ESE 417 Introduction to Machine Learning and Pattern Classification (FL2024)

General Information:

- **Instructor:** Dr. Jinsong Zhang, jinsong.zhang@wustl.edu, Senior Lecturer of ESE, Green Hall Room 1156B

- **Meetings:**
  - In-classroom meetings
  - Please go through the lecture slides before coming to the meetings.
  - **Programming Sessions:** three programming sessions will be included in this course where students will learn how to develop Python programs to implement machine learning models and methods studied in this course. (Taught by AIs of this course)

- **Office Hours:**
  - Monday: 9:00AM~9:30AM
  - Tuesday: 9:00AM~10:00AM, 3:00PM~4:00PM
  - Wednesday: 9:00AM~9:30AM, 3:00PM~4:00PM
  - Thursday: 9:00AM~10:00AM
  - By appointment

- **Reference books:**
  - C.M Bishop, Pattern Recognition and Machine Learning
  - Richard Duda, et. al, Pattern Classification (2nd Edition)
  - Tom Mitchell, Machine Learning, McGraw-Hill, 1997

- **Prerequisites:** MATH 233 and ESE326 (or equivalent), knowledge on linear algebra and optimization, and Python programming experience.

Course Description:

This course is an Introduction to the theory and practice of machine learning and pattern classification. In addition to fundamental machine learning principles, the topics of this course also cover several important supervised and unsupervised machine learning models and methods including linear and nonlinear models of regression, Perceptron, logistic regression, Bayesian learning methods, neural networks, nearest neighbor method, support vector machines, clustering, and principal component analysis. Students will apply learnt models and methods to solve pattern classification problems using Python.

Course Objectives:

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

- Model linear and nonlinear regression problems and make predictions

- Apply learnt models to solve classification problems
- Apply gradient descent method to train linear and nonlinear models on given data set
- Evaluate the performance of a machine learning algorithm
- Choose a proper machine learning model/algorithm for real-world problems to achieve satisfactory performance.
- Develop Python programs for machine learning models/algorithms to solve real pattern classification problems.

Course Summary: The following is a tentative schedule of this course

#	Date	Lectures	Module	HW due	Quizzes
1	27-Aug	Introduction (ML and AI)	#1		
2	29-Aug	Formalize the machine learning problem			
3	3-Sep	Review on linear algebra			
4	5-Sep	Review on optimization			
5	10-Sep	Programming Session#1 (Python tutorial on ML)			
6	12-Sep	Regression I	#2		Q1
7	17-Sep	Regression II		HW1	
8	19-Sep	Training, testing, generalization	#3		Q2
9	24-Sep	Programming Session#2 (Regression)			
10	26-Sep	Bias-Variance decomposition and Overfitting			
11	1-Oct	Classification and performance evaluation	#4	HW2	Q3
12	3-Oct	Perceptron			
	8-Oct	Fall Break, no class			
13	10-Oct	Logistic Regression			
14	15-Oct	Support Vector machine	#5		Q4
15	17-Oct	Programming Session#3 (classification)			
16	22-Oct	Support Vector machine		HW3	
17	24-Oct	Support Vector machine			
18	29-Oct	Artificial Neural Networks	#6		Q5
19	31-Oct	Artificial Neural Networks			
20	5-Nov	K nearest neighbor	#7		Q6
21	7-Nov	Naïve Bayes classifier			
22	12-Nov	Decision Trees	#8	HW4	Q7
23	14-Nov	Decision Trees			
24	19-Nov	Random Forest model			Q8
25	21-Nov	Midterm Exam			
26	26-Nov	Clustering	#9		
	28-Nov	Thanksgiving break, no class			
27	3-Dec	Clustering			
28	5-Dec	PCA		HW5	
		Final Project			

Grading:

- **Homework:** All homework assignments will be posted on Canvas. You need to submit your finished homework through Canvas on time. Homework that are less than 30 minutes late receive 90% credit; Homework that are more than 30 minutes but less than 2 hours late receive 70% credit; Homework that are more than 2 hours but less than 24 hours late receive 50% credit; Homework that are more than 24 hours late receive no credit. The following is the scheduled due dates of homework assignments.

HW#	1	2	3	4	5
Due	09/17	10/01	10/22	11/12	12/05

- **Exams:** There will be a midterm exams that is open-book, open-notes. There will be no make up for missed exams. If your miss of an exam is unexcused, you will receive a score of zero for the exam. The midterm exam is scheduled in **11/21/2024** (Thursday, regular class time).

- **Quizzes:** A 15-minute quiz will be given in every module. All quizzes will be open-book, open-notes. Quizzes less than 10 minutes late receive 50% credit. Quizzes more than 10 minutes late receive no credit.

- **Attendance:** Attending lecture meetings is mandatory. Please inform the instructor if you can not come to a meeting for health or family reasons. Attendance credit will be counted as an extra quiz into your final grade (this assignment is not eligible to be dropped).

- **Final project:** There will be a final project at the end of the course where students will work as groups to carry out a complete machine learning project to demonstrate the techniques learned from this course and submit a project report.

- **Grading formula:** Your grade from this class will be based on the following grading materials:

Homework	25%
Quizzes	30%
Exam	25%
Final Project	20%

Here is the grading scale:

90~100	A (or A+ or A-)
80~89.99	B (or B+ or B-)
70~79.99	C (or C+ or C-)
60~69.99	D (or D+ or D-)
Below 60	F

- **Grading rubrics:** Your answers to any assignment questions should be supported by complete, clear, and accurate work. An answer with no work or large gaps in the work will receive minimal credit.

- **Late policy:** Late submissions will be judged according to submission time on Canvas **strictly**. No exceptions will be given in any case.

Other Course Policies:

- **COVID-19 health and safety protocol:** While on campus, it is imperative that students follow all public health guidelines established to reduce the risk of COVID-19 transmission within our community. The full set of University protocol can be found at https://covid19.wustl.edu/health-safety/. This includes:
    - Completing a self-screening using the WashU COVID-19 Screening app every day before coming to campus or leaving your residence hall room.
    - Complying with universal masking.
    - Maintaining physical distancing as needed.
    - Practicing healthy personal hygiene.

- **Communications:** The instructor may make course related announcements on Canvas or through emailing the class as a whole. All course documents (assignments, solutions, slides) will be posted on Canvas. You are also encouraged to ask questions and discuss course-related topics on Piazza with your peer students and AIs.

- **Accommodations for Disabilities:** If you need exam accommodations based on the impact of a disability, you must meet with me to finalize arrangements at least one week prior to the first test/exam. Last minute arrangements will not be permitted.

- **Academic Integrity:** Academic integrity is extremely important. See the University Policies website at www.wustl.edu/policies/undergraduate-academic-integrity.html for a full statement of the university's policy on academic integrity. Cheating in any form will not be tolerated. The minimum penalty for cheating on an exam is a score of zero for that exam and notification to the engineering school's Discipline Committee. Other possible penalties include a semester grade of "F" and suspension or expulsion from Washington University. ***It is a violation of the AI rules to copy any contents from past published documents of this course in your submissions.***

- **Drop of grading items:** At the end of the semester, you will be given a chance to drop some grading items once you finish the online course evaluation survey. The items that receive penalty will not be eligible to be dropped.

Caveat:

The instructor reserves the right to make adjustment or changes on this document throughout the semester. Changes on syllabus may be made through course announcements on Canvas.