

Prove that each of the following languages is not regular.

1. $\{0^{2^n}1^n \mid n \geq 0\}$
2. Binary palindromes: Strings over $\{0, 1\}$ that are equal to their reversals. For example: **00111100** and **0100010**, but not **01100**.
3. $\{0^m1^n \mid m \neq 2n\}$
4. Strings over $\{0, 1\}$ where the number of **0**s is exactly twice the number of **1**s.
5. Strings of properly nested parentheses **()**, brackets **[]**, and braces **{}**. For example, the string **([]){}** is in this language, but the string **([])** is not, because the left and right delimiters don't match.
6. $\{0^{2^n} \mid n \geq 0\}$ — Strings of **0**s whose length is a power of 2.
7. Strings of the form $w_1\#w_2\#\dots\#w_n$ for some $n \geq 2$, where each substring w_i is a string in $\{0, 1\}^*$, and some pair of substrings w_i and w_j are equal.