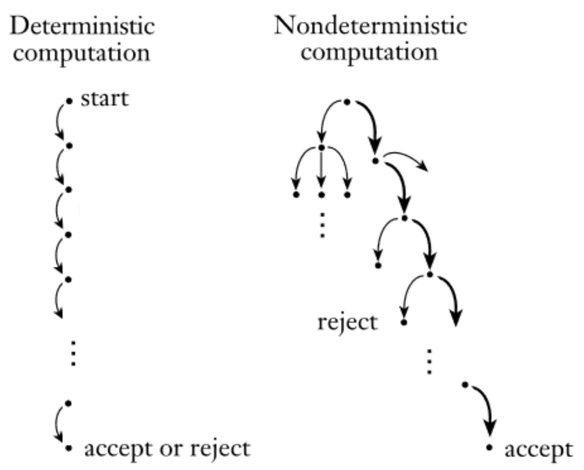
Ch 1.2 Nondeterminism (S)

- **deterministic** computation: when the machine is in a given state and reads the next input symbol, we know what the next state will be.
- **nondeterministic** machine: several choices may exist for the next state
- **DFA**: deterministic finite automaton; **NFA**: nondeterministic finite automaton.



▼ How NFA compute?

It follows all posibilities in parallel, splits into multiple copies of itself.

If there are subsequent choices, the machine splits again.

If the next input doesnot appear on any arrow existing, the copy dies.

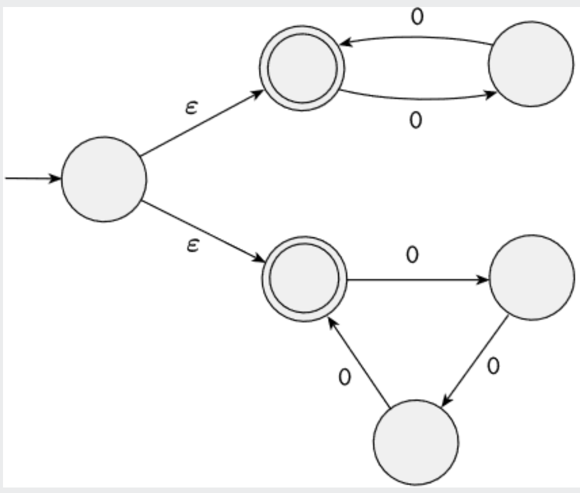
If *any one* of these copies ends up in the accept state, the NFA accepts the input string.

▼ How ϵ works?

If a state with ϵ exists, without reading any input, the machine splits into multiple copies, one stays at the current state, one follow the arrow with the ϵ-label.

▼ Example 1.33

The following NFA N_3 has an input alphabet $\{0\}$ consisting of a single symbol. An alphabet containing only one symbol is called a ***unary alphabet***.



This machine demonstrates the convenience of having ϵ arrows. It accepts all strings of the form 0^k where k is a multiple of 2 or 3. (The subscript denotes repetition, not numerical exponentiation). Ex. N^3 accepts the strings ϵ, 00, 000, 0000, 000000, but not 0, 00000.

Formal Definition of a NFA

A *nondeterministic finite automaton* is a 5-tuple $(Q, \Sigma, \delta, q_0, F)$, where
1. Q is a finite set of states,
2. Σ is a finite alphabet,
3. $\delta : Q \times \Sigma_\epsilon \longrightarrow P(Q)$ is the transition function,
4. $q_0 \in Q$ is the start state, and
5. $F \subseteq Q$ is the set of accept states.

Equivalence of NFAs and DFAs

- Two machines are **equivalent** if they recognise the same language.

Theorem Every NFA has an equivalent DFA.

Corollary A language is regular *iff* some NFA recognises it.

Closure Under the Regular Operations

Theorem The class of regular languages is closed under the *union* operation.

Theorem The class of regular languages is closed under the *concatenation* operation.

Theorem The class of regular languages is closed under the *star* operation.