CSE-217: Theory of Computation

NON-DETERMINISM

Md Jakaria

Lecturer
Department of Computer Science and Engineering
Military Institute of Science and Technology

July 24, 2019

1 Nondeterminism has had great impact on the theory of computation.

1. Nondeterminism has had great impact on the theory of computation.
2. When the machine is in a given state and reads the next input symbol, we know what the next state will be—it is determined. We call this deterministic computation.

3 In a nondeterministic machine, several choices may exist for the next state at any point.

3. In a nondeterministic machine, several choices may exist for the next state at any point.

4. Nondeterminism is a generalization of determinism, so every deterministic finite automaton is automatically a nondeterministic finite automaton.

Example - 1

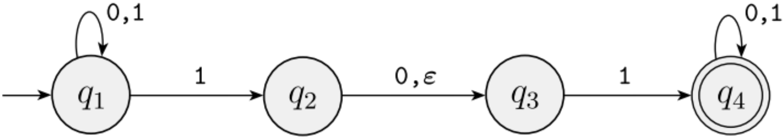


FIGURE 1.27
The nondeterministic finite automaton N_1

1. Every state of a DFA always has exactly one exiting transition arrow for each symbol in the alphabet.

2. In an NFA, a state may have zero, one, or many exiting arrows for each alphabet symbol.

3 In a DFA, labels on the transition arrows are symbols from the alphabet.

4 An NFA may have arrows labeled with members of the alphabet or ϵ. Zero, one, or many arrows may exit from each state with the label ϵ.

BIG Question

How does an NFA compute?

Example - 2

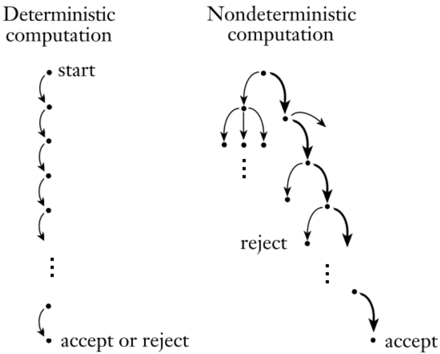


FIGURE 1.28
Deterministic and nondeterministic computations with an accepting branch

Example - 1

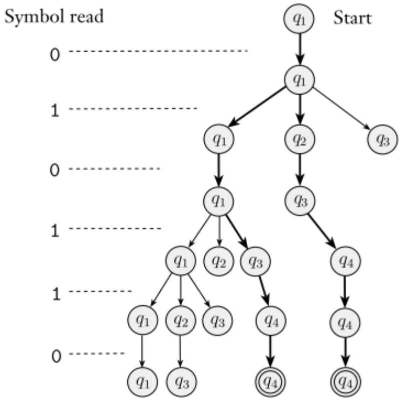


FIGURE 1.29
The computation of N_1 on input 010110

1. Every NFA can be converted into an equivalent DFA
2. Constructing NFAs is sometimes easier than directly constructing DFAs
3. An NFA may be much smaller than its deterministic counterpart.
4. Its functioning may be easier to understand

Example 3

Let A be the language consisting of all strings over {0,1} containing a 1 in the third position from the end (e.g., 000100 is in A but 0011 is not).

Example - 3

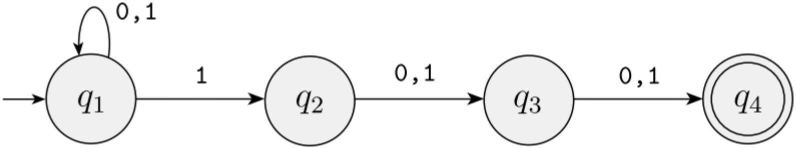
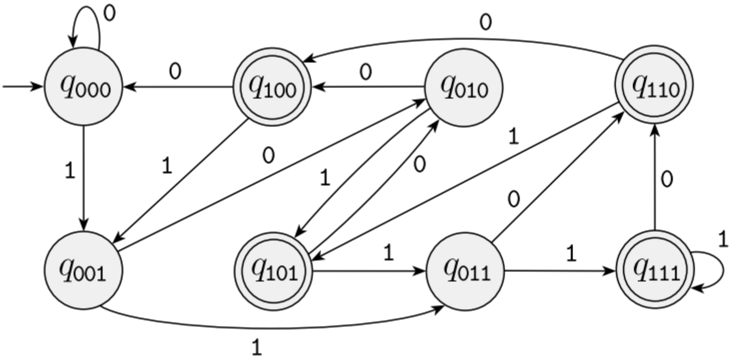


FIGURE 1.31
The NFA N_2 recognizing A

Example - 3



Example 4

Design an NFA, N_3 which has an input alphabet {0}, accepts all strings of the form 0^k where k is a multiple of 2 or 3. (Remember that the superscript denotes repetition, not numerical exponentiation.) For example, N_3 accepts the strings ϵ, 00, 000, 0000, and 000000, but not 0 or 00000.

Example - 4