

Multimodal Data Mining
BME 6938 Sections: 31B1
Class Dates: 1/08/24 - 4/25/24
Class Period: T | Period 7 (1:55 PM-2:45 PM)
R | Period 7-8 (1:55 PM – 3:50 PM)
Location: Keene-Flint Hall, Room 0121
Academic Term: Spring 2024

1. **Instructor:**

- Peng Liu, PhD
- E-mail address: pliu1@ufl.edu
- Office hours: Thursday 2:45 PM – 3:50 PM

2. **Description:** (3 credit hours) – Multimodal data mining, machine learning, and data integration course using computer programming languages for multimodal biomedical data analysis, including medical images, clinical natural language processing, genomics, and other clinical data.

3. **Pre-requisites:** Foundational knowledge in MATLAB or python and computer programming is needed to be successful in this course. If you are only familiar with MATLAB, be prepared to learn Python from scratch in this course, or take Python course first.

4. **Course Objectives:**

- Understand multimodal data mining in the biomedical domain.
- Understand the concept, approaches, and limitations in analyzing different modalities of biomedical data.
- Learn to use biomedical data processing and machine learning techniques to analyze multimodal biomedical data.

5. **Contribution of course to meeting the professional component:** 3 credits of engineering topics (no design component)

6. **Class schedule:** This is also a seminar-style course including expert lectures and an NIH-style grant proposal with a demo as the final project. Each week, you will have one to two ~50-minute recorded video lectures (recommend viewing twice at least) released on *Monday at 10 AM*. The office hour will be following the in-person meeting on *Thursday from 1:55-2:45 PM* in the classroom. On each Thursday, we will host a guest lecture or a hand-one session, followed by critiques and discussion.

7. **Material and Supply Fees:** N/A

8. **Textbooks and Software Required**

- Textbooks required for this course are freely available online at the links below. The acronyms for each textbook will be referred to in Section 10 Course Outline Readings.
 1. [DM] Data Mining: Concepts and Techniques, 3rd ed. Jiawei Han, Micheline Kamber, and Jian Pei. Morgan Kaufmann Publisher, July 2011. [\[Link\]](#)
 2. [DL] Deep Learning, MIT Press, Ian Goodfellow, Yoshua Bengio, Aaron Courville. [\[Link\]](#)
- **Software:** MATLAB (info.apps.ufl.edu or in CSE Active Learning Lab) or Python (recommend Anaconda) (free)

9. **Recommended Reading:**

- [PML] Python Machine Learning, Sebastian Raschka, Packet Publisher. 3rd ed. [[Code](#)]
- [D2L] Dive into Deep Learning (interactive book with code) [[Link](#)]
- Standard cs231n. <http://cs231n.stanford.edu/>.
- Stanford cs244d. <http://cs224d.stanford.edu/>

10. **Course Outline:** tentative schedule (subject to change)

Notation: **L:** Lecture, **S:** Hands-on Session, **G:** Guest Lectures, **Bold:** In-Person Session.

Week	Day	Date	Sec	Topic	Reading	Quiz/HW	Project	
				Part 1: Multimodal				
1	T	9-Jan	L0	Introduction & Course Logistics			Release	
	R	11-Jan	L1	Welcome! How to Read Papers				
			S1	Python: Introduction		Quiz 1 release		
2	T	16-Jan	L2	Biomedical Image Analysis		Quiz 1 due		
	R	18-Jan	G1	Google Colab and HiperGator Tutorial	HPG account			
			S2	Python: Numpy		Quiz 2 release	Group	
3	T	23-Jan	L3	Biomedical Image Filtering		Quiz 2 due		
	R	25-Jan	G2	Image Processing and Machine Learning on HPG-AI (Yunchao Yang)		HW1 release		
			S3	Python: Pandas		Quiz 3 release		
4	T	30-Jan	L4	Edge Detection		Quiz 3 due		
	R	1-Feb	G3	GitHub Tutorial and Demo (Hao Ye)		HW1 due		
			L5	Morphological Operations		Quiz 4 release		
5	T	6-Feb	L6	Neuroimage Analysis (Joseph Gullett)		Quiz 4 due		
	R	8-Feb	S4	Neuroimage Hands-on Session Project teamwork and discussion	Install FSL	No Quiz		
6	T	13-Feb	L7	Natural Language Processing (Yonghui Wu)		HW2 release		
	R	15-Feb	G4	NLP Hands-on Session (Borui Zhang)				
			S5	NLTK Toolbox Tutorial		Quiz 6 release		
7	T	20-Feb	L8	Genomic Medicine (Yan Gong)		Quiz 6 due		
	R	22-Feb	S6	GWAS Hands-On (Yan Gong) Project teamwork and discussion	Install PLink	HW2 due	Milestone 1: Topic	
				Part 2: Data Mining				
8	T	27-Feb	L9	Machine Learning (DM 8.1)				
	R	29-Feb	L10A	Feature Engineering				
			L10B	Evaluation (DM 8.5)		Quiz 8 release		
9	T	5-Mar	L11	Supervised Learning: KNN, Naïve Bayes, SVM (DM 8.3, 9.3, 9.5)		Quiz 8 due		
	R	7-Mar	S7	SVM Hands-on		HW3 release	Milestone 2: Specific Aims	
			L12	Decision Tree, Neural Networks (DM 8.2, 8.6)		Quiz 9 release		
		16-Mar	Spring Break (no class)					

10	T	19-Mar	L13	Unsupervised Learning: Partition Clustering (DM 10)	Quiz 9 due	
	R	21-Mar	S8	Partition Clustering in Python	HW3 due	
			L14	Unsupervised Learning: Hierarchical Clustering (DM 10)	Quiz 10 release	
11	T	26-Mar	L15	Deep Learning & CNN (DL 9, PML 15)	Quiz 10 due	Milestone 3: Research Strategy
	R	28-Mar	S9	PyTorch, Tensorflow, Keras, and CNN Project teamwork and discussion	Quiz 11 release	
12	T	2-Apr	L16	Recurrent Neural Networks (RNN) (DL 10, PML 16)	Quiz 11 due	
	R	4-Apr	G5	AI for Nursing EHR (Tamara Marciera & Ragnhildur Bjarnadottir)		
			S10	RNN Programming Tutorial	Quiz 12 release	
13	T	9-Apr	L17	Generative Adversarial Networks (GAN) (DL 11)	Quiz 12 due	Milestone 4: Preliminary Results
	R	11-Apr	S11A	Diffusion Generative Models	Quiz 13 release	
			S11B	GAN Programming Tutorial		
14	T	16-Apr		Project teamwork and discussion	Quiz 13 due	
	R	18-Apr	L18	Project Presentation & Demo -A		
15	T	23-Apr	L19	Project Presentation & Demo -B & Closing Remarks	Report due 4/28	

11. Attendance Policy, Class Expectations, and Make-Up Policy.

Attendance:

- View the recorded lecture videos (recommended twice) on time.
- Attend on-time attendance to in-person sessions.
- Attend office hours if having questions.

Expectations:

- Schedule video lecture “class times” for yourself.
- Complete the course activities (lecture videos, quizzes, homework) on time.
- Every week’s module will be available every **Monday at 10 AM** via Canvas.
- Quizzes are due **the coming Monday by 11.59 PM**.
- Homework assignments 1, 2, and 3 are due **the coming Saturday by 11.59 PM**.
- Write your code. Do not copy code from others (Code plagiarism will be checked)
- Practice implementing newly learned concepts will make you learn better.
- Think creatively for final projects.
- Better late than never.
- Ask for help if you need it (the instructor holds office hour every Thursday)

12. Evaluation of Grades:

Assignments	Percentage of Final Grade
Quiz	20%
Programming Assignments	35%
Admin + Attendance	5%

Final Project	40 %
Total	100%

a. Quiz

Quizzes contribute 20 points to your grade. Quiz questions will be asked at the end of each module to help students consolidate their knowledge.

b. Programming Assignments

Programming assignments will contribute 35 points to your final grade. It will be Jupiter Notebook or python programming assignments.

c. Admin & Attendance

Administrative assignments (e.g., Introduce yourself discussion, Microsoft Teams), attendance to in-person class sessions, and evaluations at the end of each module will contribute 5 points to your final grade.

d. Final Project

The Final Project will contribute 40 points to your grade. This project report will be an NIH R21/R03 style research project proposal including preliminary results (6 pages single-spaced) with a one-page specific aims page (7 pages total). Students must also include a bibliography of citations referenced in the text, but this text does not count toward the 7-page document length. The font must be Arial 11 single-spaced with no more than 1-inch margins on all sides.

This proposal can focus on the student’s specific area of graduate research and will be expected to integrate two or more methods as a central feature of the research proposal and demonstrate the integration of core knowledge of multiple modalities and machine learning/deep learning in biomedical engineering. This is intended to demonstrate the student’s mastery of the conceptual and practical application of methods and theoretical content covered during the course in their research program.

Category	Requirements	Percentage	Points	
Report (50%)	Specific Aims: with at least 2 specific aims and 1 specified hypothesis per specific aim / Abstract: 1 paragraph abstract of the MICCAI paper	R21: 1 page. Paper: ~0.5 pg	10%	4
	Research Strategy: Significance, Innovation, Design, and Methods sections / introduction and methodology	R21:6 pages Paper: 8 pages	15%	6
	Preliminary Results / Results & Analysis		15%	6
	Bibliography		5%	2
	Language & Format		5%	2
Code (10%)	The program runs well and produces the expected results	10%	4	
Present (30%)	Final Project Presentation	20%	8	
	Demo: Live demo of applying your system/method	10%	4	
Milestone (10%)	Milestone 1: Topic	2.5%	1	
	Milestone 2: Specific Aims	2.5%	1	
	Milestone 3: Research Strategy	2.5%	1	

	Milestone 4: Preliminary Results	2.5%	1
Award	(Extra Credit) Best and runner-up in Oral Presentation	+5%/+2.5%	+2/+1
Score	Total Points	(100+5)%	40+2

13. Grading Scale:

Points	Grade	Grade Points
93.00 - 100.00	A	4.00
90.00 - 92.99	A-	3.67
87.00 - 89.99	B+	3.33
83.00 - 86.99	B	3.00
80.00 - 82.99	B-	2.67
77.00 - 79.99	C+	2.33
73.00 - 76.99	C	2.00
70.00 - 72.99	C-	1.67
67.00 - 69.99	D+	1.33
63.00 - 66.99	D	1.00
60.00 - 62.99	D-	0.67
0 - 59.99	E	0.00

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

Late Policy:

- This applies to quizzes, aims page, and project milestone reports.
- Does not apply to modality presentations, project final presentations, final project reports, and final project code.
- The first-time late submission will be given a warning only. From the second time on, (number of late minutes * 0.1 points) will be deducted from the points of the late assignment, e.g., 30 min late = $30 * 0.1 = 3$ points if you did not make any mistakes.

14. Students Requiring Accommodations

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.

15. Course Evaluation

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 professionally and respectfully is available at <https://gatorevals.a.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.a.ufl.edu/public-results/>.

16. University Honesty Policy

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 (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-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.

Honor Code

- If you turn in someone else's work as if it were your own, you are guilty of cheating. This includes homework, codes, projects, quizzes, thinking critiques, presentation slides (without citation or proper credit giving), and any required course turn-in material.
- You are also guilty if you knowingly aid in cheating.
- Software will be used to compare your submitted work to others.
- However, it is okay to discuss with other classmates about homework, idea critiques, and group projects (obviously, okay to work with a project partner). But everyone must turn in their original work.
- Do not post your work on public repositories like GitHub (private repositories are fine)
- If we catch you cheating, you will get negative points on the assignment: It is better to not do the work than to cheat! If it is a midterm exam, final exam, or final project, you get an E (fail) in the class. All cases of cheating will be reported to the office of student conduct.

17. Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

18. Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

19. Student Privacy

There are federal laws protecting your privacy with regard to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

20. Campus Resources

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to

creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](#), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.

<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling.

<https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.

<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.

<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.