

Prove that each of the following languages is not regular.

1. Binary palindromes: Strings over  $\{0, 1\}$  that are equal to their reversals. For example: **00111100** and **0100010**, but not **01100**. *[Hint: We did this in class.]*
2.  $\{0^{2n}1^n \mid n \geq 0\}$
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.