Quantum Computation Seminar

Prof. Dr. Blömer & Prof. Dr. Gharibian

UNIVERSITÄT PADERBORN
Die Universität der Informationsgesellschaft

Preliminaries

PADERBORN UNIVERSITY

In addition to a solid grasp of linear algebra you should have basic knowledge in at least two of the following areas

- data structures and algorithms
- complexity theory
- quantum computation
- probability theory and stochastics

Overview

- **All meetings are mandatory**
- **General kick-off meeting (today)**
- **Topic choice**
  - Send us your top 3 topics sevag.gharibian@mail.upb.de
  - We distribute the topics
  - You can also swap your topic once with another willing person

- **Introductory Talk**
  - We will give a talk on the style of a scientific paper and how to work with literature.

Overview

- **Topic kick-off Meeting**
  - Meeting with your supervisor.
  - You should have read your assigned topic paper and understood main ideas
  - We discuss your tasks and questions you have

- **Q&A day**
  - We answer all of your questions in a personal meeting

- **Essay Draft**
  - You hand in a "feature complete“ draft of your essay
  - "feature complete", i.e. everything you plan to have in the final essay should be included in this version.
  - This is your chance to get comprehensive feedback on your work.

Overview

- **Talk Slides**
  - We ask you to turn in the slides of your talk (presentation). We will give feedback for this.

- **Talk**
  - You will present your topic for all seminar participants and the supervisors
  - Your talk should last 1h including discussion (plan to talk 45-50 minutes).

- **Essay Final Version**
  - The final version of the essay should incorporate the feedback given for the draft version and your talk.

Topics

UNIVERSITÄT PADERBORN
Die Universität der Informationsgesellschaft

Topics

PADERBORN UNIVERSITY

Quantum supremacy

1. Complexity-Theoretic Foundations of Quantum Supremacy Experiments (Aaronson, Chen)

2. Average-case complexity versus approximate simulation of commuting quantum computations (Bremner, Montanaro, Shepherd)

3. The complexity of approximate counting (Stockmeyer)

4. Quantum advantage with shallow circuits (Bravyi, Gosset, König)
   (followup papers: Average-Case Quantum Advantage with Shallow Circuits (Le Gall), Exponential separation between shallow quantum circuits and unbounded fan-in shallow classical circuits (Watts, Kothari, Schaeffer, Tal). The latter works with a simpler problem than in the original Bravyi et al paper.)

Topics

PADERBORN UNIVERSITY

Quantum Cryptography

5. Actively secure two-party evaluation of any quantum operation
   (Dupuis, Nielsen, Salvail)

6. Classical verification of quantum computations
   (Mahadev)

Topics

PADERBORN UNIVERSITY

Quantum algorithms and complexity

7. A Quantum Lovasz Local Lemma (Ambainis, Kempe, Sattath)
   (followup: On preparing ground states of gapped Hamiltonians: An efficient Quantum Lovasz Local Lemma (Gilyen, Sattath))

8. Quantum approximate counting, simplified (Aaronson, Rall)

9. Quantum walk speedup of backtracking algorithms (Montanaro)

10. Quantum speedups for exponential-time dynamic programming algorithms (Ambainis, Balodis, Iraids, Kokainis, Prusis, Vihrovs)

Topics

PADERBORN UNIVERSITY

Quantum communication complexity

11. Exponential separation for one-way quantum communication complexity, with applications to cryptography (Gavinsky, Kempe, Kerenidis, Raz, de Wolf)

12. Classical Interaction cannot replace a quantum message (Gavinsky)

Dates

UNIVERSITÄT PADERBORN
Die Universität der Informationsgesellschaft

Time table

	What
Until Monday 14th	send top 3 topics and preferred slot
Wednesday 16th	assignment of topics
Until Friday 18th	exchange topic with willing students and inform us
Individual meetings with supervisor	topic kick-off meeting
23.10.19, 16:15	introductory talk
07.11.19	Q&A day
10.12.19	first slot for talk
23.01.20	second slot for talk
21.02.20	essay draft
16.03.20	deadline: essay final version

Questions…

UNIVERSITÄT PADERBORN
Die Universität der Informationsgesellschaft