CS303T Theory of Computation

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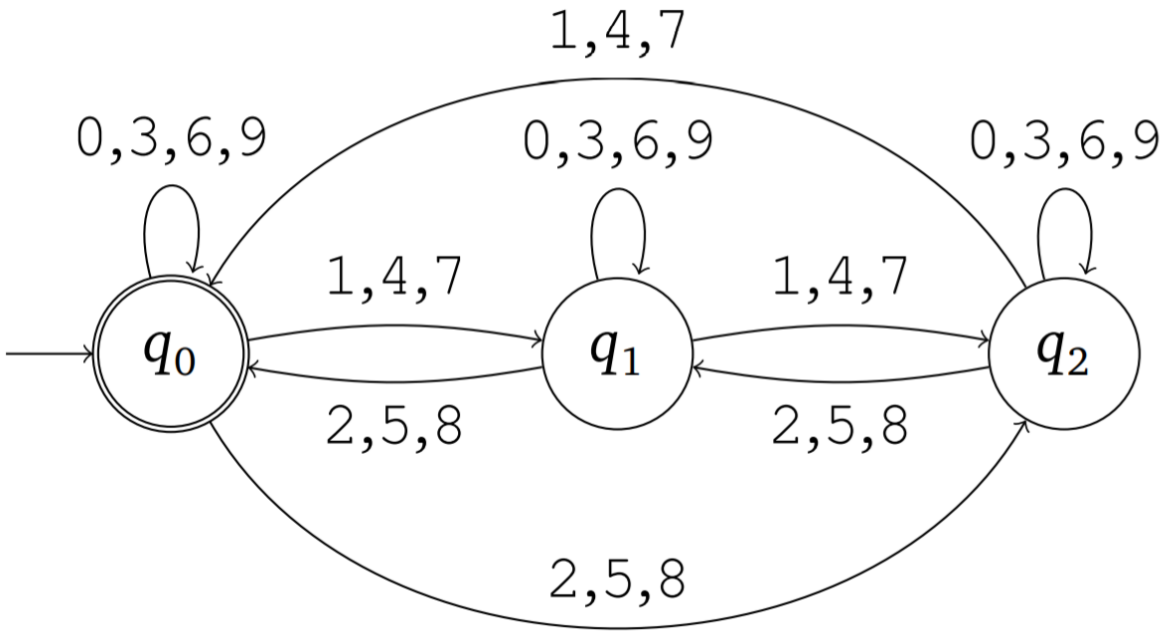
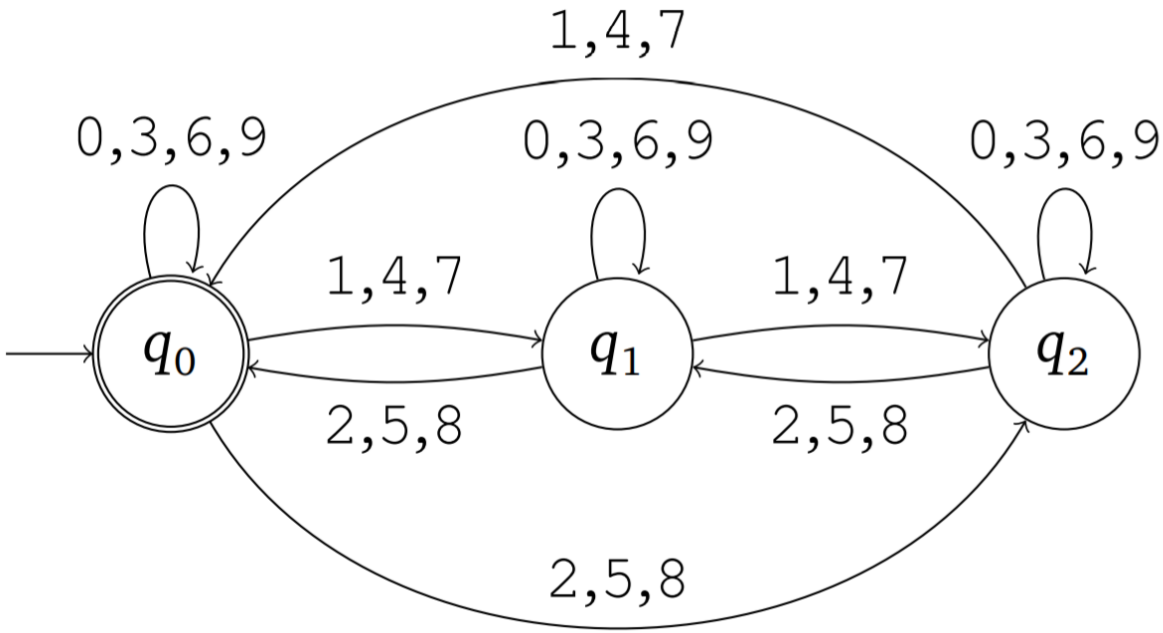
Outline

- Recap
  - Deterministic Finite Automata (DFA)
  - More Examples for DFA
  - Language to Transition Diagram
  - Transition Diagram to Language
- Today
  - More Examples for DFA
  - Non-deterministic Finite Automata (NFA)

DFA Example

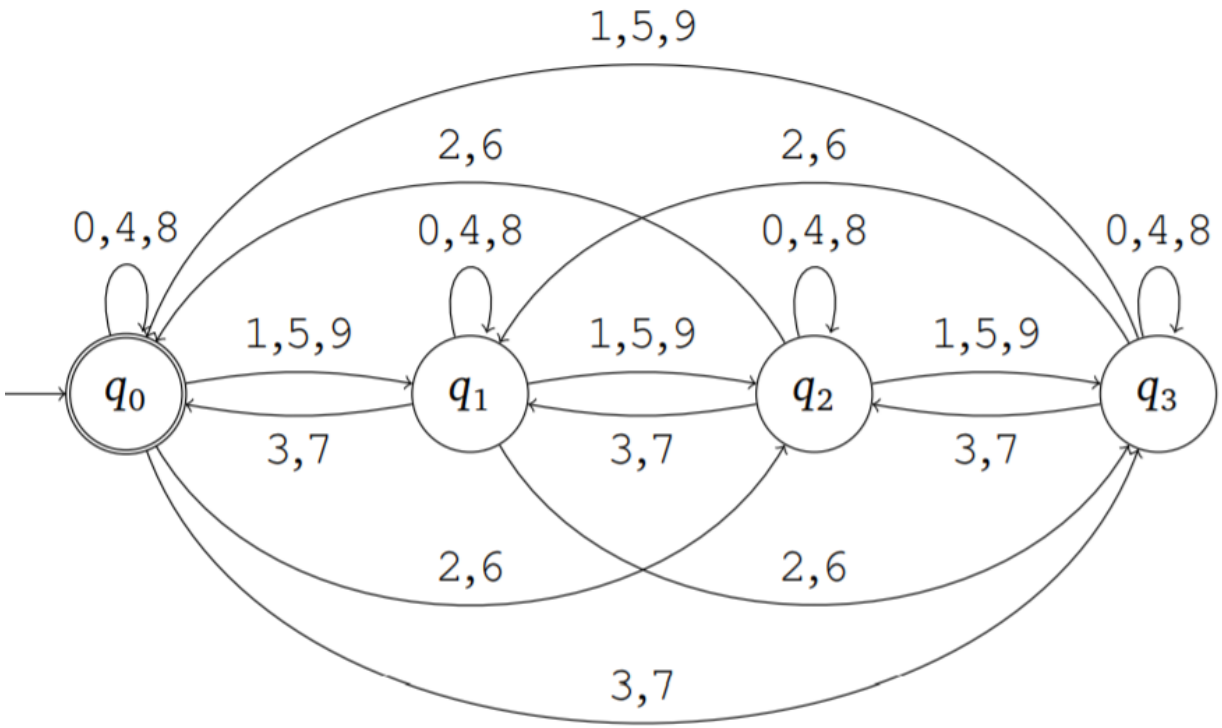


DFA Example

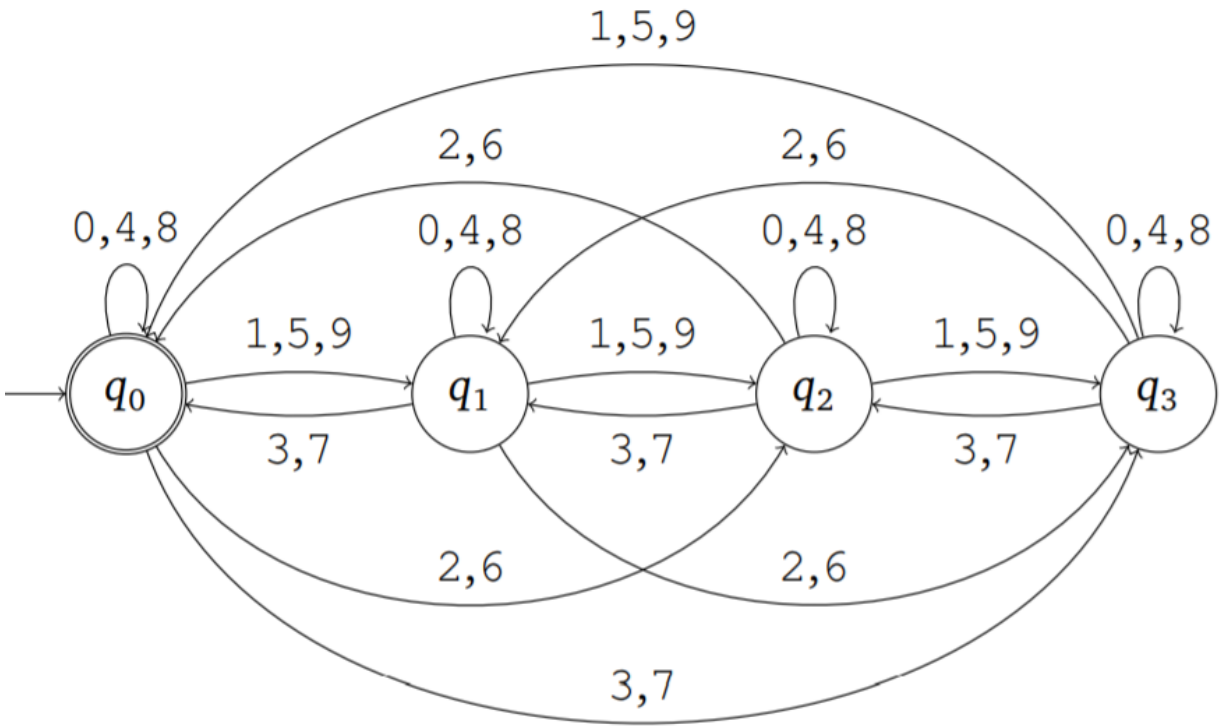


- A DFA for the language of strings whose digits add to a multiple of 3

DFA Example



DFA Example



- A DFA for the language of strings whose digits add to a multiple of 4

Questions

Give DFA's for the following languages, where $\Sigma = \{0, 1\}$.

1. The language of strings that contain at least one 1
2. The language of strings that contain exactly one 1
3. The language of strings that contain at least two 1's
4. The language of strings that contain less than two 1's
5. The language of strings of length at least two whose first two symbols are the same
6. The language of strings of length at least two whose last two symbols are the same
7. The language of strings of length at least two that have a 1 in the second-to-last position

Questions

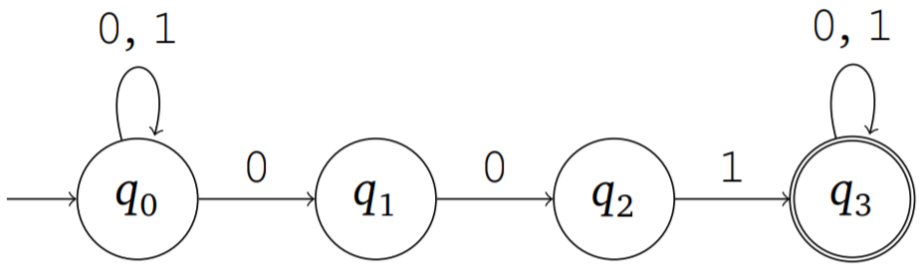
1. The language of strings of length at least two that begin with 0 and end in 1
2. The language of strings of length at least two that have a 1 as their second symbol
3. The language of strings that contain the string 001 as a substring
4. The language of strings that contain the string 001 as a subsequence
5. The language of strings that do not contain the string 001 as a subsequence
6. The language of strings that have even length and begin with the string 01

Non-deterministic Finite Automata (NFA)

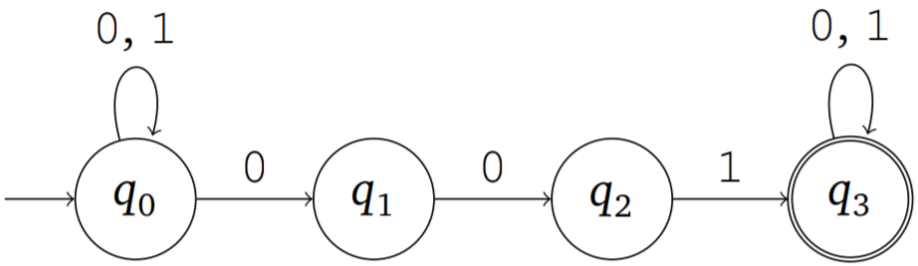
NFA is a five tuple $(Q, \Sigma, \delta, q_0, F)$,

- A finite set of states, Q
- A finite set of input symbols, Σ
- A transition function (denoted δ) that takes as arguments a state and an input symbol along with an empty string ϵ and returns a collection of states. i.e., $\delta : Q \times \Sigma \cup \{\epsilon\} \rightarrow \mathcal{P}(Q)$, where $\mathcal{P}(\cdot)$ denotes the power set.
- A start state $q_0 \in Q$
- A set of final or accepting states $F \subseteq Q$

NFA Examples

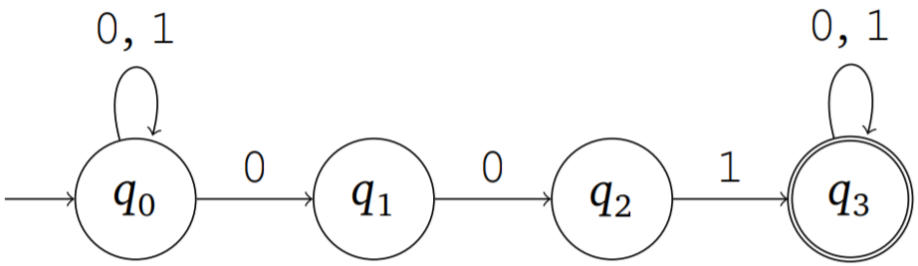


NFA Examples



- An NFA for the language of strings that contain the substring 001

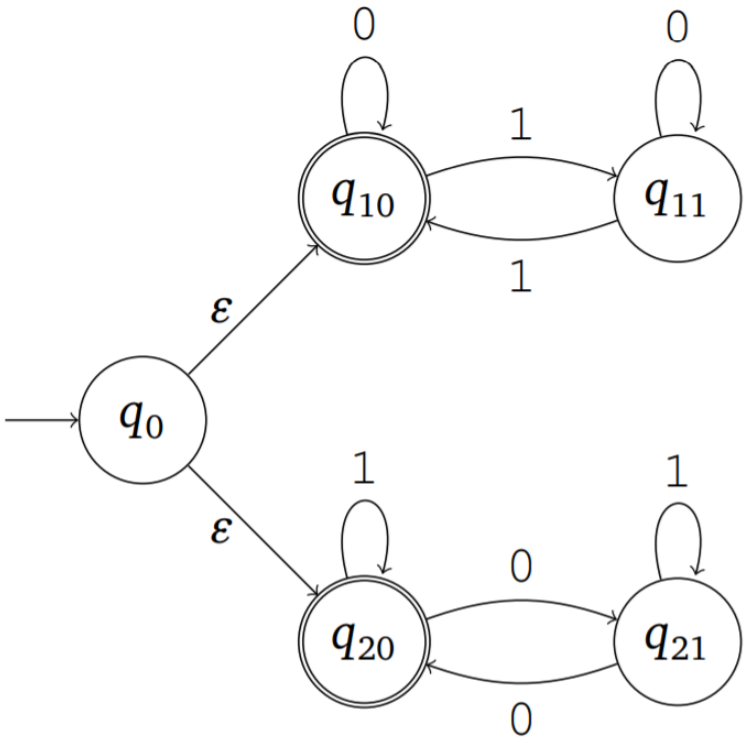
NFA Examples



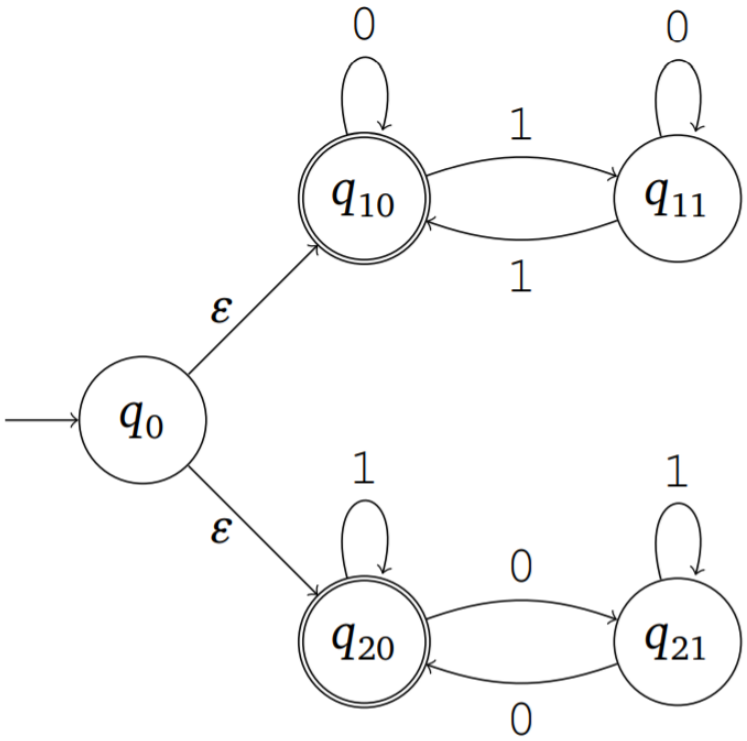
- An NFA for the language of strings that contain the substring 001

δ	0	1	ε
q_0	$\{q_0, q_1\}$	$\{q_0\}$	$\emptyset$
q_1	$\{q_2\}$	$\emptyset$	$\emptyset$
q_2	$\emptyset$	$\{q_3\}$	$\emptyset$
q_3	$\{q_3\}$	$\{q_3\}$	$\emptyset$

NFA Example

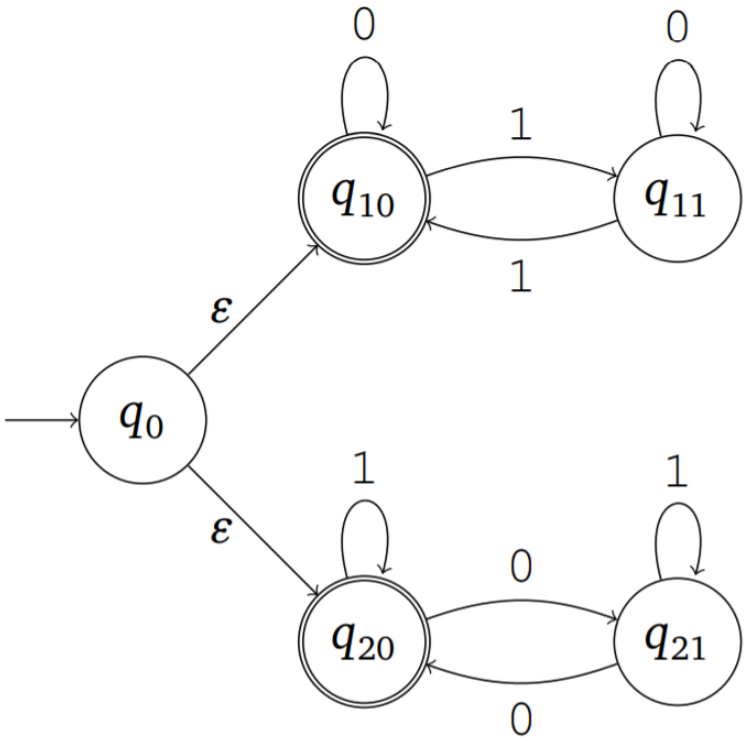


NFA Example



- An NFA for the language of strings that contain either an even number of 0's or an even number of 1's

NFA Example



- An NFA for the language of strings that contain either an even number of 0's or an even number of 1's
- Transition Table?