Universität Leipzig
Institute of Computer Science
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Exercises for the lecture

Foundations of Complexity Theory

Exercise Sheet 3

for the exercise on November 4, 2026

Exercise 3.1

Formulate the theorem of Borodin-Trakhtenbrot (page 8 of 2nd lecture) for DSPACE.
Does it also hold for NTIME resp. NSPACE?

Exercise 3.2

Remember the theorem on linear tape compression (page 67 of 2nd lecture):

$$\mathsf{DSPACE}(f) \subseteq \mathsf{DSPACE}(g) \text{ for all } \epsilon > 0 \text{ and } g(n) = \lceil \epsilon f(n) \rceil \text{ for all } n \in \mathbb{N}$$

Prove this theorem.

Exercise 3.3

Prove the statement $\mathsf{DTIME}(\mathcal{O}(f)) = \mathsf{DTIME}(f)$ for all $f : \mathbb{N} \to \mathbb{N}$ such that there exists $\epsilon > 0$ with $f(n) \geq (1+\epsilon)n$ for all $n \in \mathbb{N}$ (page 67 of 2nd lecture).

Exercise 3.4

Recall the proof of the Theorem of Hennie and Stearns (pages 27–114 of 3rd lecture).
Why do we not simply call $\mathsf{Simulate}\big(f(n)\big)$?

Exercise 3.5

Determine the time-consumption of Savitch's algorithm (page 135 of 3rd lecture).