MATH3322: Matrix Computation
Spring 2023 - 2024

Meeting: TuTh 09:00AM - 10:20AM at Rm 4620

Instructor:
Guibo YE, email: magbye@ust.hk, Room 3419

Office Hours: TuTh 10-11:30AM.

Teaching Assistant: LUO, Jianzhou, jluobn@connect.ust.hk; Ruizhe Xia, rxiaac@connect.ust.hk.

Course Description:
This course will introduce some basic matrix analysis theory and some popular matrix computation algorithms, and illustrate how they are actually used in data science. Specific topics include advanced linear algebra such as orthogonal projections and vector and matrix norms; the theories and computations of matrix factorizations such as QR decomposition, Singular Value Decomposition (SVD), and Schur decomposition; and applications to data analysis problems such as principle component analysis via SVD and collaborative filtering via matrix completion.

Assessment Scheme:
20% Homeworks (every two weeks), 30% Midterm exam (1.5 hours) 60% Final Exam (3 hours).

Reference books:
1. Gene H. Golub and Charles F. Van Loan, *Matrix computations*, 4th Edition, JHU Press, 2013.
2. Justin Solomon, *Numerical Algorithms – Methods for Computer Vision, Machine Learning, and Graphics*, CRC Press, 2015.
3. Lloyd N.Trefethen and David Bau, III, *Numerical Linear Algebra*, SIAM, 1997.

Tentative Course Schedule (Subject to change):

01 Feb: Introduction. Basic matrix operations
06 Feb: Basic matrix operations
08 Feb: Solvability of linear equations, Gaussian elimination.
13 Feb: Chinese New Year
15 Feb: Gaussian elimination
20 Feb: LU decomposition
22 Feb: LU decomposition
27 Feb: Pivoting
29 Feb: Pivoting, Cholesky decomposition 02 Mar: Cholesky decomposition, Tridiagonal LU decomposition
05 Mar: Case studies: Google's PageRank
07 Mar: Case studies: Image Deblurring; QR decomposition
12 Mar: QR decomposition
14 Mar: QR decomposition by Projection
19 Mar: QR decomposition by Projection
21 Mar: QR decomposition by Reflection
24 Mar. Midterm Exam 11:00am—12:30pm
26 Mar: QR decomposition by Rotation
28 Mar: Midterm break
02 Apr: Midterm break
04 Apr: Midterm break
09 Apr: Case studies: Least squares for MIMO and Linear regression.
11 Apr: Eigenvalue, Eigenvectors, Power Iteration,
16 Apr: Power Iteration
18 Apr: Power Iteration
23 Apr: Power Iteration

25 Apr: QR algorithm
30 Apr: Practical QR algorithm
02 May: Non-Symmetric Eigenvalue problems, Schur Decomposition
07 May: Singular value decomposition.
09 May: Case studies: Least Squares, PCA, Matrix completion and recommender system