SE 498 Health Intelligence Systems: From Sensing to AI-Driven Discovery

Class Schedule:	**Tue & Thu 3:30 pm - 4:50 pm**	**3101 Sidney Lu Mech Engr Bldg**
Instructor:	**Prof. Yiwen Dong**	
	Office:	Room 104A, Transportation Building
	Phone:	(650) 505-8034
	Email:	yiwen@illinois.edu
	Office Hours:	Tue 4:50 - 5:50 pm or by appointment
Website:	**https://canvas.illinois.edu/** Course materials can be found on the Canvas. You are responsible for regularly checking the course site as well as your email and canvas announcements to learn of any updates. (Note: Class material is copyright to the University of Illinois at Urbana-Champaign and should not be distributed or disseminated.)	
Credits:	4	
Readings:	Related conference papers from SenSys, UbiComp, MobiCom, MobiSys, NeurIPS, ICML, ICLR, CVPR, ACL. Book: Siam, S.I., et al. (2024). Artificial Intelligence of Things: A Survey (link).	

Course Description:

This course explores the **development of AI-driven intelligent systems** with an emphasis on creating **real-world impact** on healthcare and the built environment. The main components of this course include lectures and group projects. Students will be guided through a research project cycle, starting with **sensing and data collection** from diverse sources, such as wearables, images, videos, acoustics, and ambient vibrations, to **AI and data modeling** of the collected data for predictive analysis, anomaly detection, and decision-making. By the end of this course, students will be able to: 1) Understand the basics of sensors, data processing, and AI models. 2) Formulate a research study motivated by real-world problems. 3) Gain hands-on experience in designing a health intelligence system and present the outcomes through scientific writing and presentations. Prior exposure to probability, statistics, and programming (e.g., MATLAB, Python) is needed. It is necessary to be able to code in order to complete the assignments and projects.

Learning Objectives:

Upon successful completion of this course, students will be able to:

- Understand the basic principles of sensors, data processing, and AI models
- Gain hands-on experience developing a health intelligence system
    - Develop and leverage sensors and data acquisition systems to collect health data; compare the advantages and disadvantages of different sensing modalities
    - Apply data processing techniques such as signal filtering, windowing, data augmentation to the collected data
    - Select good features and justify the choices

    - Compare and choose appropriate AI models and implement
    - Evaluate the system and interpret the results
- Effectively present your research through scientific writing and presentations.

Prerequisites:

This course is intended for advanced undergraduate and graduate level engineering students with prior exposure to probability, statistics, and computer programming. It is necessary to be able to code in order to complete the assignments and the course project.

Grading:

Component	Weight
Assignments (10% each)	30%
Project Proposal + Presentation (10% each)	20%
Final Presentation	20%
Final Report	25%
Participation (attendance, questions, discussions, etc.)	5%

***Late policy: 10% of final grade reduction applied each day for all written submissions.
No late presentation will be allowed.

Grading Scale: Straight (i.e., no +/-)
90% and up: A, 80% - 89%: B, 70% - 79%: C, 60% - 69%: D, below 59%: F

Tentative Course Structure: (*can be adjusted based on the actual learning pace)

Date	**Topic**	**Due**
Week 1: System I		
Tue	Introduction/Syllabus/Projects	
Thu	System development & research	
Week 2: System II		
Tue	Sensing systems	Project Team
Thu	Project discussion - motivation, goal	
Week 3: Sensing I		
Tue	Sensing system examples, team discussion	
Thu	Proposal Presentation	Proposal and Slides
Week 4: Sensing II		
Tue	Signal conditioning	
Thu	Project discussion - sensing	
Week 5: Data analysis I		
Tue	Signal processing - time, frequency domain analysis	

Thu	Project discussion - exploration	
Week 6: Data analysis II		
Tue	Exploratory data analysis	
Thu	Project discussion - signal analysis	Assignment 1
Week 7: Data analysis III		
Tue	Feature extraction	
Thu	Project discussion - features	
Week 8: AI and Data modeling I		
Tue	AI and machine learning basics	
Thu	Project discussion - methodology	
Week 9: AI and Data modeling II		
Tue	Regression	
Thu	Project discussion - methodology	Assignment 2
Week 10: AI and Data modeling III		
Tue	Classification	
Thu	Project discussion - methodology	
Week 11: AI and Data modeling IV		
Tue	Special topic: Physics-informed AI	
Thu	Project discussion - methodology	
Week 12: AI and Data modeling V		
Tue	Special topic: Multimodal sensing and learning	
Thu	Project discussion - methodology	
Week 13: AI and Data modeling VI		
Tue	Special topic: LLMs and foundation models	
Thu	Thanksgiving, no class	
Week 14: Putting it together		
Tue	Application of health intelligence systems	Assignment 3
Thu	Project discussion - overall system	
Week 15: Presentation		
Tue	Final presentations	Presentation Slides
Thu	Final presentations	Final Report

Course Communication:

All communication of announcements, assignments, and other materials will be done through the course website on canvas.illinois.edu. Please check the syllabus and Canvas before asking questions. When emailing the instructor, please begin your email subject line with [SE 498].

Academic Integrity:

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: http://studentcode.illinois.edu/.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: https://studentcode.illinois.edu/article1/part4/1-401/. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any

misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.
I will enforce the university's standards of Academic Integrity. All alleged infractions will be documented in the campus-wide FAIR database and investigated, and all committed infractions will result in sanctions.

Religious Observances:
Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at: https://odos.illinois.edu/community-ofcare/resources/students/religious-observances/ to request appropriate accommodations. This should be done in the first two weeks of classes.

Accommodations for Individuals with Disabilities:
To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible during the first week of the course. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu, dres-testing@illinois.edu (for testing accomodations) or go to the http://www.disability.illinois.edu/. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available on campus that can help diagnosis a previously undiagnosed disability by visiting the DRES website and selecting "Sign-Up for an Academic Screening" at the bottom of the page. I am happy to follow your DRES accommodations but do need to know how I can help – please feel free to see me after class, during office hours or by appointment.

Family Educational Rights and Privacy Act (FERPA):
Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See https://registrar.illinois.edu/academic-records/ferpa/ for more information on FERPA.

Sexual Misconduct Policy and Reporting:
The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX and Disability Office. In turn, an individual with the Title IX and Disability Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options. I am a mandatory reporter. A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: https://wecare.illinois.edu/resources/students/#confidential. Other information about resources and reporting is available here: wecare.illinois.edu.

General Emergency Response Recommendations:
Emergency response recommendations can be found at the following website: https://police.illinois.edu/em/run-hide-fight/. I encourage you to review this website and the campus building floor plans website within the first 10 days of class. http://police.illinois.edu/emergencypreparedness/building-emergency-action-plans/. Check out campus safety video and be sure to join Illini Alerts. Here is a handout they requested we share with you.

Statement of Ethical Research Conduct:
This course project may involve the collection of data from human participants. As a student in this course, your research activities are governed by the ethical principles established by the Belmont Report: Respect for Persons, Beneficence, and Justice. These principles are further defined by the University of Illinois Urbana-Champaign's Office for the Protection of Research Subjects (OPRS). Your project is considered a Research Practica and is intended solely for educational purposes. It is not designed to contribute to generalizable knowledge. As such, it does not require formal review by the Institutional Review Board (IRB). However, you are ethically and professionally obligated to uphold the highest standards of conduct:

1. Informed Consent: Before you collect any data, you must obtain voluntary and informed consent from all participants. This is a process that ensures participants understand the purpose of the study, the procedures they will undergo, the duration of their participation, and any potential risks or benefits. You must provide this information in a clear, understandable manner, free of academic jargon. Participation must be presented as completely voluntary, and participants must be informed that they can withdraw at any time without penalty.
2. Confidentiality and Privacy: You must take all necessary steps to protect the privacy and confidentiality of your participants. All personal and identifiable data must be kept confidential unless explicit permission to do otherwise is granted. Data should be de-identified to the greatest extent possible to reduce the risk of re-identification. All data collected must be stored securely, such as in a password-protected file or a secure folder on a university server.
3. Participant Protections: You must be respectful of all participants and avoid causing any unnecessary discomfort or distress. Any deception, if used, must be minimal and a debriefing must be provided immediately after the data collection. Special attention and care must be taken if your research involves vulnerable populations, such as minors.
4. Academic Integrity: All research must be conducted with the highest degree of academic integrity. Falsifying data, plagiarizing others' work, or fabricating results is a serious academic and ethical violation and will be subject to disciplinary action.

For any questions or concerns regarding the ethics of your project, you must contact me immediately. You may also contact the Office for the Protection of Research Subjects (OPRS) at UIUC for additional guidance.