MACHINE LEARNING AND SENSING

Northwestern University, Spring 2025

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SUMMARY

Modern technology relies heavily on the ability to process and understand sensor data through machine learning. Whether it's a smartphone interpreting touch gestures, smart speakers recognizing voice commands, or autonomous vehicles perceiving their environment, the challenge lies in extracting reliable information from complex sensor inputs. This course examines this critical intersection, teaching students how to build intelligent sensing systems from the ground up. Through practical assignments and hands-on projects, students will learn the complete pipeline: collecting sensor data, data and signal pre-processing, feature engineering, developing machine learning models, and visualizing results. The course emphasizes real-world applications through interactive demonstrations, in class tutorials and collaborative project work, with special focus on cutting-edge deep learning techniques for processing multimodal sensor data. Students will develop their skills through technical assignments and a team project, preparing them to develop next-generation sensing applications.

PREREQUISITES

No formal requirements. The course expects students to have a background in python programming.

DETAILED COURSE SYLLABUS

Date	Topic	Notes
4/1	Course Overview & Introduction	A0 Released
4/3	Indirect Sensing & Machine Learning	
4/8	Feature Extraction & Signal Processing	A0 Due, A1 Released
4/10	Classification Fundamentals	
4/15	Regression & Model Evaluation	

4/17	Time Series Modeling	
4/22	Deep Learning Basics	Form Project Teams
4/24	Sound, IMU and Camera as a Sensor I	A1 Due, A2 Released
4/29	Case Study I	
5/1	Case Study II	
5/6	Multimodal Deep Learning	
5/8	Transfer Learning	
5/13	Unsupervised & Semi-supervised Learning	A2 Due, A3 Released
5/15	Sound, IMU and Camera as a Sensor II	Project Proposals Due
5/20	Health & Activity Sensing	
5/22	Privacy & Ethics in ML	
5/27	End-to-end ML & Sensing Systems: Demos	A3 Due
5/29	In-class Project Lab	
6/3	Emerging Applications	
6/5	Final Project Demos	
Finals Week	No Class	Final Project Reports Due

GRADING

- Final Team Project: 30%
- Assignments: 60% (20% for each Assignment)
- In-Class Participation: 10%