Nondeterministic TM I

- δ:
$$\delta : Q \times \Gamma \rightarrow P(Q \times \Gamma \times \{L, R\})$$
  P: power set
- Note that following the textbook, we allow only $\{L, R\}$ instead of $\{L, S, R\}$
- Example:
$$\begin{aligned} q_0, a &\rightarrow q_1, b, R \\ &\rightarrow q_2, c, L \end{aligned}$$

Nondeterministic TM II

- What if

$$\begin{aligned} q_0, a &\rightarrow q_{accept} \\ &\rightarrow q_{reject} \end{aligned}$$

- For NTM, by definition w is accepted if one branch works
- In this sense, unless all branches are finite

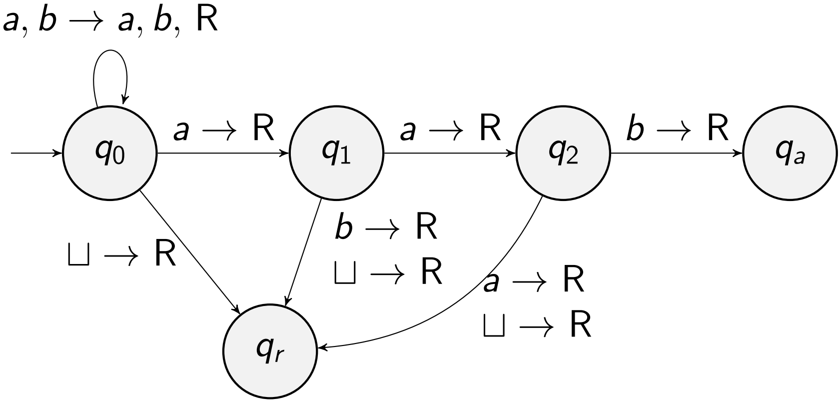
$$\text{NTM} \rightarrow \text{accept or endless loop}$$

- Thus NTM is like an "acceptor"

Example of NTM I

- $A = \{w \mid w \text{ contains } aab\}$
- State diagram

Example of NTM II



Example of NTM III

- You may recall that this is an NFA example discussed before
- Only the first node is nondeterministic

Example of NTM I

- $L = \{0^n \mid n \text{ composite number}\}$
- From p. 204 of Lewis and Papadimitriou
- Composite number: product of two natural numbers
- Procedure
  - Nondeterministically choose p and q
    Sequentially try p from 2 to $n-1$
  - Check if $n = pq$
    This can be done by the earlier example

$$\{a^n b^p c^q \mid n = p \times q\}$$

Example of NTM II

- Question: details about "non-deterministically" choose p and q?
- If we sequentially try all (p, q) combinations, then looks like we have a deterministic setting?
- Our generation of p and q can be non-deterministic
- Say we do a copy operation to generate p elements. The TM can stop this operation at any time point