Prove that each of the following languages is not regular.

1. \( \{0^{2^n} \mid n \geq 0\} \)

2. \( \{0^{2n}1^n \mid n \geq 0\} \)

3. \( \{0^{m}1^n \mid m \neq 2n\} \)

4. Strings over \( \{0, 1\} \) where the number of 0s is exactly twice the number of 1s.

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.

Work on these later:

6. Strings of the form \( w_1 \# w_2 \# \cdots \# w_n \) 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.

7. \( \{0^n \mid n \geq 0\} \)

*8. \( \{w \in (0+1)^* \mid w \) is the binary representation of a perfect square\)