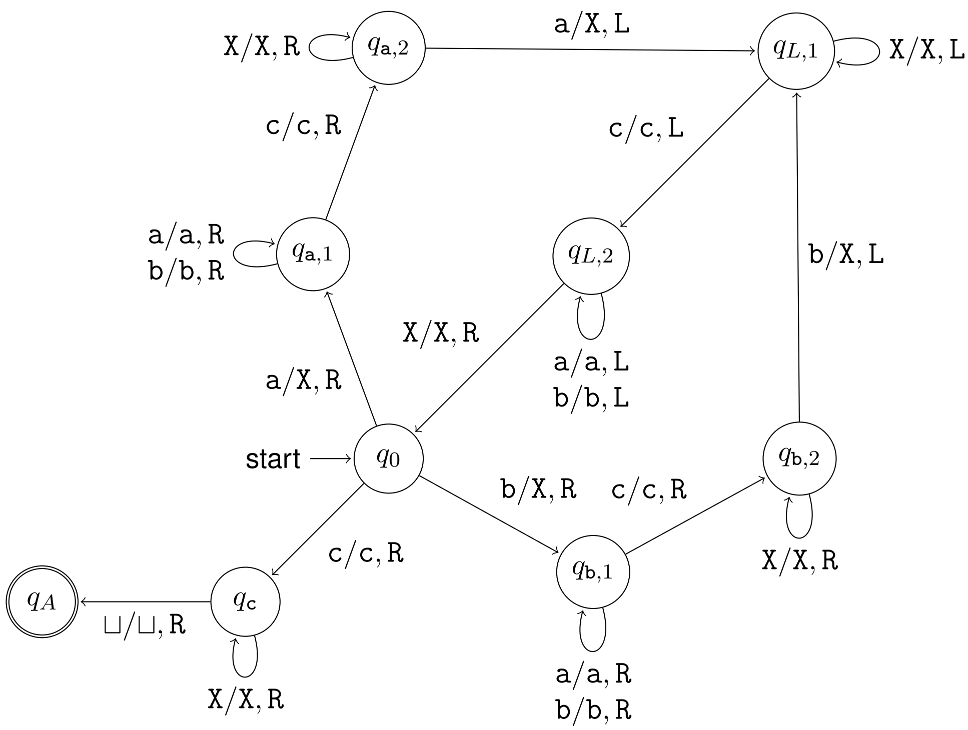
Lecture #10: Introduction to Turing Machines
Supplement for Lecture Presentation

Let $\Sigma = \{\mathrm{a}, \mathrm{b}, \mathrm{c}\}$. The first part of the presentation concerns the Turing machine

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

where $\Gamma_1 = \{\mathrm{a}, \mathrm{b}, \mathrm{c}, \mathtt{X}, \sqcup\}$, with an incomplete transition diagram that is as follows:

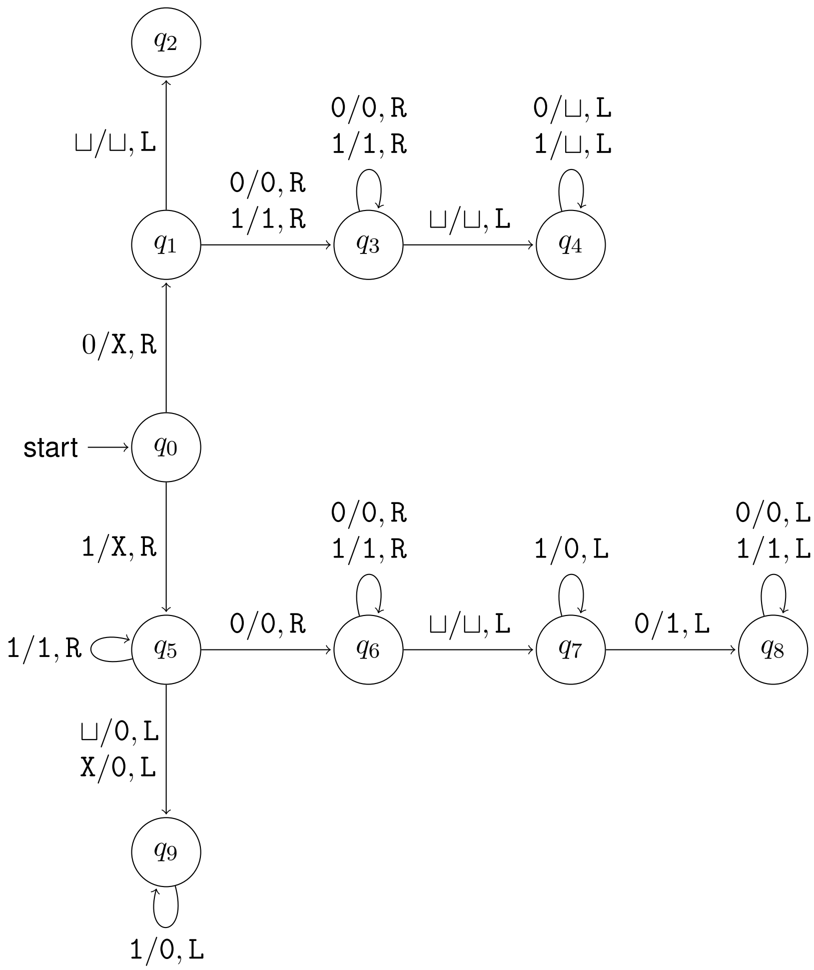


In this diagram, the accepting state q_{accept} is shown as "q_A" instead. As the above 7-tuple indicates, this Turing machine has start state q_0, accepting state q_{accept}, and rejecting state q_{reject}. Transitions for states $q \in Q_1 \setminus \{q_A, q_R\}$ and symbols $\sigma \in \Gamma$ that are not shown all have the form $\delta_1(q, \sigma) = (q_R, \sigma, \mathtt{R})$.

Now let $\Sigma_1 = \Sigma_2 = \{0, 1\}$. Consider the Turing machine

$$M_2 = (Q_2, \Sigma_1, \Sigma_2, \Gamma_2.\delta_2, q_0, q_{\text{halt}})$$

where $\Gamma_2 = \{\mathtt{0}, \mathtt{1}, \mathtt{X}, \sqcup\}$, with an incomplete transition diagram as follows:



This is a Turing machine where $\Gamma = \{\mathtt{0}, \mathtt{1}, \mathtt{X}, \sqcup\}$ and with a set of states

$$Q_2 = \{q_0, q_1, q_2, q_3, q_4, q_5, q_6, q_7, q_8, q_9, q_{\text{halt}}\}.$$

The halt state, q_{halt}, and transitions leading to it, are not shown in this diagram. The missing transitions, leading to the halting state, are as follows.

(a) $\delta_2(q_0, \sigma) = (q_{\text{halt}}, \sqcup, \mathtt{L})$ for $\sigma = \sqcup$ and $\sigma = \mathtt{X}$.

(b) $\delta_2(q_1, \mathtt{X}) = (q_{\text{halt}}, \sqcup, \mathtt{L})$ — so that $\delta_2(q_1 \mathtt{X}) = \delta_2(q_1, \sqcup)$.

(c) $\delta_2(q_2, \sigma) = (q_{\text{halt}}, \mathtt{1}, \mathtt{L})$ for $\sigma \in \Gamma$.

(d) $\delta_2(q_3, \mathtt{X}) = (q_{\text{halt}}, \sqcup, \mathtt{L})$ — so that $\delta_2(q_3, \mathtt{X}) = \delta_2(q_3, \sqcup)$.

(e) $\delta_2(q_4, \sigma) = (q_{\text{halt}}, \sqcup, \mathtt{L})$ for $\sigma = \sqcup$ and $\sigma = \mathtt{X}$.

(f) $\delta_2(q_6, \mathtt{X}) = (q_{\text{halt}}, \sqcup, \mathtt{L})$ — so that $\delta_2(q_6, \mathtt{X}) = \delta_2(q_6, \sqcup)$.

(g) $\delta_2(q_7, \sigma) = (q_{\text{halt}}, \sqcup, \mathtt{L})$ for $\sigma = \sqcup$ and $\sigma = \mathtt{X}$.

(h) $\delta_2(q_8, \sigma) = (q_{\text{halt}}, \mathtt{1}, \mathtt{L})$ for $\sigma = \sqcup$ and $\sigma = \mathtt{X}$.

(i) $\delta_2(q_9, \sigma) = (q_{\text{halt}}, \mathtt{1}, \mathtt{L})$ for $\sigma = \sqcup$ and $\sigma = \mathtt{X}$.