BIOE 210: Linear Algebra for Biomedical Data Science

Spring 2022

Tu/Th 9:30 – 10:50 am, 2310 Everitt Lab
http://bioe210.github.io

Course Instructor

Paul A. Jensen
pjens@illinois.edu
Office Hours: Friday, 3–4pm, online using the course Zoom link

Teaching Assistant

Kurt Kostan
kkosta2@illinois.edu
Office Hours: Thursday, 1–2pm, online using the course Zoom link

Course Assistants

Emma Riedl
edriedl2@illinois.edu
Matlab Help Session: Wednesday, 1–2pm, online using the course Zoom link

Nathan Chung
nychung2@illinois.edu
Matlab Help Session: Friday, 10–11am, 2100 Everitt Lab

Description

Using analytical and computational tools from linear algebra, we will

- Solve large systems of linear equations, systems of linear ODEs, and linear PDEs.
- Analyze large, multivariable datasets to quantify relationships between variables.
- Decompose complex datasets into simpler representations.
- Introduce and solve common problems in classification, image processing, and machine learning.
- Develop a geometric understanding of high-dimensional spaces.

Topics

- Vector spaces and field algebra
- Linear systems, solvability, and rank
- Basis vectors, eigenvectors, and network matrices
- Vector and matrix decompositions

- Singular values and principal components
- Deterministic and stochastic optimization

Applications

- Linear, logistic, and regularized regression
- Support Vector Machines
- Artificial neural networks
- Image compression
- Examples in bioengineering, medicine, and biology

Textbook

Linear Algebra: Foundations of Machine Learning by P.A. Jensen
Available for free on the course website.

Matlab is required for the course and can be accessed via the EWS machines (https://it.engineering.illinois.edu/ews/lab-information/remote-connections).

Assessments

Three in-class exams (2/15, 3/29, 5/3). Any non-electronic materials are allowed during the exam, including the course textbook and notes. Exams are during the lecture period.

Fourteen homework sets. Homeworks are due every Monday by 5:00 pm Central. Homework assignments will include both analytical problems plus Matlab-based exercises. Written answers to the analytical problems and Matlab solutions (plus code) must be uploaded using Gradescope (additional details regarding homework submission are available on the course website). Gradescope asks you to assign each question to part of your submission. Submission that do not assign questions or are illegible will not be accepted.

It is recommended that all students complete all 14 assignments. However, only a student's best 10 scores will be used to compute their grade. Dropping the lowest four scores is our method of fairly dealing with requests for homework extensions—both excused and unexcused. If a student cannot complete an assignment *for any reason*, they will receive a zero but will be able to drop this score as one of their four unscored assignments. The only possible exception to this policy is if a student has five or more documented, excused absences in a single semester—a highly unlikely scenario.

Late Work

Any work submitted after the deadline will be penalized. The penalty is 10% if submitted within 24 hours of the deadline and 50% within 48 hours of the deadline. Homework submitted more than 48 hours after the deadline will not be scored. The submission time of an assignment is the time of the latest submission. (If half of the assignment is submitted before the deadline and the other half late, the entire assignment will be scored as late.)

Grading

Homework 40% (10 × 4% each; only the 10 best scores of the 14 assignments are used to compute the grade)
Exams 60% (3 × 20% each)

Letter Grades:

A+	>97%	B+	>87%	C+	>77%
A	>93%	B	>83%	C	>73%
A−	>89.5%	B−	>79.5%	C−	>67%

Grades will be posted on Gradescope.