Nondeterminism I

- Deterministic algorithm:

  Given current state and current input, next step is known
- Nondeterministic algorithm:

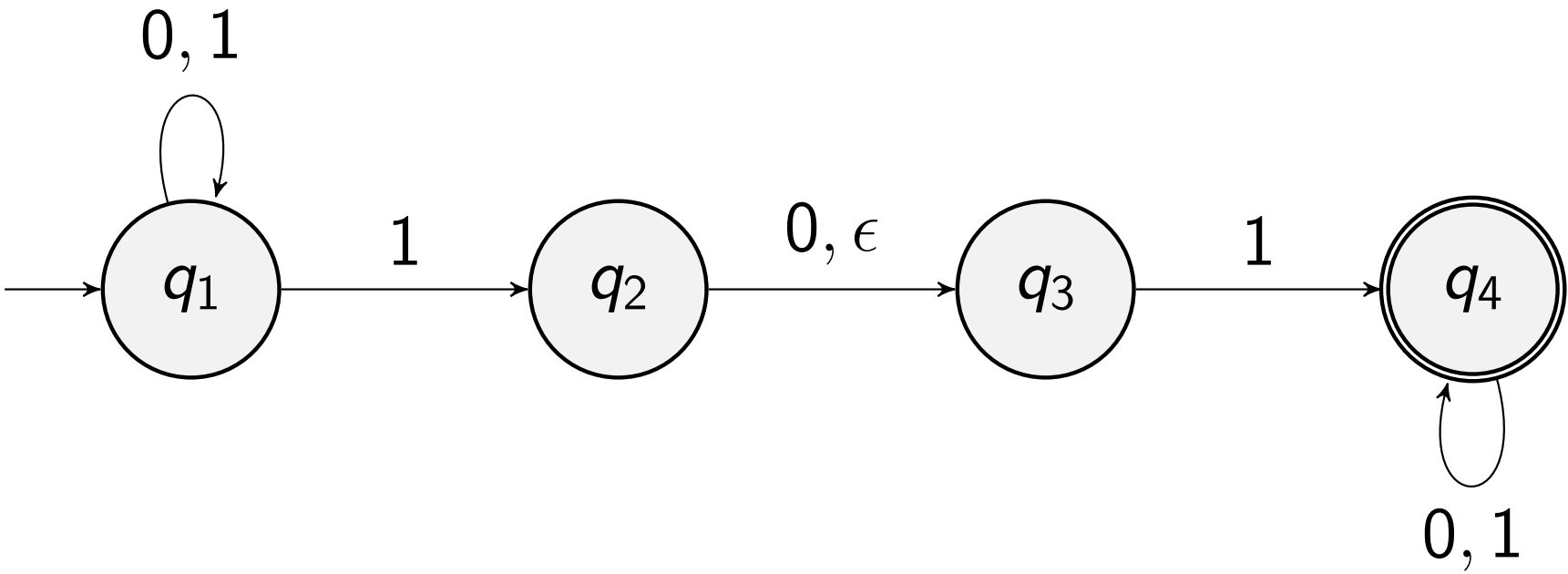
  Several choices are possible
- They will be respectively called

  DFA: deterministic finite automata

  and

  NFA: non-deterministic finite automata
- Fig 1.27

Nondeterminism II

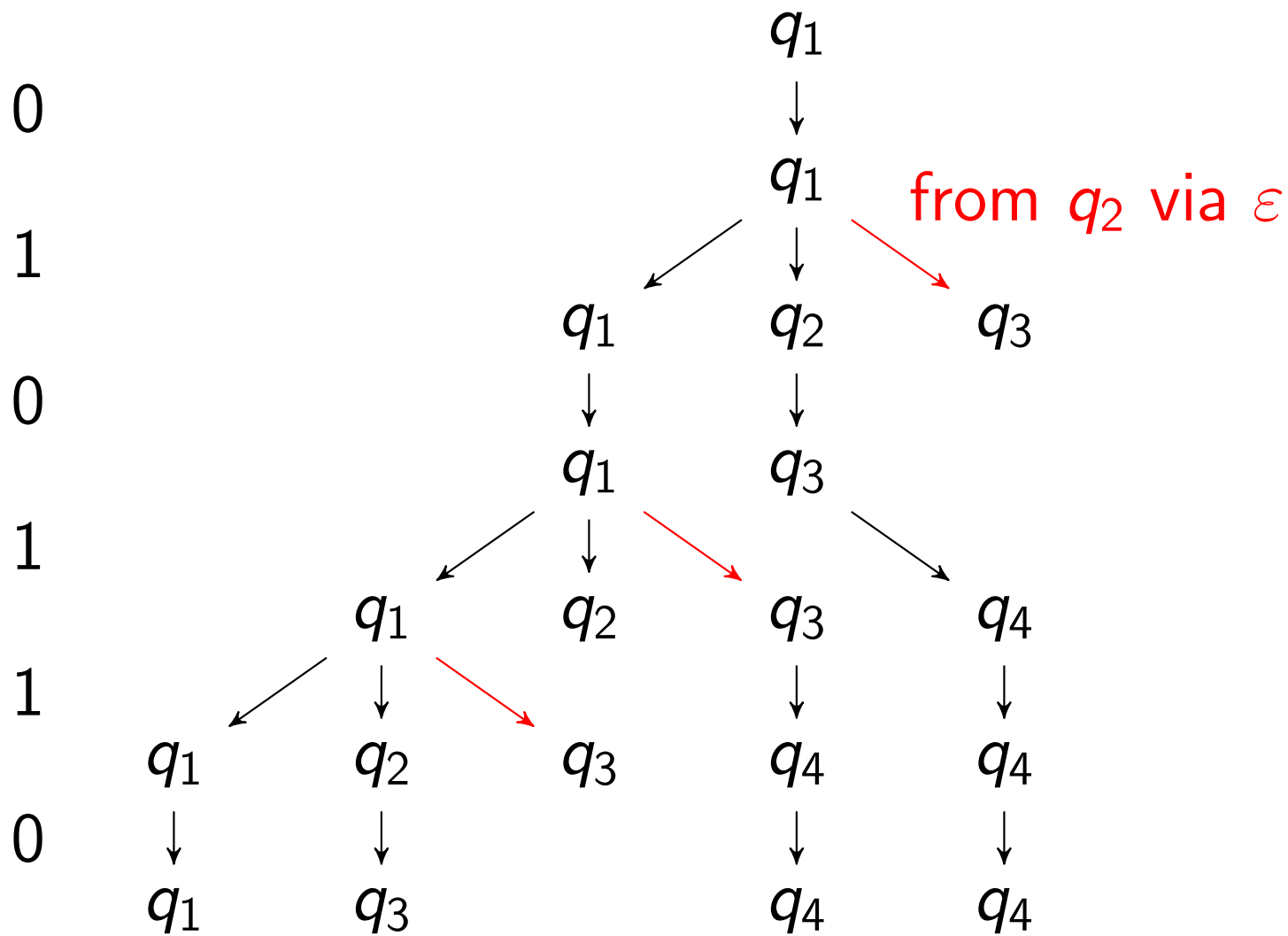


- δ is not a function any more: $\delta(q_1, 1) = q_1$ or q_2
- ϵ between q_2 and q_3: q_2 can move to q_3 without any input

Nondeterminism III

- How to run a string? We can separately consider different situations
- It's like we have a kind of parallel machines
- ex: 010110
- Fig 1.29

Nondeterminism IV

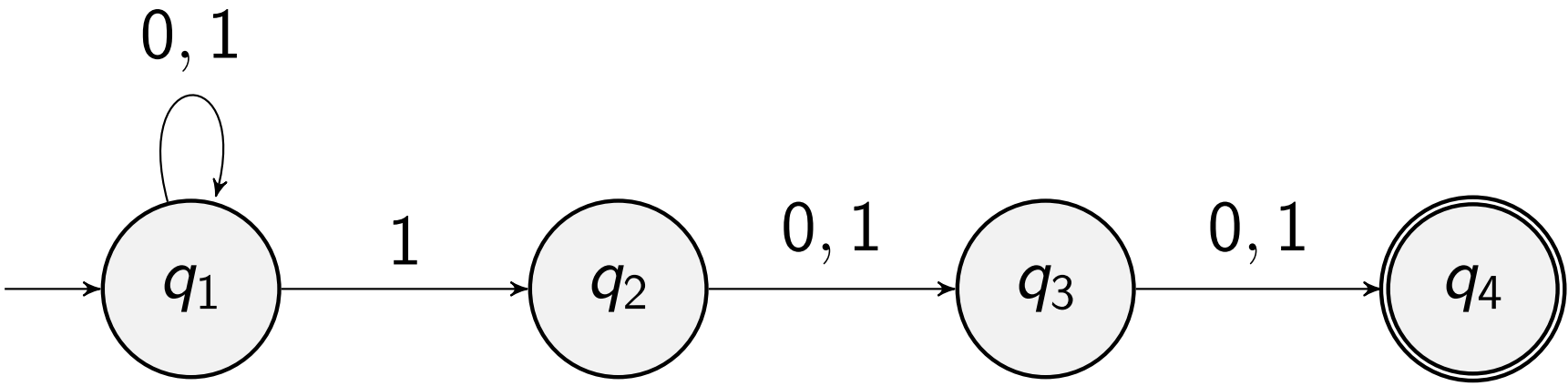


Nondeterminism V

- After processing the string, if one path reaches an accept state, then the string is accepted
- Note that we handle the ϵ 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
- Strings 00100, 0100 are accepted, but 0010 is not
- Fig 1.31



- The only nondeterministic place is at q_1

Example 1.30 II

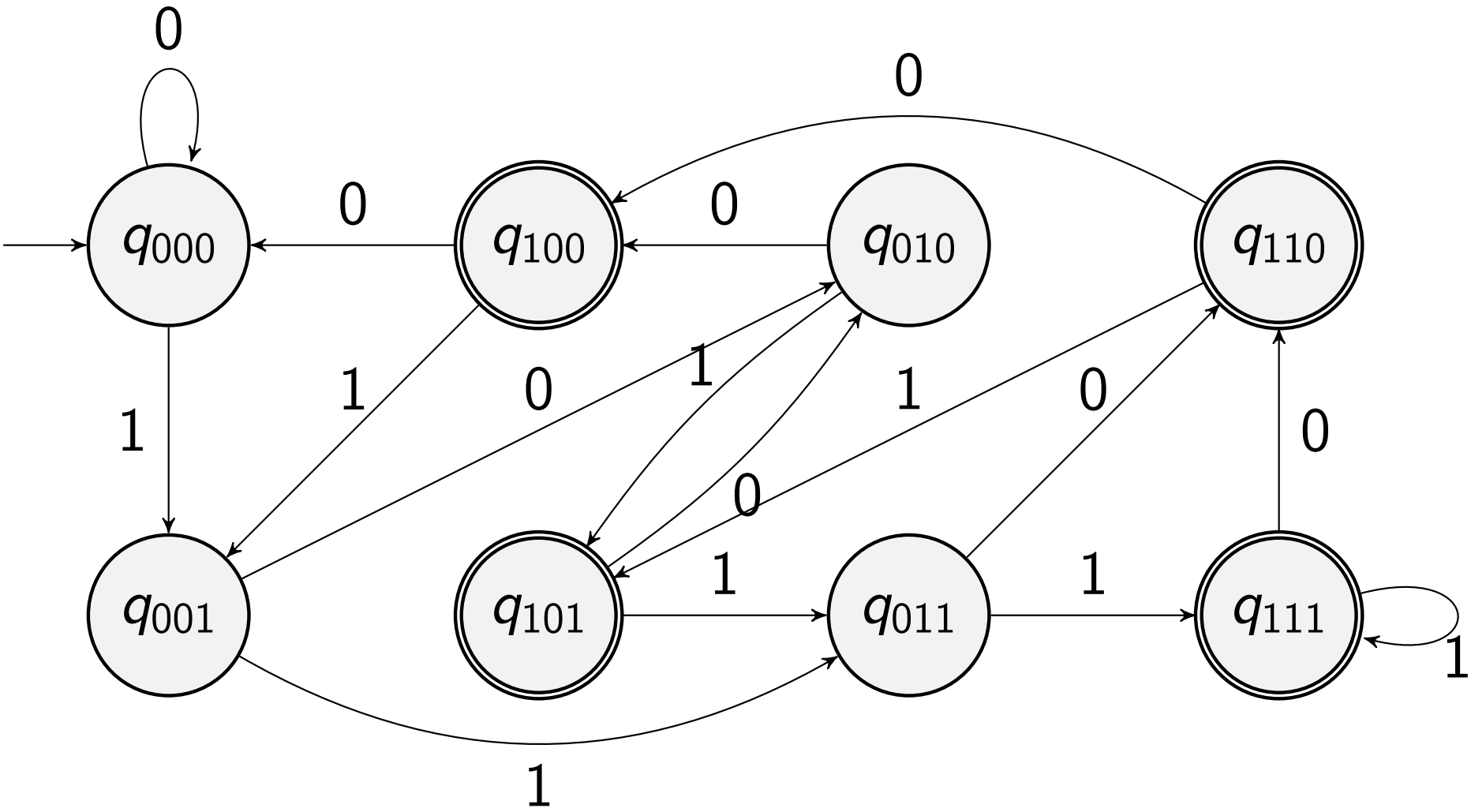
- At q_1 we nondeterministically guess if we are already at the third position from the end
- Another difference is that at q_4, there are no out-links

  This is crucial. It ensures that at q_4 we have 1 in the 3rd position from the end and can accept the string
- Can we recognize this language by a DFA?
- An interesting issue is about the relationship between DFA and NFA
- They are equivalent. We will formally explain this later

Example 1.30 III

- For this example we can directly design a DFA for the language
- Fig 1.32

Example 1.30 IV



Example 1.30 V

- Idea of this diagram: using 8 states to record the past 3 digits so far
- Accept states: any q_{1xx} can be an accept state
- 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

Example 1.30 VI

- For example,

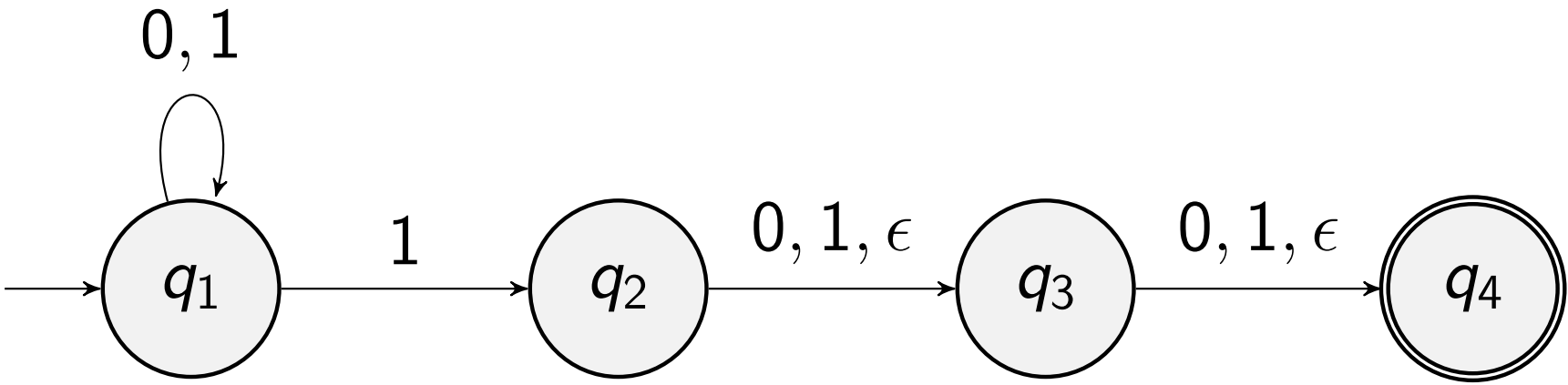
$$\_\_\_ \xrightarrow{0} \_\_0 \xrightarrow{1} \_01$$

A modification of example 1.30 I

- Consider a modification of the NFA in example 1.30

$$q_2 \to q_3 : 0, 1 \Rightarrow 0, 1, \epsilon$$
$$q_3 \to q_4 : 0, 1 \Rightarrow 0, 1, \epsilon$$

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