

# Computational Complexity

## Exercise Session 3

**Exercise 1.** Is there an oracle such that, relative to this oracle, ...? If so, then give such an oracle and prove that it works. If not, prove why not.

(a)  $\text{DTIME}(n^2) = \text{DTIME}(n^3)$

(b)  $\text{DTIME}(n^2) \neq \text{DTIME}(n^3)$

(c)  $P = \text{coNP}$

(d)  $P \neq \text{coNP}$

**Exercise 2.** Show that if  $\text{NTIME}(n) \subseteq \text{DTIME}(n)$ , then  $P = \text{NP}$ .

- $\text{NTIME}(n)$  can be characterized as the set of all decision problems that can be verified in linear time with a linear-size certificate. That is,  $A \in \text{NTIME}(n)$  if and only if there is a linear-time Turing machine  $\mathbb{M}$  and a constant  $c$  such that for all  $x \in \{0, 1\}^*$  it holds that  $x \in A$  if and only if there exists some  $u \in \{0, 1\}^{c \cdot |x|}$  such that  $\mathbb{M}(x, u) = 1$ .
- *Hint:* Use a padding argument.