BMED 3201 Syllabus

Introduction to Machine Learning for Biomedical Engineers (3 credits)

Fall 2026

Instructor Information

Instructor: Peng Qiu

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General Course Information

Description

This course is designed to provide biomedical engineering undergraduates with a solid foundation in the principles and applications of machine learning. Students will learn the fundamental concepts, techniques, and algorithms used in machine learning. Applications to various biomedical engineering problems will provide context for the fundamental ML concepts. The course will include hands-on programming exercises and projects to reinforce theoretical concepts and develop practical skills.

Course Learning Outcomes

The course aims to introduce the basic principles and techniques of machine learning, and its applications in biological data analysis. Projects are intended to relate computational algorithms to biological applications, involving program implementations of algorithms in Python and analysis of real datasets. At the end of the course the students should:

1. Understand the basic concepts in machine learning.
2. Have mastered standard techniques for supervised and unsupervised learning algorithms.
3. Understand the formulation and challenges of machine learning problems in biological applications.
4. Have acquired skills for implementing a set of machine learning algorithms for their own applications.

Required Course Materials

There is no required textbook for this course. Students are encouraged to read the following materials:

1. *Andrew Ng*, "Machine Learning Yearning"
2. *Andreas C. Müller and Sarah Guido*, "Introduction to Machine Learning with Python"
3. *Trevor Hastie et al*. "The Elements of Statistical Learning"

Grading Policy:

Graded deliverables	Weight distribution (%)
Class attendance (individual)	15
Python program exercises (individual)	15
Math review assignment (individual)	10
Data science project 1 (team)	30
Data science project 2 (team)	30
No final exam	

Description of Graded Components

Data science projects

(1) AML classification: Use flow cytometry data of blood samples to classify whether the samples were collected from health subjects or AML patients. Graded deliverables include predicted class labels and analysis code. 1/3 of the project grade is awarded if the submitted code runs. Remaining 2/3 of the project grade is determined by prediction performance.
(2) Protein localization: Use fluorescence microscopy images of proteins to determine whether the proteins' subcellular localization is in the nucleoli, mitochondria or both. Graded deliverables include predicted class labels and analysis code. 1/3 of the project grade is awarded if the submitted code runs. Remaining 2/3 of the project grade is determined by prediction performance.

Notes about projects:

- Data science projects are done in teams of 1~3 students. Students on the same team receive the same grade for the projects.
- No switch teams between the two projects.

Course Policies

Attendance and/or Participation

Instructor will use sign-in sheets in class to track class attendance. Class attendance accounts for 15% of the final grade. In the event of absence due to illness, medical emergency or approved institute activities (e.g., field trips, professional conferences, and athletic events), students are responsible for providing dated documentations, so that the absence is excused and not counted against the attendance grade.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review Georgia Tech's Honor Code and the student Code of Conduct. Any student suspected of cheating or plagiarism on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (404-894-2563) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Student-Faculty Expectations Agreement

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations articulate some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Pre-Requisites

BMED 2400 or ISYE 3770 or ISYE 3030

Tentative Topical Outline

	Date	Topic
Week 01	8/18	Intro lecture, course logistics, some fun stuff
	8/20	Setup programming environment Python programming basics
Week 02	8/25	Python programming basics
	8/27	Math review
Week 03	9/1	Labor Day, no class
	9/3	Introduction to data science projects (AML Classification, protein localization, drug mechanism of action, other data resources)
Week 04	9/8	Introduction to data science projects (AML Classification, protein localization, drug mechanism of action, other data resources)
	9/10	Supervised learning framework, KNN,
Week 05	9/15	Linear and Logistic Classification
	9/17	Linear regression, overfitting, regularization
Week 06	9/22	Feature selection (t-test, var, p-value, FDR, forward, backward)
	9/24	Model assessment (CV, P-R, ROC, AUC, F1, overfit) Support Vector Machine
Week 07	9/29	Decision Tree and Random Forest
	10/1	Neural Networks basics (MLP)
Week 08	10/6	Fall Break, no class
	10/8	Example classification code and hints for course projects
Week 09	10/13	Deep Learning (computational graph and MLP)
	10/15	Deep Learning (image-based analysis, CNN)
Week 10	10/20	Deep Learning (sequence analysis, RNN, LSTM)
	10/22	Deep Learning (auto-encoder) Deep Learning (hyper-parameters)
Week 11	10/27	more PyTorch examples
	10/29	Clustering algorithms (hierarchical, kmeans)
Week 12	11/3	Clustering algorithms (spectral clustering, community finding)
	11/5	Clustering algorithms (DBSCAN, density peaks) Hints for course projects
Week 13	11/10	Dimension Reduction and Visualization (PCA, isomap, spring embedding)
	11/12	Dimension Reduction and Visualization (tSNE, UMAP, TPE, SPADE)
Week 14	11/17	Adv topics: Seurat pipeline for scRNA-seq
	11/19	Adv topics: Gene set discovery project
Week 15	11/24	Data science project results and solutions
	11/26	Thanksgiving Recess, no class
Week 16	12/1	Data science project results and solutions