Philip Boyland
Department of Mathematics

Linear Algebra for Data Science

Course Numbers: MAT4930 (section 24192)

Time and Location: MWF 7, MAT006

Office Hours : MWF period 8 and by appointment made 24 hours in advance.

Required Text: *Linear Algebra and Learning from Data,* by Gilbert Strang, Wellesley-Cambridge Press; First edition (2019). We will not cover all the material in this book and will cover some material not in the book.

Course Description: A second course in linear algebra, focusing on topics that are the most essential for data science. Introduces theory and numerical methods required for linear problems associated with large data-sets and machine learning. Topics include LU, QR, and singular-value decompositions of matrices; conditioning and stability; the DFT and linear filters; deep learning; fully connected and convolutional nets; and stochastic descent.

Prerequisites: A course in linear algebra (MAS 3114, MAS4105 or equivalent course) is required.

Programming Prerequisite: Class assignments will require Matlab or comparable platform, and so if you don't know one of these you will need to have enough experience with a programming language to pick up Matlab reasonably quickly.

Homework: Homework will be assigned week on a Friday and due the next Friday (with breaks for exams), so there will be about 12 total assignments. It will be posted on the course homework web page. The homework will foster mastery over the material covered in class in the previous two weeks. It will include hand computations, proofs and Matlab computations. All problems will be graded and the graded homework will be returned by the following Friday. All homework is due in **hard copy** at the **start** of class. No email submissions will be accepted. You may turn in the homework the next Monday for 2/3 credit. No submissions will be accepted after that. The lowest homework score will be dropped.

Exams: There will be three 50 minute exams. The first two will take place in class in the regular classroom on Wednesday, February 12 and Wednesday, March 25. The third exam will take place during the class's final exam slot as designated by the University which is 3:00 on Thursday, April 30.

Grades: The three exams are weighted equally and are not cumulative. The three exams constitute 75% of the grade and the homework is 25%. The grade ranges for the total scores are 93-100% A, 90-92% A-, 88-89% B+,83-87% B, 80-82% B-, 78-79% C+,73-77% C, 70-72% C-, 60-69% D, <60% F.

Weekly Schedule (subject to change):

Week 1: Review of basic Linear Algebra: linear independence, basis, dimension,

Week 2: Matrices, linear transformations, associated subspaces

Week 3: Systems of equations, LU decomposition

Week 4: Inner products, orthogonality, QR decomposition, Eigenvalues, eigenvectors

Week 5: Jordan normal form, linear differential equations

Week 6: EXAM 1, Spectral theorem, norms, spectral radius, introduction to least squares

Week 7: Singular value decomposition, principal component analysis, best low rank approximation

Week 8: Basic numerical linear algebra, conditioning, stability, iterative methods

Week 9: Fourier Series and Discrete Fourier Transform, convolution,

Week 10: Toeplitz matrices and shift invariant linear filters

Week 11: EXAM 2, Optimization, Levenberg-Marquardt, Gradient Descent

Week 12: Deep learning, layers, learning and loss functions

Week 13: Fully connected and convolutional nets

Week 14: Back propagation and chain rule, stochastic descent

Week 15: Overflow of previous

Finals week: EXAM 3

Announcements: You are responsible for all announcements made in class which could include changes in exam dates and material covered.

Class Attendance: Most students benefit a great deal from attending class regularly. Arriving late and/or leaving early, reading the newspaper, looking at your cell phone, etc. disrupts the class and is rude and unprofessional.

Excused Absences: In certain circumstances a student will be able to make up a missed exam. These circumstances could include medical situations, family emergencies, travel for University activities (eg. band, debating club, etc), and religious observances. In these cases the student must inform me before or within one week after the missed work and **provide written documentation**.

Grading Disputes: Any issues or questions about the grading of exams must be brought to my attention within one week after the exams or homework are returned to the class

Additional Information:

Grades: Grading will be in accord with the UF policy stated at https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx.

Honor Code: "UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class."

Class Attendance: "Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found at: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx."

Accommodations for Students with Disabilities: "Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester."

Online Evaluations: "Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/."

Contact information for the Counseling and Wellness Center: https://counseling.ufl.edu/, 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

U Matter, We Care: If you or someone you know is in distress, please contact umatter@ufl.edu, 352-392-1575, or visit umatter.ufl.edu/ to refer or report a concern and a team member will reach out to the student in distress.

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