MATH-251(b): Numerical analysis

This repository contains the teaching material of the course MATH-251(b) Numerical analysis at EPFL.

Course outline

Numerical analysis

1. Introduction
2. The Julia programming language
3. Revision and preliminaries
4. Root finding and fixed-point problems
5. Direct methods for linear systems
6. Iterative methods for linear systems
7. Interpolation
8. Numerical integration
9. Numerical differentiation
10. Boundary value problems
11. Eigenvalue problems
12. Initial value problems

Accompanying Excercise sheets

- Sheet 0: Getting Started with Julia
- Sheet 0: Basic Plotting in Julia

Improving these notes

If you **spot an error** feel free to make a pull request to the **github repository** generating this website.

EPFL resources

If you are an EPFL student you find the internal course resources following these links:

- **Moodle link:** https://go.epfl.ch/numerical-analysis
- **Lecture recordings:** https://mediaspace.epfl.ch

Summary

The students will learn key numerical techniques for solving standard mathematical problems in science and engineering. The underlying mathematical theory and properties are discussed.

Content

The topics covered include:

- Properties and issues with numerical computation
- Finding roots and fixed points
- Interpolation and curve regression
- Solving linear and non-linear equations
- Solving eigenproblems
- Numerical integration and differentiation
- Basic numerical techniques for solving differential equations

Algorithm demonstrations and implementations will be based on the Julia programming language and interactive Pluto notebooks.

Prerequisites

- Analysis
- Linear algebra

The course is designed with an audience of applied scientists (physics, biology, materials science) or engineers in mind. With a basic first-year mathematics background and prior exposure to some programming the material should be accessible.

Literature and further reading

The outline of the course as well as many examples are taken from the excellent lecture notes **"Numerical analysis" by Prof. Fabio Nobile**. A copy of these notes in French as well as English is available on moodle.

For further reading and plenty of Julia code examples related to our subjects, take a look at the book **Fundamentals of Numerical Computation by Tobin A. Driscoll and Richard J. Braun** published by SIAM. An online version is further available at https://tobydriscoll.net/fnc-julia/. I will also link to this text in the lecture notes from time to time.

A slightly different emphasis in topics, but otherwise a good summary provide the lecture notes **First Semester Numerical analysis by Giray Ökten**. At places the text is more mathematical than our treatment. In the initial sections it has a good summary of basic Julia commands an concepts. An online PDF is available.

For an in-depth treatment with mathematical details and proofs for the results where we skip these details for brevity can be found in **Numerical Mathematics by A. Quarteroni, R. Sacco, F. Saleri**. A PDF can be downloaded from Springer by EPFL students.

Finally, if you are curious about Julia, I can highly recommend **MIT's computational thinking class**, which introduces Julia as well as its way of solving scientific problems in a hands-on and fun way.

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