# Algorithmic Combinatorics — Winter 2018–19

### Course webpage

`http://discretemath.imp.fu-berlin.de/DMII-2018-19/`


### Lecture

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### Exercises

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### Schedule

Lectures: Tuesdays 14:30-16:00 (Takustr 9, Seminar room 046),
Wednesdays 12:30-14:00 (Arnimallee 6, Seminar room 007/008).
Exercises: Tuesdays, 16:15-18:00 (Takustr 9, Seminar room 006) or
Thursdays, 10:30-12:00 (Arnimallee 6, Seminar room 032).

### Topics of the course

The use of algorithms in combinatorics, including:

- graph algorithms (shortest routes: Djikstra, Travelling Salesman. approximation algorithms; matchings: Tutte's Theorem, Hungarian Algorithm; network flows and applications: Menger's Theorem, Baranyai's Theorem; stable matchings and applications: list colouring),
- linear programming (Simplex Algorithm; duality and its applications; integer programming and LP relaxations), and
- randomised algorithms (randomised matching algorithms; derandomisation and the Erdős–Selfridge criterion; the Algorithmic Local Lemma).

### Literature

Recommended texts:

- L. Lovász, J. Pelikán and K. Vesztergombi, *Discrete Mathematics*.
- J. Matoušek and B. Gärtner, *Understanding and Using Linear Programming*.
- D. West, *Introduction to Graph Theory*.
- D. Hefetz, M. Krivelevich, M. Stojaković and T. Szabó, *Positional Games*.

Further reading:

- V. Chvátal, *Linear Programming.*
- A. Schrijver, *Theory of Linear and Integer Programming.*
- A. Schrijver, *Combinatorial Optimization.*

### Prerequisites

We expect students to have successfully completed Discrete Maths I, or an equivalent course elsewhere (please contact the instructors in this case). During the course we will also make use of undergraduate linear algebra, calculus and probability.

### Quizzes

Each week an online quiz will be made available on the course website. This is meant to be a quick and easy way to test your knowledge of some of the material from that week's lectures. The quizzes are completely optional and not for credit.

### Requirements for "active participation at the exercises"

The "aktive Teilnahme" credit for this course is based on three components: collecting points on the homework, authoring solutions to the homework problems, and presenting solutions during the exercise classes. We now explain what is required in greater detail.

During the semester, there will be 12 exercise sheets, which will usually be posted to the course website by the end of the Wednesday lecture. Each sheet will have five or six exercises, and you should **submit solutions for two exercises** that you would like corrected.

If you want to **excel** in your craft, you are strongly encouraged to try to solve **all** exercises, not least because any of them may appear in the final exam. Write them all up and they will be looked at, but only the two you indicated will be graded for credit.

Please submit your written solutions by 16:00 on the Tuesday of the following week, either by the end of lecture or in the mailbox of Anurag Bishnoi. **Late solutions will not be accepted.** Your submission will be graded and returned to you in the following exercise class. For the signature on the exercises ("aktive Teilnehme") you must earn at least **60% of the total score** (each exercise will be worth 10 points).

It is very beneficial to think about and discuss mathematics in small groups. You are encouraged to solve the exercises in study groups and **submit your solutions in pairs**. Please remember to clearly write the names of both members of the pair on your submission.

We would also like to encourage you to please feel free to approach us to discuss your thoughts on particular exercises and ask for hints when stuck. Nevertheless, we discourage you from searching for solutions on the Internet. Most likely you *can* find one to most exercises, but copied solutions will never give you the deep understanding necessary to succeed on the final, so you unfortunately cannot spare the struggle on your own or with your study group while trying to solve exercises. Actually, *why* would you want to: that's exactly the most creative and enjoyable part of the course!

It is also crucial to practice writing up proofs and solutions independently. Hence every student is required to **write up solutions to at least ten graded problems** (out of the twenty-four total for her or his pair). In order to properly get credit for this, please clearly state the name of the author at the beginning of each solution to be graded.

Finally, each student must **present a correct solution in the exercise classes at least once** in the semester. We recommend you take care of this requirement as early as possible — time is limited during these exercise classes, and it will not be possible for everyone to present in the last couple of weeks.

In conclusion, to earn the "aktive Teilnahme", you need to meet each of the following criteria:

- earn at least 60% of the point value of $2 \times 12 = 24$ homework problems,
- present at least one correct solution in the exercise classes. [-8mm]
- be the author of at least ten solutions,[1]

### Final exam

The grade for the course is based solely on the final written exam. The exam will take place on February 20th, 13:00-16:00. A make-up exam will be offered on April 2nd, 13:00-16:00.

The final is a closed-book/closed-notes exam. You must learn everything that was presented and be familiar with how to apply the learned methods. In order to succeed, it is absolutely necessary to actively follow the lectures throughout the semester, immediately revise the new material, and try to solve all the exercises.

There will be two different types of tasks on the final:

[1]Doing just this part, that is being the author of at least ten solutions will only earn you the so-called "reguläre Teilnehme" credit

- Lexical knowledge: definitions, statements and proofs of theorems
- Problem solving: applying the encountered theorems and methods to solve exercises (some of these may be from the homework, some may be new)