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1. Show that the language $L = \{w : w \in \{0, 1\}^* \text{ is a palindrome}\}$ is not regular.

Proof : Assume L is regular and p is the number from the pumping Lemma.
Consider $S = 0^p 10^p$
Since $S \in L$ and $|S| \geq P$ then the conditions of the pumping lemma must hold for S = xyz.
Let $y = 0^k$ for some $k > 0$,
Then $S = 0^{p-k}0^k10^p$ (respective to S = xyz) for $|xy| \leq P$
Consider the string $S' = xy^2z = 0^{p-k}0^{2k}10^p$ .
Then $p-k +2k = p+k \neq p$ so $|xy| > p$
Therefore, $S'$ breaks the pumping lemma, thus, L is not a regular language.

2. Show that the language $L = \{0^n 1^m 0^n : m, n \geq 0\}$ is not regular.
Proof : Assume L is regular and p is the number from the pumping Lemma.
Consider $S = 0^p 10^p$
Since $S \in L$ and $|S| \geq P$ then the conditions of the pumping lemma must hold for S = xyz.
Let $y = 0^k$ for some $k > 0$,
Then $S = 0^{p-k}0^k10^p$ (respective to S = xyz) for $|xy| \leq P$
Consider the string $S' = xy^2z = 0^{p-k}0^{2k}10^p$ .
Then $p-k +2k = p+k \neq p$ so $|xy| > p$
Therefore, $S'$ breaks the pumping lemma, thus, L is not a regular language.

3. Show that the language $L = \{www : w \in \{0, 1\}^*\}$ is not regular.
Proof : Assume L is regular and p is the number from the pumping Lemma.
Consider $S = 0^p 1^p$
Since $S \in L$ and $|S| \geq P$ then the conditions of the pumping lemma must hold for S = xyz.
Let $y = 0^k$ for some $k > 0$,
Then $S = 0^{p-k}0^k1^p$ for $|xy| \leq P$
Consider the string $S' = xy^2z = 0^{p-k}0^{2k}1^p$.
Then $p-k +2k = p+k \neq p$ so $|xy| > p$
Consider the string $S' = xy^3z = 0^{p-k}0^{3k}1^p$.
Then $p-k +3k = p+2k \neq p$ so $|xy| > p$
Consider the string $S' = xy^4z = 0^{p-k}0^{4k}1^p$.
Then $p-k +4k = p+3k \neq p$ so $|xy| > p$
Therefore, $S'$ for all provided i's ,breaks the pumping lemma, thus, L is not a regular language.

4. Design a context-free grammar for the language L = {w : w contains more 0s than 1s}.
$S \rightarrow 0S1 \mid 1S0 \mid 01S \mid 10S \mid S0 \mid 0$