1. Show that the language of palindromes violates the Pumping Theorem and thus is not a regular language. Assume the alphabet {0,1}.

$|y| > 0$

$|xy| \leq p$

$xy^*z \in L$

$xyz \rightarrow \underbrace{0}_{x}\underbrace{01}_{y}\underbrace{100}_{z}$ pumping y makes this string not a palindrome → not regular

2. Show that the below language of repeated halves is not regular:

$$\{ww \mid w \in (a+b)^*\}$$

$\underset{x}{a}\ \underset{y}{a}\ \underset{z}{bb}$

$|xy| \leq p$ → pumping length

$\underset{x}{a}\ \underbrace{aaaa}_{y^*}\ \underset{z}{bb}$

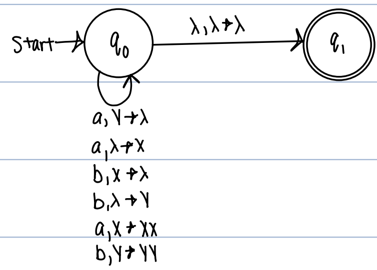
$xy^*z \notin L$ ∴ not a regular language

$|s| \geq p$ → pumping length
States in state machine

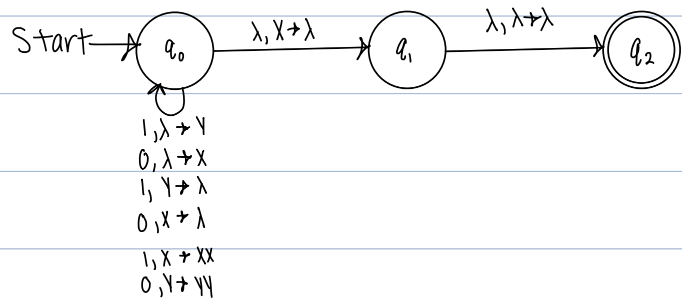
3. Draw a PDA that accepts the below language:

$$L_{eq} = \{n_a(w) = n_b(w) \mid w \in (a+b)^*\}$$

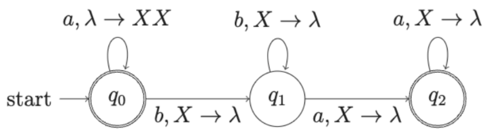
$\underbrace{\lambda}_{\text{input}}, \underbrace{\lambda}_{\text{pop/read}} \rightarrow \underbrace{\lambda}_{\text{push}}$



4. Draw a PDA that accepts the below language. This is the language where there must be one additional 1 than the number of 0s. $\{n_1(w) = n_0(w) + 1 \mid w \in (0+1)^*\}$



5. What language does the following PDA accept?



$\to a^n b^* a^n$

$a^* + (a^n b^n a^n)^*$

or

$a^n b^m$ where $n \geq m$