CS/MA 522 – Matrix Theory and Numerical Linear Algebra I

Section 001, Fall 2020

MWF 13:00 – 13:50, Aug 17 – Nov 24

Department of Mathematics, University of Kentucky

Instructor

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Online office hours: MWF 14:00 – 15:00 (or by appointment)

Basic info

- **Course website**: Canvas (`https://www.uky.edu/canvas/`).
- **Lecture**: Organized as online via *Zoom Meeting* (check Canvas for meeting ID).
- **In-person discussion**: Available on Friday by appointment.
- **Homework & Exams**: Organized as online.

Required materials

- Textbook: *Applied Numerical Linear Algebra* by **James W. Demmel**, 1997, SIAM.

  Notes: The following are not required but can serve as good supplemental reading.
  - *Matrix Computations* by **Gene H. Golub** and **Charles F. Van Loan**, 2013, JHUP.
  - *Numerical Linear Algebra* by **Lloyd N. Trefethen** and **David Bau III**, 1997, SIAM.
- MATLAB programming are required. Blow you can find some useful links.
  - UKy has a campus-wide license for MATLAB: `https://download.uky.edu/`.
  - MATLAB has its own tutorials: `https://www.mathworks.com/help/matlab/index.html`, where you can find detailed documentation and free online courses.
  - Some other free manual/text:
    -MATLAB Primer: `http://www.math.ucsd.edu/~bdriver/21d-s99/matlab-primer.html`
    -Textbooks by Cleve Moler: `https://www.mathworks.com/moler.html`

Course objective

In this course we are going to learn about the following four classical problems in linear algebra: the linear systems of equations, linear least square problems, matrix eigenvalue problems, and singular value decomposition. We will discuss the mathematical basis and the numerical methods for the solution of those problems, with topics covering the matrix factorization techniques, perturbation theory, rounding error analysis, implementation schemes, and efficiency analysis of the algorithms. We will focus on the so-called 'direct' solvers, targeting at problems of small to medium size, whereas the methods for large-sparse problems will be left to the advanced course of CS/MA 622.

Our lecture will follow closely the textbook, and will cover most part of Chapter 1 – 5:

1. Introduction: review of basic linear algebra and other preliminaries (1 week);
2. Linear equations: perturbation theory, Gaussian elimination, error analysis, examples (4 weeks);
3. Least squares: perturbation theory, QR/SVD factorization, orthogonal matrices (3 weeks);
4. Non-symmetric eigenproblems: eigen-decomposition, perturbation, algorithms (3 weeks);
5. Symmetric eigenproblems & SVD: perturbation, symmetric eigensolvers, SVD solvers (3 weeks);

Grading policy

Percentage of course grade		Comments
Written homework	45%	about 9 assignments*; late work penalty -50%;
Programming	15%	about 5 assignments; late work penalty -50%;
Midterm	15%	Mon., Oct. 12, during class time*;
Final exam	25%	Fri., Dec. 4, 13:00 - 15:00*;

* Written assignments/Exams: finish on paper and submit by scanned copy.

Course policy and information

- Video and audio recordings by students are not permitted during the class unless the student has received prior permission from the instructor. Any sharing, distribution, and or uploading of these recordings outside of the parameters of the class is prohibited. Students with specific recording accommodations approved by the Disability Resource Center should present their official documentation to the instructor.
- All content for this course, including handouts, assignments, and lectures are the intellectual property of the instructors and cannot be reproduced or sold without prior permission from the instructors. A student may use the material for reasonable educational and professional purposes extending beyond this class, such as studying for a comprehensive or qualifying examination in a degree program, preparing for a professional or certification examination, or to assist in fulfilling responsibilities at a job or internship.