MTH 4920 Special Topics in Applied Mathematics:

Introduction to Machine Learning

Classroom: Skurla 116
Class Time: MWF, 3:00-3:50 PM

Instructor: Ryan White, rwhite@fit.edu, 321-848-8301 (call/text/WhatsApp)
Office: Crawford 102
Office Hours: TR 12:00-2:00 PM (or by appointment)

MAC Tutoring: Tutors/GSAs are always available to help in the MAC.

Course Description: A broad introduction to machine learning and data mining. Topics include (i) supervised learning (feature selection, Bayesian classifier, nearest neighbors, logistic regression, decision trees, support vector machines) and (ii) unsupervised learning (dimensionality reduction, k-means clustering, hierarchical clustering, principal component analysis).

Practical Description: In general, we take some data points (could be text, images, audio/video files, database entries) and try to map them to desired targets (numbers, categories, patterns, other data points, etc) or find patterns in the data.

Examples: Can a computer classify a picture of an animal as a cat? Can it differentiate between hip-hop and rock music? Can it suggest movies similar to the ones we like? Can it predict the performance of a basketball player?

Prerequisites: MTH 1002 and CSE 1001 (or any other programming course), or equivalent background.

Learning Objectives

- Understand common concepts and techniques of supervised/unsupervised machine learning.
- Learn to choose and implement machine learning methods to solve real-world problems.
- Develop skills to effectively evaluate the success of machine learning methods.

References: Along with class notes, we will reference the following books for most topics.

- *Data Mining and Machine Learning: Fundamental Concepts and Algorithms* by Zaki and Meira (free at https://dataminingbook.info/).
- *The Elements of Statistical Learning: Data Mining, Inference, and Prediction* by Hastie, Tibshirani, and Friedman (free at https://web.stanford.edu/~hastie/ElemStatLearn/).

Programming: Use of Python is highly recommended for homework and projects. Code in class and course materials will be written in Python, but all will be explained line-by-line and well-commented so it will be understandable if you understand the basics of programming: loops, if statements, functions, etc.

Grading: Grading will be based on a point system. The point structure on the right give the *minimum* letter grade you will receive for each point value.

Category	Points
Homework	200
Midterm Exam	100
Projects	300
Final Exam	100

Points	Course Grade
630-700	A
560-629	B
490-559	C
420-489	D
0-419	F

Homework: Homework assignments will be given regularly, including both practical machine learning tasks and related mathematical problems.

Projects: Two projects are planned, each involving applying machine learning methods to real-world data. Students will have significant freedom to choose the topic of their projects, but must submit a proposal for instructor approval. Group work may be permitted for ambitious projects.

Exams: There will be a midterm exam and a final exam, each worth 100 points.

Weekly Schedule: This is a tentative plan and is subject to change. The planned dates of exams and deadlines for projects are listed.

Mathematical Preliminaries, Intro to Machine Learning

Week 1: Intro to machine learning, matrix representation of data
Week 2: Probability for ML, Bayes classifier
Week 3: Some linear algebra, linear regression
Week 4: Gradient descent, Regularization

Classification

Week 5: k-Nearest neighbors classifier (kNN)
Week 6: Logistic regression
Week 7: Linear/quadratic discriminant analysis (LDA/QDA)
Week 8: Resampling methods, **Midterm Exam**

More Supervised Learning

Week 9: Decision trees
Week 10: Random forests and ensemble models, **Project 1 due**
Week 11: Support vector machines (SVM)
Week 12: More on SVMs

Unsupervised Learning

Week 13: Dimensionality reduction, more on linear algebra
Week 14: Principal component analysis (PCA)
Week 14: K-means and hierarchical clustering
Week 16: Anomaly detection, **Project 2 due**

Finals week: **Final Exam**

ADA Policy: Any student may need an accommodation based on the impact of a disability should contact me privately to discuss your specific needs. Please contact the Office for Disability Services at (321) 674-8285 to coordinate reasonable accommodations for documented disabilities.

Title IX Policy: Title IX of the Educational Amendments Act of 1972 is the federal law prohibiting discrimination based on sex under any education program and/or activity operated by an institution receiving and/or benefiting from federal financial assistance. Behaviors that can be considered "sexual discrimination" include sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct, and gender discrimination. You are encouraged to report these behaviors.

Reporting: Florida Tech can better support students in trouble if we know about what is happening. Reporting also helps us to identify patterns that might arise - for example, if more than one complainant reports having been assaulted or harassed by the same individual. Florida Tech is committed to providing a safe and positive learning experience. To report a violation of sexual misconduct or gender discrimination, please contact Fanak Baarmand, Title IX Coordinator:

Office: Room 135, Quad 401, Miller Building
Phone: 321-674-8885
Email: fbaarman@fit.edu

*** Please note that as your professor, I am required to report any incidents to the Title IX Coordinator.** Confidential support for students is available by contacting the Counseling And Psychological Services (CAPS) at 321-674-8050.