Exercise 5.32.

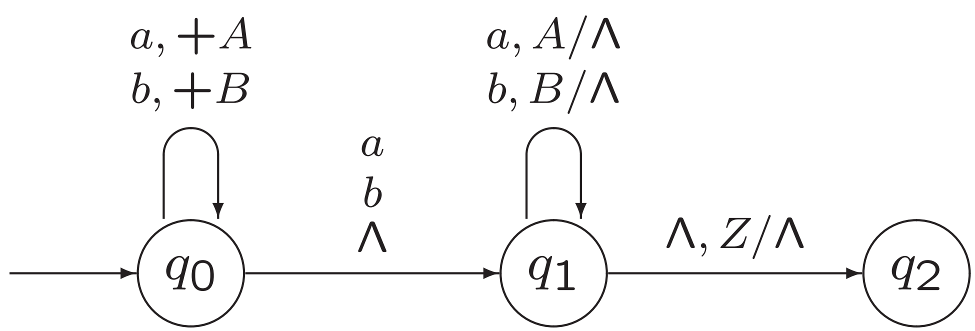
Lem M be the PDA below, accepting

$$Pal = \{y \in \{a,b\}^* \mid y = y^r\} = \{xx^r, xax^r, xbx^r \mid x \in \{a,b\}^*\}$$

(by empty stack). Let $x = ababa$.

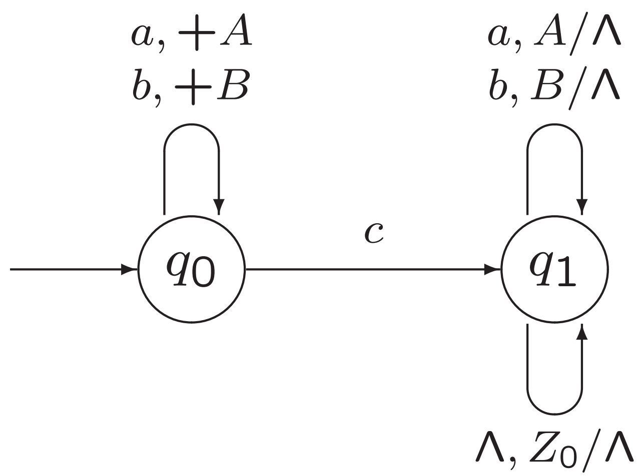
a. Find a sequence of moves of M by which x is accepted.

b. Give the corresponding leftmost derivation in the CFG obtained from M as in Theorem 5.29.



Exercise 5.35.

Let M be the PDA below, accepting *SimplePal* by empty stack.



Consider the simplistic approach to obtaining a CFG described in the discussion preceding Theorem 5.29. The states of M are ignored, the variables of the grammar are the stack symbols of M, and for every move that reads σ and replaces A on the stack by $BC \dots D$, we introduce the production $A \to \sigma BC \dots D$.

a. Give all productions resulting from this approach.

b. Find a string $x \in \{a, b, c\}^*$ that is generated by this CFG, but is not accepted by M.

Example 6.4. $XX = \{xx \mid x \in \{a,b\}^*\}$ is not context-free.
Use $u = a^n b^n a^n b^n$

Exercise 6.4.

In the proof given in Example 6.4 using the pumping lemma, the contradiction was obtained in each case by considering the string vw^0xy^0z.

Would it have been possible instead to use vw^2xy^2z in each case?
If so, give the proof in at least one case;
if not, explain why not.

Example 6.4. $XX = \{xx \mid x \in \{a,b\}^* \}$ is not context-free.
Use $u = a^n b^n a^n b^n$

Exercise 6.3.

In the pumping-lemma proof in Example 6.4, give some examples of choices of strings $u \in L$ with $|u| \geq n$ that would not work.

Exercise 6.2.

In each case below, show using the pumping lemma that the given language is not a CFL.

a. $L = \{a^i b^j c^k \mid i < j < k\}$

b. $L = \{a^{2^i} \mid i \geq 0\}$

d. $L = \{a^i b^{2i} a^i \mid i \geq 0\}$

e. $L = \{s \in \{a, b, c\}^* \mid n_a(s) = \max\{n_b(s), n_c(s)\}\ \}$

g. $L = \{a^i b^j a^i b^{i+j} \mid i, j \geq 0\}$

Exercise 6.5.

For each case below, decide whether the given language is a CFL, and prove your answer.

a. $L = \{a^i b^j a^j b^i \mid i, j \geq 0\}$

c. $L = \{scs \mid s \in \{a,b\}^*\}$

d. $L = \{sts \mid s, t \in \{a,b\}^* \text{ en } |s| \geq 1\}$

g. $L =$ the set of non-balanced strings of parentheses