

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)	10
Homework (individual)	30
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. Deliverables and grading are the same as above.
- (3) Drug mechanisms of action: Use image-based cell morphology data to predict drug mechanisms of action among 13 mechanisms. Deliverables and grading same as above.

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.
- Each team can only submit deliverables for two projects. If one team works on more than two projects, the team should decide which two to submit for grading. Overall course grade will be determined by two projects. No partial credits for additional projects.
- For data science project options 1~3, deliverables can be submitted any time before **Nov 30 (beginning of week 15)**. Once submitted, the deliverables will be graded, and the project grade will be released and thus finalized.

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

	Date	Topic	Assignments
Week 01	8/24	Intro lecture, course logistics, some fun stuff Setup programming environment	
	8/26	Python programming basics Math review	
Week 02	8/31	Introduction to data science projects (AML Classification, protein localization, drug mechanism of action, other data resources)	HW1 & HW2 (due date: 9/14)
	9/2	Introduction to data science projects (AML Classification, protein localization, drug mechanism of action, other data resources)	
Week 03	9/7	Labor Day, no class	
	9/9	Supervised learning framework, KNN	
Week 04	9/14	Linear and Logistic Classification	
	9/16	Linear regression, overfitting, regularization	HW3 (due date: 9/23)
Week 05	9/21	Feature selection (t-test, var, p-value, FDR, forward, backward)	
	9/23	Model assessment (CV, P-R, ROC, AUC, F1, overfit)	HW4 (due date: 9/30)
Week 06	9/28	Support Vector Machine	
	9/30	Decision Tree and Random Forest	HW5 (due date: 10/14)
Week 07	10/5	Fall Break, no class	
	10/7	Neural Networks basics (MLP)	
Week 08	10/12	Example classification code and hints for course projects	
	10/14	Deep Learning (computational graph and MLP)	HW6 (due date: 10/26)
Week 09	10/19	Deep Learning (image-based analysis, CNN)	
	10/21	Deep Learning (sequence analysis, RNN, LSTM)	
Week 10	10/26	Deep Learning (graph analysis, GNN)	HW7 (due date: 11/2)
	10/28	Deep Learning (auto-encoder) Deep Learning (hyper-parameters)	
Week 11	11/2	more PyTorch examples	
	11/4	Clustering algorithms (hierarchical, kmeans)	
Week 12	11/9	Clustering algorithms (spectral clustering, community finding)	
	11/11	Clustering algorithms (DBSCAN, density peaks) Relevance of clustering to course projects	HW8 (due date: 11/18)
Week 13	11/16	Dimension Reduction and Visualization (PCA, isomap, spring embedding)	
	11/18	Dimension Reduction and Visualization (tSNE, UMAP, TPE, SPADE)	
Week 14	11/23	Adv topics: Seurat pipeline for scRNA-seq	
	11/25	Thanksgiving Recess, no class	
Week 15	11/30	Adv topics: Embracing the dropouts in scRNA-seq data	Two data projects (due date: 11/30)
	12/2	Adv topics: Gene set discovery project	
Week 16	12/7	Data science project results and solutions	

