Universität Rostock
Traditio et Innovatio

INSTITUT FÜR INFORMATIK

Field Seminar: Complexity

Winter Semester 2024/25

Jens Schmidt, Christian Rosenke, Mark Scheibner
Universität Rostock, Institut für Informatik, Lehrstuhl Algorithmen und Komplexität

What is Complexity Theory?

- Branch of Theoretical Computer Science – *Formal field of study that explores options and limits of computational problem solving.*
- Natural Extension of Computability Theory – *Investigates how resource consumption increases with the input size growth for computational problems. Resources of interest are usually time and memory.*
- Extensive Classification of Problems – *Drawing a map for computational problems to categorize them by machine model, result type, difficulty, resource constraints and so on.*

Why is it exciting to learn about Complexity Theory?

- Understand Computational Costs – *Find out for all kinds of problems how easy or difficult it is for a computer to solve them.*
- Explore Computational Limits – *Become aware of fundamental barriers in problem solving that prohibit certain efficient approaches.*
- Discover the Frontier of Efficient Algorithms – *Master the most efficient algorithmic methods known to us, today.*
- Take Notice of Practical Implications – *Hear about real word applications like in logistics, communication and security and in other sciences such as physics and biology.*
- Learn about famous Mathematical Riddles – *See what is behind the many unsolved questions at the heart of computer science like P vs. NP.*

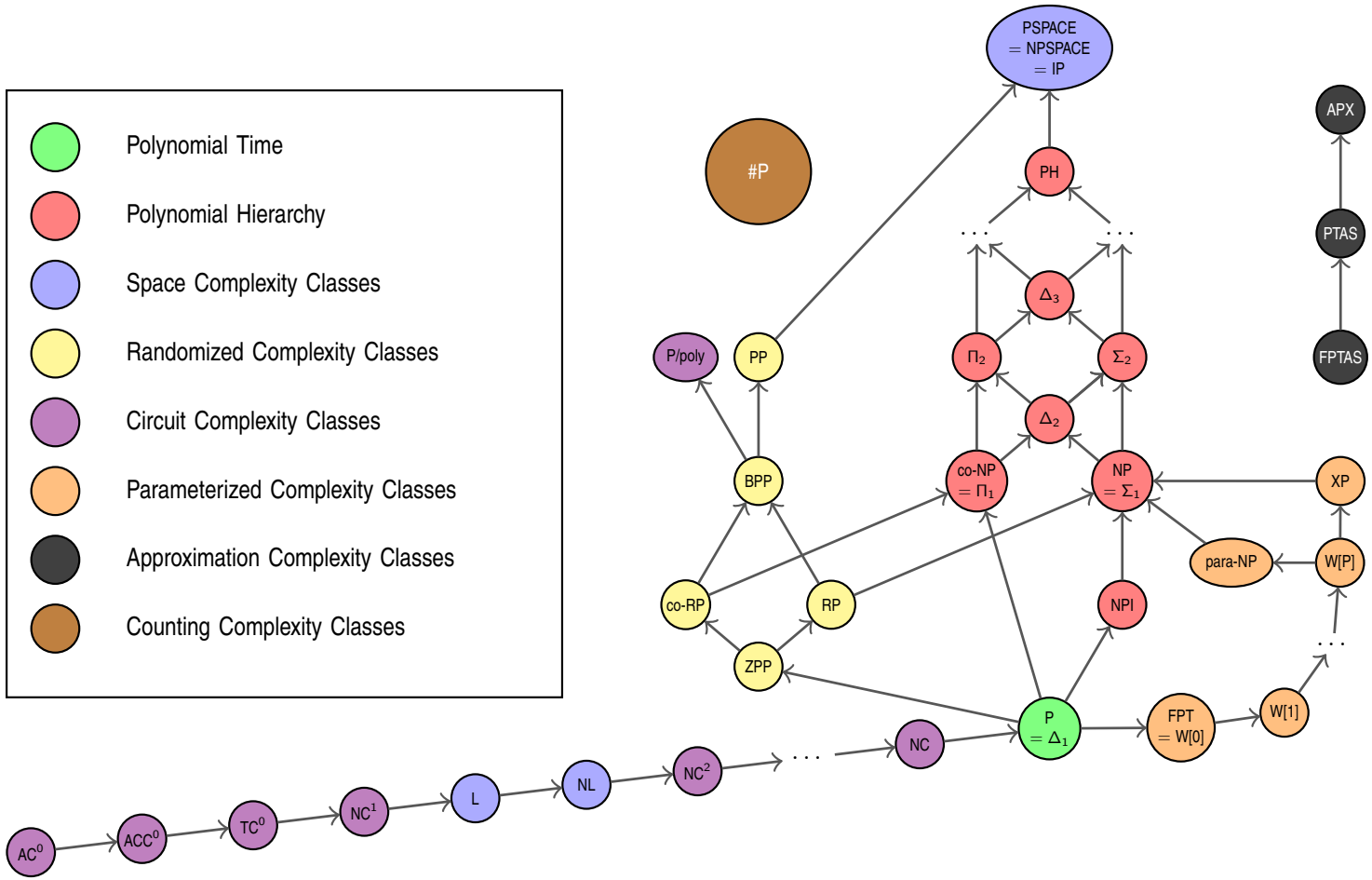
Schedule

- We will start with 2 – 3 introductory lectures to reiterate results given in basic courses from complexity theory and outline the available topics.
- After that you will pick a topic and receive references to useful literature.
- While you do your research, there will be weekly meetings where you can ask questions and get advice.
- At the end of the seminar, you will give a 30 minutes talk about the state of the art in your chosen field of complexity theory.
- Having the feedback on your talk, you will write a $\sim$ 8 pages survey paper on your topic and hand it in four weeks after your talk.

Possible Topics of this Seminar

1. Time Classes beyond P and NP i. e., CO-NP, NP-INTERMEDIATE, Polynomial Hierarchy
2. Space Classes i. e., L, NL, PSPACE, Savitch's Theorem, Space-Hierarchy-Theorem
3. Randomized Complexity i. e., ZPP, RP, CO-RP, BPP, PP
4. Circuit Complexity i. e., AC^0, ACC^0, TC^0, NC, P/poly
5. Approximation Complexity i. e., APX, (F)PTAS, WEAKLY NP-HARDNESS
6. Parameterized Complexity i. e., FPT, XP, W-Hierarchy, para-NP
7. Other Topics i. e., Interactive Proof Systems, Fine-Grained Complexity, Exponential-Time-Hypothesis, PCP-Theorem, Counting Complexity, Game Theory

Complexity Landscape explored during the Seminar



Registration

- We have topics for at most 16 students.
- Please register by Sep. 30, 2024 at the latest.
- Join StudIP course 23942 for the English-language seminar and 23935 for the German-language seminar.
- Send your questions to
  - Jens Schmidt
    jens.schmidt@uni-rostock.de
  - Christian Rosenke
    christian.rosenke@uni-rostock.de
  - Mark Scheibner
    mark.scheibner@uni-rostock.de