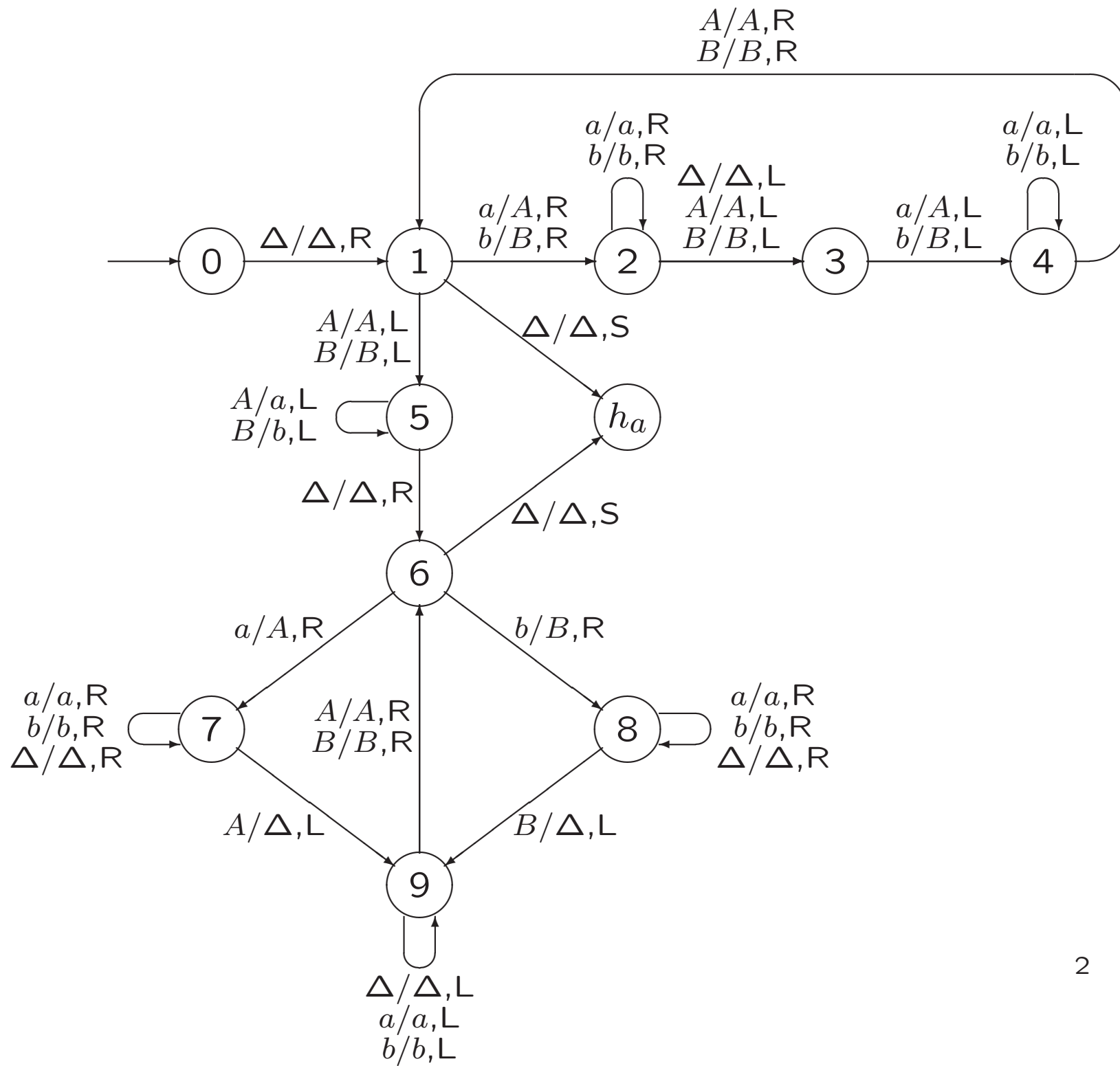


Exercise 7.1.

Trace the TM in Figure 7.6 (see next slide), accepting the language $\{xx \mid x \in \{a,b\}^*\}$, on the string *aaba*. Show the configuration at each step.



Exercise 7.2.

Below is a transition table for a TM with input alphabet $\{a, b\}$.

q	σ	$\delta(q, \sigma)$	q	σ	$\delta(q, \sigma)$	q	σ	$\delta(q, \sigma)$
q_0	Δ	(q_1, Δ, R)	q_2	Δ	(h_a, Δ, R)	q_6	a	(q_6, a, R)
q_1	a	(q_1, a, R)	q_3	Δ	(q_4, a, R)	q_6	b	(q_6, b, R)
q_1	b	(q_1, b, R)	q_4	a	(q_4, a, R)	q_6	Δ	(q_7, b, L)
q_1	Δ	(q_2, Δ, L)	q_4	b	(q_4, b, R)	q_7	a	(q_7, a, L)
q_2	a	(q_3, Δ, R)	q_4	Δ	(q_7, a, L)	q_7	b	(q_7, b, L)
q_2	b	(q_5, Δ, R)	q_5	Δ	(q_6, b, R)	q_7	Δ	(q_2, Δ, L)

What is the final configuration if the TM starts with input string x ?

Exercise 7.3.

Let $T = (Q, \Sigma, \Gamma, q_0, \delta)$ be a TM, and let s and t be the sizes of the sets Q and Γ , respectively.

How many distinct configurations of T could there possibly be in which all tape squares past square n are blank and T 's tape head is on or to the left of square n ? (The tape squares are numbered beginning with 0.)

Exercise 7.10.

We do not define Λ -transitions for a TM. Why not?

What features of a TM make it unnecessary or inappropriate to talk about Λ -transitions?

Exercise 7.17.

For each case below, draw a TM that computes the indicated function.

In the first four parts, the function is from $\mathbb{N}$ to $\mathbb{N}$. In each of these parts, assume that the TM uses unary notation — i.e., the natural number n is represented by the string 1^n .

a. $f(x) = x + 2$

b. $f(x) = 2x$

c. $f(x) = x^2$

e. $E : \{a, b\}^* \times \{a, b\}^* \rightarrow \{0, 1\}$
defined by $E(x, y) = 1$ if $x = y$, $E(x, y) = 0$ otherwise.

Exercise.

Draw a TM that computes the function

$$f(x, y) = x + y$$

where x, y are integers ≥ 0 .

Assume that the TM uses unary notation, both for its input and for its output.

Exercise.

Draw a TM that computes the function $f(x, y) = x \bmod y$

Hint: implement the following algorithm:

```
while (x >= y)
    x = x - y;
```

Exercise 7.12.

Suppose T is a TM that accepts a language L . Describe how you would modify T to obtain another TM accepting L that never halts in the reject state h_r .

Exercise 7.16.

Does every TM compute a partial function? Explain.

Exercise 7.20.

Draw a transition diagram for a TM with input alphabet $\{0, 1\}$ that interprets the input string as the binary representation of a nonnegative integer and adds 1 to it.

You may assume that the input string is not empty.

Exercise 7.24.

In Example 7.5, a TM is given that accepts the language $\{xx \mid x \in \{a,b\}^*\}$.

Draw a TM with tape alphabet $\Gamma = \{a,b\}$ that accepts this language.