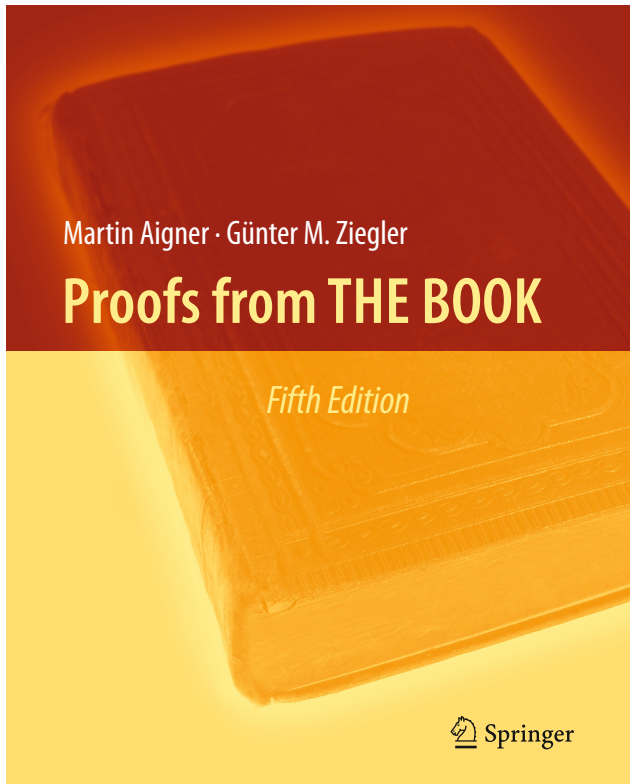
Proofs from THE BOOK

(Winter 20021/2022 Proseminar)



If you want to participate, turn on your camera.

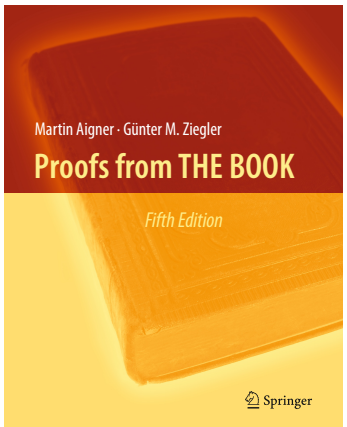
Organization

Lecturer

Marcelo Fonseca Faraj

- University of Heidelberg - Algorithm Engineering Group
- E-Mail: `marcelofaraj@informatik.uni-heidelberg.de`
- Room 1/331
- Slides and proseminar format originally due to Lorenz Huebschle-Schneider and Tobias Maier

Organization
Material



Material for the proseminar

- Proofs from THE BOOK - Fifth Edition (pdf here)
- Moodle page here

Organization

The course will be **[on campus | online]**.

Workload: 90h
Passing the course: Regular participation in the proseminar and discussion. Giving two talks of roughly 23 minutes (18min talk, 5min discussion) in English. Writing a report (of 7 pages, not more, not less) in English.

Overall schedule:

- Weekly meetings with 3 talks about selected book sections.
  $\rightsquigarrow$ talk grading from me per email
- Handing in report (11.12.2021)
  $\rightsquigarrow$ report feedback from costudents via Easychair
- Handing in revised report (15.01.2022)
  $\rightsquigarrow$ report feedback from me
- Handing in final report (22.01.2022)
  $\rightsquigarrow$ report grading from me per email

Organization

Talks

Dates and times

- Tuesdays from 16:15h until 17:45h
- Three talks per week
- Weekly attendance is mandatory

Talk format

- Mostly based on whiteboard
  - → Jamboard if you have a writing device, such as a tablet with pen
  - → Smartphone Document Camera:
    https://mhenr18.github.io/improvised-document-camera/
  - → Laptop Document Camera with mirrored video:
    https://twitter.com/romps/status/1237617042338897921
- Maybe a few slides to support the talk
- Talk and discussion in English
- Feedback and grading from me per email

Organization

Talks

Subject of a talk

- Proofs in 1 or 2 chapters of the book
- Themes will be announced 2 weeks in advance

Sequence

- Students will be divided in 2 groups
  - → The groups take turns
  - → Each group gives the talks every second week
- Three students from a group are drawn
  - → Regular preparation for every second week is necessary!

Rules

- Every student must present at least twice during the semester
- Both talks have to be approved for the student to pass
- One failed talk can be replaced using a Joker*

* More explanations about the Joker will be given later

Organization
Talks

Themes for the talks in November 9

- Chapter 1: Six proofs of the infinity of primes:
  - → Talk 1: Proofs 1 and 2
  - → Talk 2: Proofs 3 and 5
  - → Talk 3: Proof 6

Organization

Talks

Each student has a Joker , which can be used

- To avoid being selected to give a talk
  - → But it is only possible before drawing lots!
- To cancel a failed lecture
  - → But the best possible grade in the repetition talk is 2.0

Organization

Report

There are up to 18 spots in this proseminar. In order to subscribe to the proseminar, you need to send me an email containing:

- Your full name
- Your matriculation number
- Your student email (so I can add you to the Moodle)
- Your transcripts
- Your preference for this proseminar (either *online* or *on campus*)
- Ordered list of 4 preferred topics** for your report

The first 9 spots will be given on a first come, first serve basis.

Deadline: 22nd October

**The 4 preferred topics for your report should be chosen among the topics listed in the following two slides. That means you should get the book, pick some topics and briefly check if you like them. Afterwards, I will assign one topic per student.

Organization

Topics for the report (5th edition of the book)

- Chap 02: Bertrand's postulate
- Chap 03: Binomial coefficients are (almost) never powers
- Chap 04: Representing numbers as sums of two squares
- Chap 05: The law of quadratic reciprocity
- Chap 06: Every finite division ring is a field
- Chap 07: The spectral theorem and Hadamard's determinant problem
- Chap 08: Some irrational numbers
- Chap 10: Hilbert's third problem: decomposing polyhedra
- Chap 12: The slope problem
- Chap 14: Cauchy's rigidity theorem
- Chap 15: The Borromean rings don't exist
- Chap 16: Touching simplices
- Chap 17: Every large point set has an obtuse angle
- Chap 18: Borsuk's conjecture
- Chap 19: Sets, functions, and the continuum hypothesis

Organization

Topics for the report (5th edition of the book)

- Chap 21: The fundamental theorem of algebra
- Chap 22: One square and an odd number of triangles
- Chap 23: A theorem of Plya on polynomials
- Chap 24: On a lemma of Littlewood and Offord
- Chap 25: Cotangent and the Herglotz trick
- Chap 29: Three famous theorems on finite sets
- Chap 31: Lattice paths and determinants
- Chap 33: Identities versus bijections
- Chap 34: The finite Kakeya problem
- Chap 35: Completing Latin squares
- Chap 36: The Dinitz problem
- Chap 37: Permanents and the power of entropy
- Chap 41: Communicating without errors
- Chap 42: The chromatic number of Kneser graphs

Rules and tips

Talks

Explain in your own works

- Normally: the better YOU understood the topic, the easier it will be for your costudents to understand your talk
- But understanding alone is not enough
  - → Carefully plan beforehand how you will explain each proof

Convince the audience

- Some thinking/reasoning steps in the book are often a bit long (*"since . . . it follows that . . . ", "one can see that . . . ", "clearly . . . "*)
  - → In some cases, you should clarify/prove these steps
  - → At least on request
- Assume the audience did not read the book

Prepare your own notes and calculations

- Repeating mistakes from the book is absolutely not allowed
- Calculation steps are boring, the idea behind them is exciting
- Submit talk notes + slides on Moodle (don't throw them away)

Rules and tips

Talks

Using slides is not mandatory, but they might be helpful

- If there are many intermediary results
- To organize central definitions, claims, and theorems
- To include images for clarification

Rules for good slides

- Use latex beamer for your presentation
- One picture per slide (or at least one per every other slide)
- Avoid long sentences on your slides
- Avoid line breaks ending on one or two words (often one can shorten the preceding sentence).

Rules and tips

Report

- Make it clear that you are reviewing and summarizing one or more specific chapters of a specific book.
- Use your own words, never copy from the book
- Use the template available here
  `https://github.com/AlgoEngHeidelberg/template_AEseminars`
- Stick to 7 pages overall (not more, not less), this includes references
- Make sure that you make motivation, high-level view, and applications of the problems/theorems/claims very clear
- NOTE: you have to have understood all problems, claims, theorems, and proofs very well to do that (understand everything first, then write your report)
- Use figures to explain your problems and proofs as much as possible
- Always explain the highlevel view / intution first
- Then go into technical details

Rules and tips

Report

- Common pitfalls:
  - use consistent upper and lower case (especially in captions)
  - referencing a figure/section is this with upper case, i.e. Figure 3 and Section 2 etc..
  - avoid one or two line paragraphs
  - use spell checking, e.g. under linux “aspell -len check document.tex”
  - center figures
  - use high quality images, e.g. if you copy some figure from the book, make sure that the image you are screenshotting is very large on your screen when you do that
  - use bibtex entries from dblp.org (most of them should be correct and contain everything you need)
  - paragraphs should not end on a single word (use ~ in latex code as a space, then it will not make a line break there)
  - same for references: references should not start at the beginning of a line, i.e. use xyz \cite{,,,} to avoid that