = \{q_0\}$

2 $\hat{\delta}(q_0, 0) = \delta(q_0, 0) = \{q_0, q_1\}$

3 $\hat{\delta}(q_0, 00) = \delta(q_0, 0) \cup \delta(q_1, 0) = \{q_0, q_1\} \cup \emptyset = \{q_0, q_1\}$

4 $\hat{\delta}(q_0, 001) = \delta(q_0, 1) \cup \delta(q_1, 1) = \{q_0\} \cup \{q_2\} = \{q_0, q_2\}$

5 $\hat{\delta}(q_0, 0010) = \delta(q_0, 0) \cup \delta(q_2, 0) = \{q_0, q_1\} \cup \emptyset = \{q_0, q_1\}$

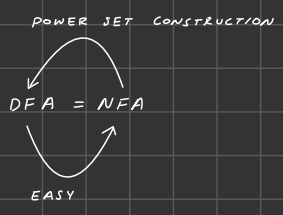
6 $\hat{\delta}(q_0, 00101) = \delta(q_0, 1) \cup \delta(q_1, 1) = \{q_0\} \cup \{q_2\} = \{q_0, q_2\}$

LANGUAGE OF NFA $A = (Q, \Sigma, \delta, q_0, F)$

$L(A) := \{w \mid \delta(q_0, w) \cap F \neq 0\}$

- TWO SETS ARE NOT DISJOINTED
- IF YOU HAVE A DFA CAN BE TURNED INTO AN NFA
- AN NFA CAN SERIALIZED INTO A DFA

EX POWER SET CONSTRUCTION APPLIED OVER NFA



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

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THEOREM 2.1 GIVEN AN NFA $N = (Q_N, \Sigma, \delta_N, q_0, F_N)$,

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

USING THE ABOVE SUBSET CONSTRUCTION, THEN $L(D) = L(N)$

PF PROVE BY INDUCTION ON $|w|$ THAT

$$\hat{\delta}_D(\{q_0\}, w) = \hat{\delta}_N(q_0, w)$$