

Projects in ML and AI – Spring 2025

Instructor

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Office Location

Amos Eaton 111

Office Hours

Thu-10:30 am-11:30am

Or by appointment

Course Overview

This course will expose students to applying their knowledge of ML and AI to real-world problems using real world datasets. The larger focus of the course is on Deep Learning and its applications. Students will learn to implement ML and AI concepts by creating medium to large sized projects throughout the course. Through the final project students will demonstrate in-depth understanding of Deep Learning concepts and an ability to apply these to real-world problems.

Learning Outcomes

1. Demonstrate proficiency in identifying problems that can be solved using ML and/or AI as a tool.
2. Develop techniques and overcome challenges of working with big datasets.
3. Write and test algorithms to implement ML and AI models.
4. Demonstrate an understanding of results both quantitatively and qualitatively.
5. Demonstrate an understanding for existing research and new research directions.

Lecture and Course Organization

- Each week a new ML/AI topic will be introduced (Monday) and some research related to the topic will be presented (Thursday).
- Students will read research papers (a few will be provided), figure out a real-world problem (may include your own research for a topic).
- Every 2-3 weeks figure out a real-world problem that can be solved by the topics covered in those weeks.
- Find a real-world dataset, perform data cleaning, data visualization, data-preprocessing, and feature engineering.
- Implement the Model, Evaluate and Present your results in a jupyter notebook OR Google Collab (<https://colab.research.google.com/>)

Resources

- Submittity (<https://submittity.cs.rpi.edu/>)

Week	Subject	Topics
Week 1	ML Basics	Regression, Logistic Regression, Loss Functions, Gradients and Initialization
Week 2	Tree-Based Methods, Ensemble Learning	Homework 1 Released
Week 3	Deep Neural Networks	Deep Neural Networks Homework 2 Released
Week 4	Training Neural Networks	Improve Training of Neural Networks Overfitting, Regularization Homework 3 Released
Week 5	Recurrent Neural Networks	Sequential Data 1 Page Project Proposal Due,
Week 6	Convolution Neural Networks	Homework 4 Released
Week 7	Auto-Encoders Deep Generative Modeling	
Week 8	Natural language Processing	Homework 5 Released
Week 9	Transformers Large Language Models (LLMs)	
Week 10	Reinforcement Learning	Homework 6 Released
Week 11	Boltzmann Machines Recommender systems	
Week 12	Time Series Analysis	
Week 13	Diffusion Models, Other advanced topics.	
Week 14		Project Presentations

Homework Policy

6 Homeworks – 40 % of the Grade

Participation (Weekly discussions on discussion forum) – 10%

Final Project/ Paper - 50% of the Grade

Additional Information

Minor updates to the schedule may happen depending on the progress we make during the semester.

Final Group Project/Paper Guidelines:

- Must address a real-world problem or use case.
- Utilize a variety of ML and AI techniques covered in the course.
- Emphasize collaboration, code quality, and documentation.
- Present findings, methods, experiments, data collection etc.
- The final report must meet the standards of a conference paper.
- Optional – If the final project work is ‘conference ready’ that may lead to extra credit.

Academic Integrity

If found responsible for committing academic dishonesty, a student may be subject to one or both types of penalties: an academic (grade) penalty administered by the professor and/or disciplinary action through the Rensselaer judicial process described in the RPI handbook.