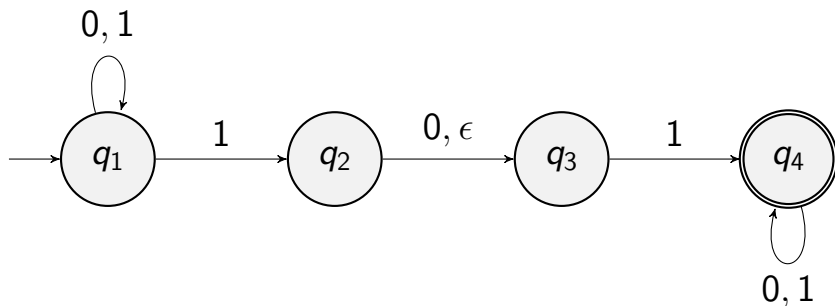


# Nondeterminism I

- Deterministic algorithm:  
Given current state and current input, next step is known
- Nondeterministic algorithm:  
Several choices are possible
- They will be respectively called  
DFA: deterministic finite automata  
and  
NFA: non-deterministic finite automata
- Fig 1.27

# Nondeterminism II

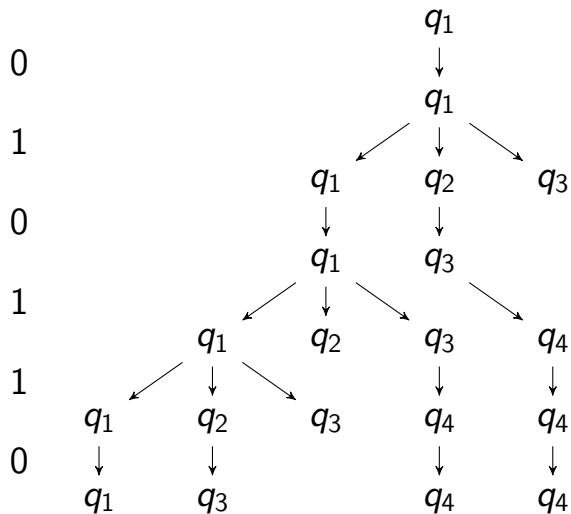


- $\delta$  is not a function any more:  $\delta(q_1, 1) = q_1$  or  $q_2$
- $\epsilon$  between  $q_2$  and  $q_3$ :  $q_2$  can move to  $q_3$  without any input

# Nondeterminism III

- How to run a string? It can be run by split
- A kind of parallel machines
- ex: 010110
- Fig 1.29

# Nondeterminism IV

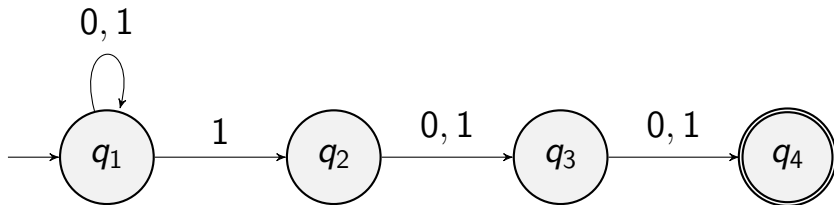


# Nondeterminism V

- After processing the string, if one path reaches an accept state, then the string is accepted
- Note that we handle the  $\epsilon$  edge **immediately**
- So each layer of the tree is the collection of states that can be reached up to the current input character

## Example 1.30 I

- Strings with 1 in 3rd position from the end  
00100, 0100 are accepted, but 0010 is not
- Fig 1.31

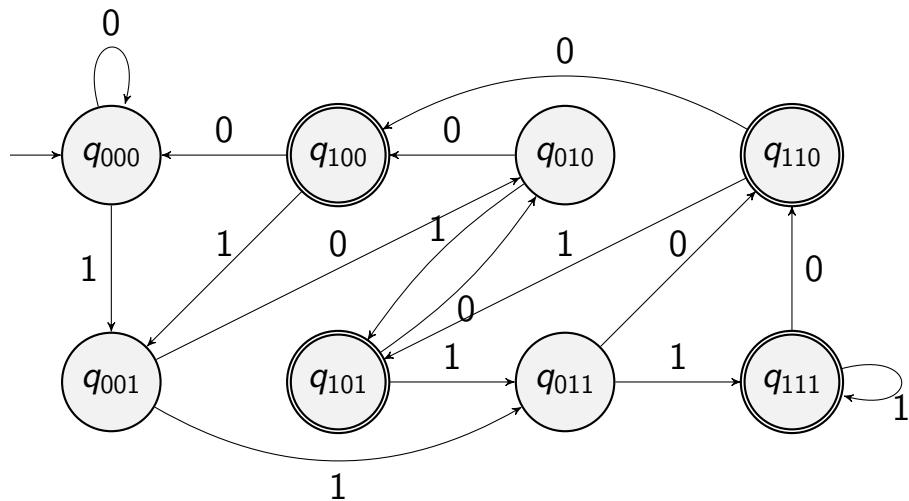


- The only nondeterministic place is at  $q_1$

## Example 1.30 II

- At  $q_1$  we nondeterministically guess if we are already at the third position from the end
- DFA and NFA
- They are equivalent. We will formally explain this later
- For this example we can directly design a DFA for this language
- Fig 1.32

# Example 1.30 III





## Example 1.30 IV

- Idea of this diagram: using 8 states to record the past 3 digits so far
- The idea is simple. But why can we use 000 as the start state?
- Looks like we need other nodes:

---, --0, --1, \_01, \_10, \_00, \_11

- Then we see that the path is the same as if we start from 000
- For example,

---  $\xrightarrow{0}$  --0  $\xrightarrow{1}$  \_01

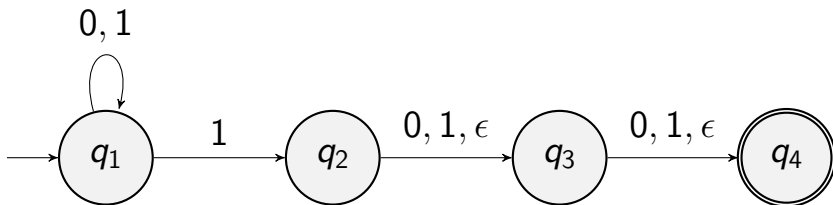
# A modification of example 1.30 I

- Consider a modification of the NFA in example 1.30

$$q_2 \rightarrow q_3 : 0, 1 \Rightarrow 0, 1, \epsilon$$

$$q_3 \rightarrow q_4 : 0, 1 \Rightarrow 0, 1, \epsilon$$

# A modification of example 1.30 II



- What is the language: at least one of the last three characters is 1
- How about DFA for this language?  
Except  $q_{000}$ , all others are in  $F$