

## **Homework #5** due May 6 Thursday before the recitation

(1) Let  $M$  be the PDA defined by  $Q = \{q, q_0, q_1, q_2\}$ ,  $\Sigma = \{a, b\}$ ,  $\Gamma = \{a\}$ ,  $F := \{q, q_1\}$ .

$$\delta(q_0, a, Z_0) = \{(q, Z_0)\}$$

$$\delta(q, a, Z_0) = \{(q, aZ_0)\}$$

$$\delta(q, a, a) = \{(q, aa)\}$$

$$\delta(q, b, a) = \{(q_1, e)\}$$

$$\delta(q_1, b, a) = \{(q_1, e)\}$$

$$\delta(q_1, b, Z_0) = \{(q_2, e)\}$$

a) Describe the language accepted by  $M$ .

b) Trace all computations of the strings  $aab$ ,  $abb$ ,  $aba$  in  $M$ .

c) Show that  $aaabb, aaab \in L(M)$ .

(2) Construct PDAs that accept each of the following languages.

a)  $\{a^i b^j \mid 0 \leq i \leq j\}$

b)  $\{a^i c^j b^i \mid i, j \geq 0\}$

d)  $\{a^i b^j c^k \mid i+k = j\}$

e)  $\{a^i b^j \mid 0 \leq i \leq j \leq 2i\}$

f)  $\{a^{i+j} b^i c^j \mid i, j > 0\}$

(3)  $L = \{w \in \{a, b\}^* \mid \text{at least one prefix of } w \text{ contains strictly more } b \text{'s than } a \text{'s.}\}$ .

For example,  $baa$ ,  $abb$ ,  $abbbbaa$  are in  $L$ , but  $aab$ ,  $aabbab$  are not in  $L$ .

a) Construct a PDA that accepts  $L$  by final state.

b) Construct a PDA that accepts  $L$  by empty stack.

(4) From the main text **Exercises 6.2.6, 6.3.2, 6.3.4**