Complexity Theory

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P vs. NP

$$\mathbf{P} \stackrel{?}{=} \mathbf{NP}$$

Many questions - few answers

- Algorithms = upper bounds - know how to do it, mostly
- Lower bounds - few results, e.g. on single tape Turing machines palindromes cannot be recognized in subquadratic time
- Best known lower bound for an **NP**-complete problem is $3n$
- Why is it so difficult to prove lower bounds?
- To prove lower bound, we need to show that *every* algorithm or *every* Turing machine that solves a certain problem requires certain time
- Why can we not use diagonalization to prove lower bounds (for specific problems)?

Topics and goals

- Is space as difficult to understand as time?
- Show **PSPACE** = **NPSPACE**!
- Look into class **NP** in more detail.
- Show power and limitations of diagonalization.
- Show that in certain universes or relativized worlds $\mathbf{P} \neq \mathbf{NP}$.
- Generalize **NP** and consider the class **PSPACE** in more detail.
- Look at randomness as an additional resource.

Organization

Information about this course
http://cs.uni-paderborn.de/cuk/lehre/veranstaltungen/ss-2016/komplexitaetstheorie/

Here you find

- announcements
- handouts
- slides
- literature

Course mostly uses: **Michael Sipser: Introduction to the Theory of Computation**

Prerequisites

- Data structures and algorithms
- Introduction to computability and complexity
- Discrete probability

Tutorials and exams

- There is a single tutorial: Monday, 4-5pm
- At the end of the semester there will be oral exams.