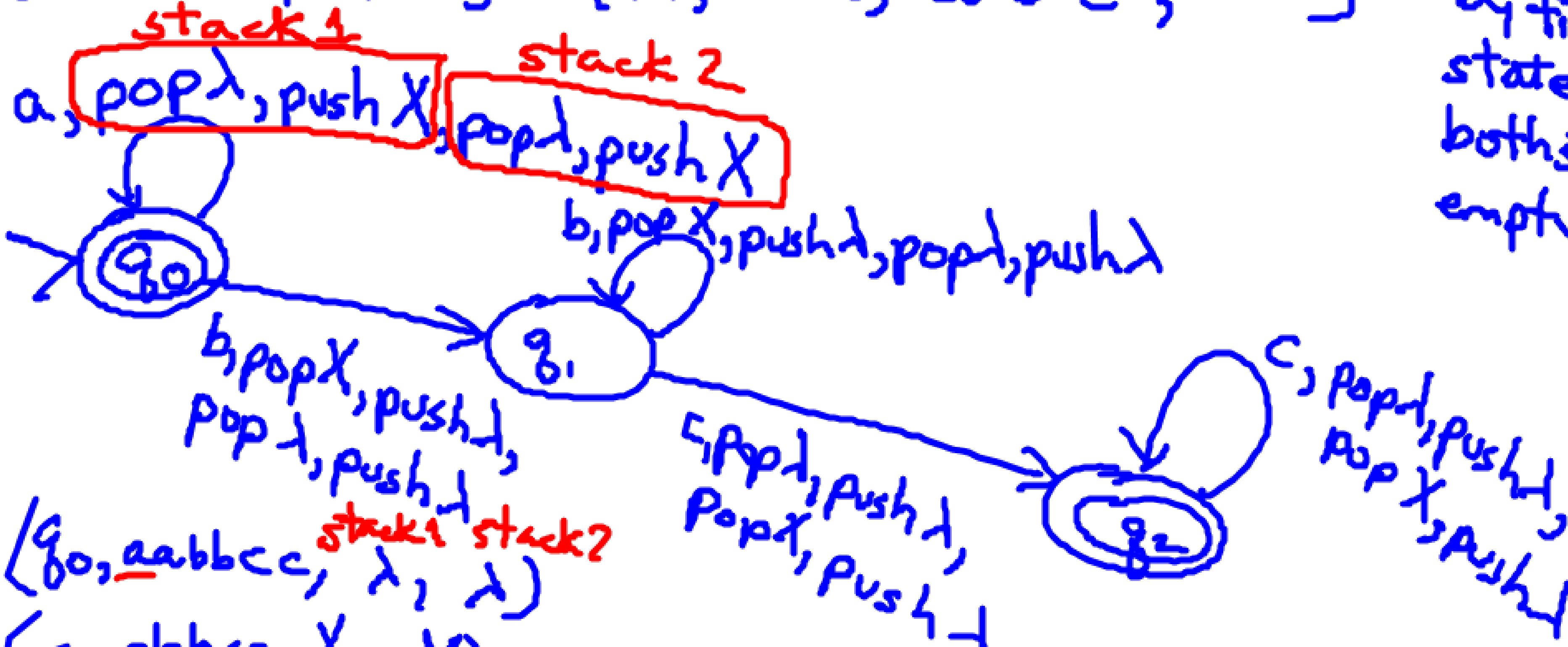
2-stack PDA $\equiv$ FA + 2 stacks

$\{a^n b^n c^n \mid n \geq 0\} = \{\lambda, abc, a^2b^2c^2, \dots\}$

Acceptance by final state and both stacks empty



stack1 stack2

$(q_0, \underline{a}abbcc, \lambda, \lambda)$

$(q_0, \underline{a}bbcc, X, X)$

$(q_0, \underline{b}bcc, XX, XX)$

$(q_1, \underline{b}cc, X, XX)$

$(q_1, \underline{c}c, \lambda, XX)$

$(q_2, \underline{c}, \lambda, X)$

$(q_2, \lambda, \lambda, \lambda)$ ✓✓✓ accept

$\{a^n b^m \mid m,n \geq 0,\ n \leq m \leq 2n\}$

$G = (N, \Sigma, P, S)$

$$\boxed{\begin{aligned} S &\to \lambda \\ S &\to aSb \\ S &\to aSbb \end{aligned}}$$

Any CFG can be converted into an equivalent 1-stack PDA.

make transition

$\delta(q_0, \lambda) = \{(q_1, \boxed{\text{pop } Z}, \text{push } S)\}$

$A \to w \in P$

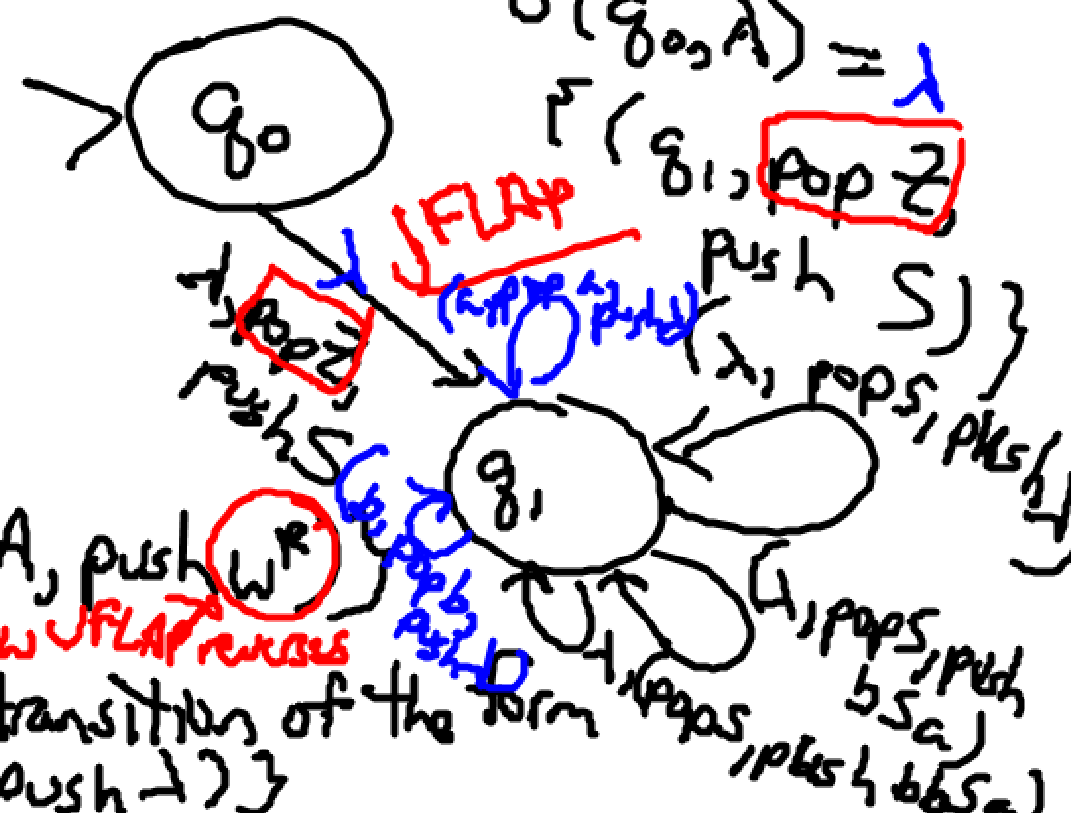
Foreach rule make a transition of the form

$\delta(q_1, \lambda) = \{(q_1, \text{pop } A, \text{push } w^R)\}$

w JFLAP reverses

Foreach $a \in \Sigma$, make a transition of the form

$\delta(q_1, a) = \{(q_1, \text{pop } a, \text{push } \lambda)\}$



String x is a palindrome iff $x = x^R$.

6/14/16 . . .

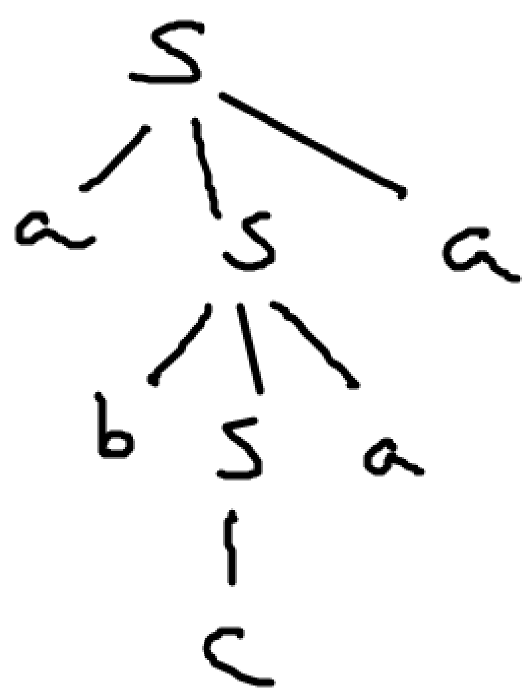
$L(G) = \{ wcw^R \mid w \in \{a,b\}^* \}$

$(xy)^R = y^R x^R$

$S \to aSa$

$S \to bSb$

$S \to c$



$(\boxed{wcw^R})^R =$

$(w^R)^R c^R w^R =$

$\boxed{wc\ w^R}$

$\{a^n b^m \mid m,n \ge 0,\ n \le m \le 2n\}$

$G = (N, \Sigma, P, S)$

$S \to \lambda$
$S \to aSb$
$S \to aSbb$

Any CFG can be converted into an equivalent 1-stackPDA.

make transition
$\delta(q_0, \lambda) = \lambda$
$\{(q_1, \boxed{\text{pop } Z}, \text{push } S)\}$

$A \to w \in P$

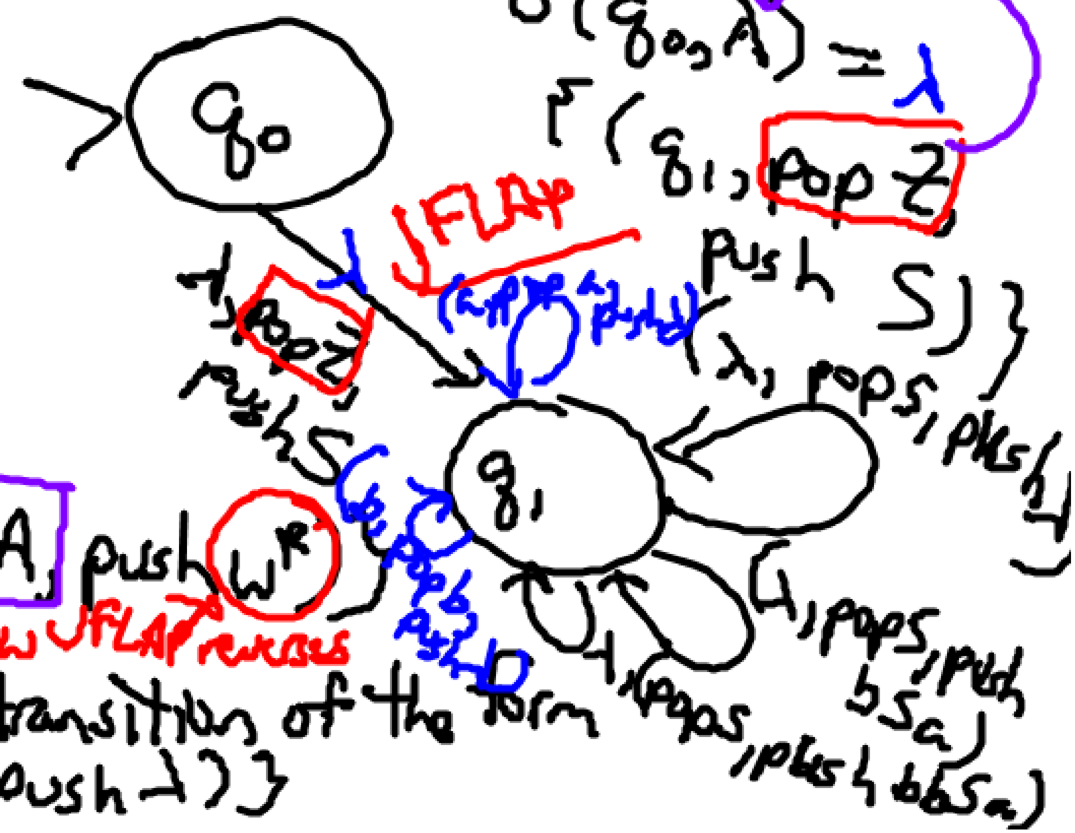
For each rule make a transition Correction of the form

$\delta(q_1, \lambda) = \{(q_1, \boxed{\text{pop } A}, \text{push } w^R)\}$

w JFLAP reverses

For each $a \in \Sigma$, make a transition of the form

$\delta(q_1, a) = \{(q_1, \boxed{\text{pop } a}, \text{push } \lambda)\}$



Let $L = \{x \in \Sigma^* \mid \exists w \in \Sigma^* \mid x = ww^R\}$ even length palindromes

$\Sigma = \{a, b\}$

$x^R = (ww^R)^R =$

$(w^R)^R w^R = ww^R = x$

$L_{allpalindromes} = \{x \in \Sigma^* \mid x = x^R\}$

$S \to aSa$

$S \to bSb$

for all palindromes

$S \to \lambda$ $\quad$ $S \to a$ $\quad$ $S \to b$ for odd length palindromes

$L_{oddPalindromes} = \{x \in \Sigma^* / \exists w \in \Sigma^* \mid x = wcw^R$ for some c in $\Sigma\}$

Derivations in PDAs

$$(\underbrace{q_i}_{\text{where we are}},\ \overbrace{\underline{a}w}^{\text{what's left to consume}},\ \overbrace{\underline{A}y}^{\text{full stack}}) \vdash_M (\underbrace{q_j}_{\text{where to go}},\ \underbrace{w}_{\text{what's left}},\ \overbrace{\underline{B}y}^{\text{full stack}})$$

a: current char. A: top of stack. B: new top.

$a \in \Sigma \cup \{\lambda\}$ $\quad A \in \Gamma \cup \{\lambda\}$ $\quad B \in \Gamma \cup \{\lambda\}$

$aw \in \Sigma^*$ $\quad Ay \in \Gamma^*$ $\quad q_i, q_j \in Q$

When $\delta(q_i, a, A)$ contains (q_j, B)

q_i: where we are; a: char/λ; A: what to pop/λ; q_j: where to go; B: what to push/λ

$$q_i \xrightarrow{a,\ \text{pop } A,\ \text{push } B} q_j$$

appears in picture

p. 222 $\quad (q_j, B) \in \delta(q_i, a, A)$.