1. **Getting started on hierarchies**
   Show that $\text{NTIME}(n) \subsetneq \text{PSPACE}$.

2. **Diagonalization: hands-on**
   Prove that $\text{NTIME}(n^2) \neq \text{coNTIME}(n)$.

3. **Scaling down or scaling up?**
   (Now a part of HW10)
   Consider the function $\text{pad} : \Sigma^* \times \mathbb{N} \rightarrow \Sigma^*\#^*$ defined as $\text{pad}(s, l) = s\#^j$, where $j = \min(0, l - |s|)$. Thus, $\text{pad}(s, l)$ just adds enough copies of the new symbol $\#$ to the end of the string $s$ so that the length of the new string is at least $l$. For a language $A$ and a function $f : \mathbb{N} \rightarrow \mathbb{N}$, define the language $\text{pad}(A, f(n))$ to be
   $$\text{pad}(A, f(n)) = \{\text{pad}(s, f(|s|)) \mid s \in A\}$$

   (a) Prove that if $A \in \text{TIME}(n^6)$, then $\text{pad}(A, n^2) \in \text{TIME}(n^3)$

   (b) Define $\text{EXPTIME} = \text{TIME}(2^{\mathcal{O}(n)})$ and $\text{NEXPTIME} = \text{NTIME}(2^{\mathcal{O}(n)})$. Use the function $\text{pad}$ to prove that
   $$\text{NEXPTIME} \neq \text{EXPTIME} \Rightarrow \text{P} \neq \text{NP}$$