

# Introduction to Turing Machines

## Supplement for Preparatory Viewing

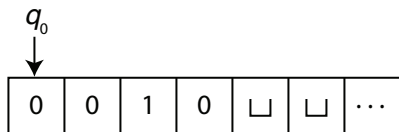
### Representing and Working with Configurations

Consider a Turing machine with input alphabet  $\Sigma = \{0, 1\}$  and start state  $q_0$ . Suppose that the set of this Turing machines also includes states  $q_1$  and  $q_2$ , and that its tape alphabet is

$$\Gamma = \Sigma \cup \{\sqcup, \$\}.$$

Let this Turing machine's transition be a partial function  $\delta : Q \times \Gamma \rightarrow Q \times \Gamma \times \{L, R\}$ .

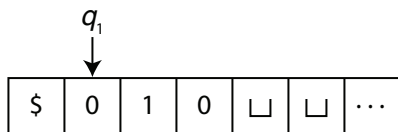
- The **initial configuration** on an input string  $\omega = 0010 \in \Sigma^*$  looks like



and is represented by the string

$$q_00010$$

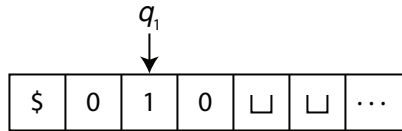
- Suppose that  $\delta(q_0, 0) = (q_1, \$, R)$ . Then, after the first step of the Turing machine's execution on the input string  $\omega = 0010$ , the configuration looks like



and is represented by the string

$$\$q_1010$$

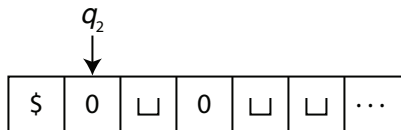
- Suppose, as well, that  $\delta(q_1, 0) = (q_1, 0, R)$ . Then, after the second step of the Turing machine's execution on the input string  $\omega = 0010$ , the configuration looks like



and is represented by the string

$\$0q_110$

- Suppose that  $\delta(q_1, 1) = (q_2, \square, L)$ . Then, after the third step of the Turing machine's execution on the input string  $\omega = 0010$ , the configuration looks like



and is represented by the string

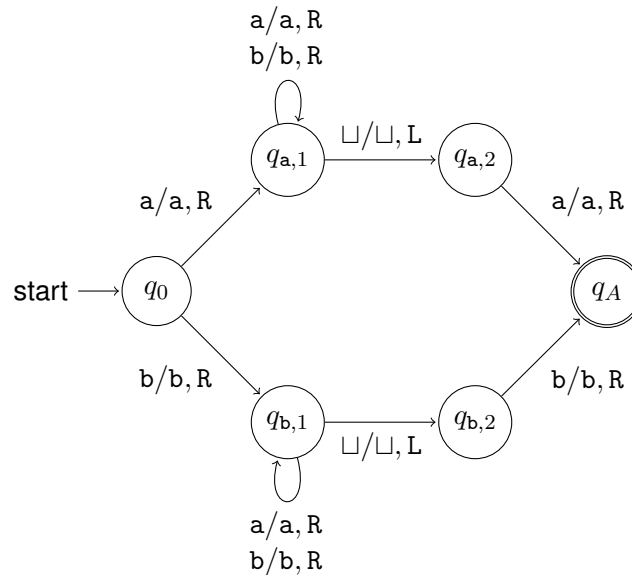
$\$q_20 \square 0$

## An Example of Turing Machines

The first complete example of a Turing machine is a Turing machine

$$M_1 = (Q_1, \Sigma_1, \Gamma_1, \delta_1, q_0, q_{\text{accept}}, q_{\text{reject}})$$

with the following transition diagram.



To keep the picture simple, the accept state is shown as “ $q_A$ ” instead of  $q_{\text{accept}}$ , and transitions to the reject state, and this state, are left out — but

$$\delta(q, \sigma) = (q_{\text{reject}}, \sigma, R)$$

for  $q = q_0$  and  $\sigma = \sqcup$ , for  $q = a, 2$  and either  $\sigma = b$  or  $\sigma = \sqcup$ , and for  $q_{b,2}$  and either  $\sigma = a$  or  $\sigma = \sqcup$ .