Exercise 8.34.

Suppose $G_1 = (V_1, \Sigma, S_1, P_1)$ and $G_2 = (V_2, \Sigma, S_2, P_2)$ are unrestricted grammars generating L_1 and L_2, respectively.

(a) Using G_1 and G_2, describe an unrestricted grammar generating L_1L_2.

(b) Using G_1, describe an unrestricted grammar generating L_1^*.

Exercise.

In lecture 5, we have discussed an implementation of phase 2 of the construction from Theorem 8.13, which simulates arbitrary derivations in an unrestricted grammar, in a nondeterministic Turing machine.

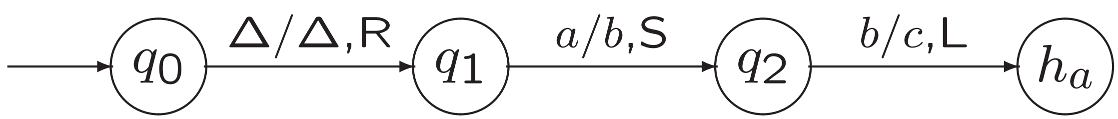
Draw the resulting NTM for the unrestricted grammar below:

$S \to LaR \quad L \to LD \mid \Lambda$
$Da \to aaD \quad DR \to R \quad R \to \Lambda$

N.B.: You may need components *Insert*(σ) and *Delete* in your answer.

Exercise.

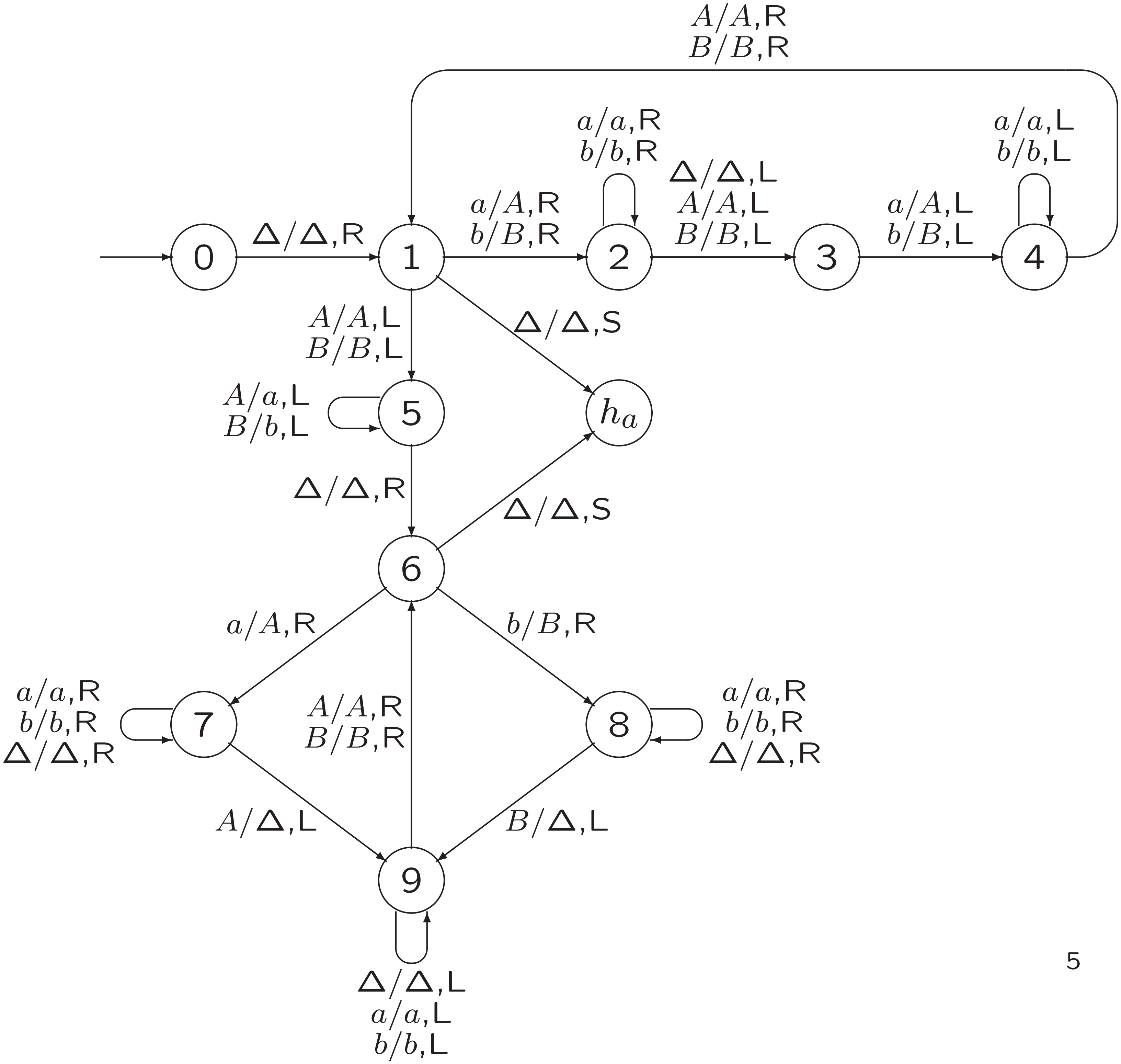
For the Turing machine below, give all productions of the second type (to simulate the computation of the Turing machine) that result from the construction in the proof of Theorem 8.14.



Exercise 8.22.

Figure 7.6 (see next slide) shows the transition diagram for a TM accepting $XX = \{xx \mid x \in \{a,b\}^*\}$.

In the grammar obtained from this TM as in the proof of Theorem 8.14, give a derivation for the string $abab$.


A/A,R
B/B,R
a/a,R
b/b,R
Δ/Δ,L
A/A,L
B/B,L
a/a,L
b/b,L
Δ/Δ,R
0
1
a/A,R
b/B,R
2
3
a/A,L
b/B,L
4
A/A,L
B/B,L
Δ/Δ,S
A/a,L
B/b,L
5
h_a
Δ/Δ,R
Δ/Δ,S
6
a/A,R
b/B,R
a/a,R
b/b,R
Δ/Δ,R
7
A/A,R
B/B,R
8
a/a,R
b/b,R
Δ/Δ,R
A/Δ,L
B/Δ,L
9
Δ/Δ,L
a/a,L
b/b,L

Exercise 8.27.

Show that if L is any recursively enumerable language, then L can be generated by a grammar in which the left side of every production is a string of one or more variables.