Western University Faculty of Engineering
Department of Electrical and Computer Engineering

ECE 9039/9309: Machine Learning: From Theory to Applications
Winter 2023

Description: The objective of this course is to introduce students to Machine Learning techniques based on a unified, probabilistic approach. The course will review regression, classification, and clustering machine-learning models. In addition, the course will introduce neural networks, mixture models, reinforcement learning, and federated learning methods. Students will get hands-on experience with machine learning from a series of practical engineering case studies. Python-based machine learning libraries will be used.

Instructor: Dr. Soodeh Nikan
TEB 239, snikan@uwo.ca
Office Hours: Check OWL course website
Contact policy: Please contact the instructor through OWL Messages. If there is a problem with OWL, use snikan@uwo.ca

Prerequisite(s):

- Courses:
  1. ECE 9063: Data Analytics Foundations
     or
  2. ECE 9013 (Programming for Engineers) and ECE 9014 (Data Management & Applications)
- Knowledge of probability and statistics, calculus, and linear algebra is required as well as strong programming skills in Python.

Enrollment Restrictions: Enrollment in this course is restricted to graduate students in Electrical and Computer Engineering Program, as well as any student that has obtained special permission to enroll in this course from the course instructor as well as the Graduate Chair (or equivalent) from the student's home program.

Course Format:
The course is delivered in-person. Online delivery will be adopted only when the University is closed.

Recommended References:

- **NNDL**: C. Aggarwal. Neural Networks and Deep Learning, Springer 2018. [Free through Western]

- **HTF**: Hastie, Tibshirani, Friedman. The Elements of Statistical Learning. New York: Springer. [Free: https://web.stanford.edu/~hastie/ElemStatLearn/]
- **JWHT**: James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning with applications in R. New York: Springer. [Free through Western]
- **MLPP**: Murphy, K. P. (2012). Machine Learning: a Probabilistic Perspective. MIT press. [Free: https://www.cs.ubc.ca/~murphyk/MLbook/]
- **BSH**: Legler and Roback. Broadening Your Statistical Horizons. [Free: https://bookdown.org/roback/bookdown-bysh/]
- **HML**: Géron, A. (2019). Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow: Unsupervised learning techniques. O'Reilly Media, Incorporated. [Free Code: https://github.com/ageron/handson-ml2]
- Class Notes

Other Required References:

Students must check OWL (http://owl.uwo.ca) on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class. Students are responsible for checking OWL on a regular basis.

Major Topics:

- Supervised Learning
  - Regression
  - Classification
- Regularized Regression
  - Lasso Regression
  - Ridge Regression
- Unsupervised Learning
  - Clustering
  - Principle Component Analysis
- Decision Tree - based models
- Introduction to Neural Networks
- Introduction for Deep Learning Models
  - Convolutional Neural Network (CNN)
  - Recurrent Neural Network (RNN)
- Introduction to Reinforcement Learning
- Introduction to Federated Learning
- Hyperparameter Optimization and Fairness
- Machine Learning Workflow:
  - Feature selection
  - Algorithms Evaluation
  - Variance: Test set, cross-validation, bootstrap
  - Bias: Confounding, causal inference
  - Performance Measures

SPECIFIC LEARNING OBJECTIVES:

At the end of the course, the students will be able to:

- Have a good understanding of the fundamental issues and challenges of machine

learning: data, features selection, model selection, and model complexity.

- Have an understanding of the strengths and weaknesses of many popular machine learning approaches.
- Understand the underlying mathematical relationships within and across machine learning algorithms and the paradigms of supervised and unsupervised learning.
- Be able to design and implement various machine learning algorithms in a range of real-world engineering applications.

EVALUATION:

Course Component			**Weight**
Exam			35%
Programming Assignments			20 %
Attendance & Quizzes			5%
Project	Progress report	5%	40%
	Group presentation	25%	
	Final project report and code submission	70%	

Project & Homework Assignments Code: The students' project software will be released under Apache License Version 2.0. Apache License Version 2.0 details are available at https://www.apache.org/licenses/. Project information and deadlines will be released before the end of January 2023.

Exam: The Exam will cover concepts covered in the lectures. The exam will include a practical component; each student will need a laptop/computer to completethe exam. Students will be given a data set and a set of practical data analytic problems to solve. Python programming language and various Python-based machine learning packages will be used in this course. The exam is "open book & open web", meaning that students can access any notesor any documents on the web. Electronic communication with other people inside or outside the classroom is prohibited. The exam will be conducted in-person. The date and location will be shared on OWL.

Attendance: Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the department, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Late Submission Policy: Assignments should be submitted by the specified duedate. Late assignment submissions will be penalized 20% per day.

Recording Online Activities: If there is any remote learning sessions for this course, it may be recorded. The data captured during these recordings may include your image, voice recordings, chat logs and personal identifiers (name displayed on the screen). The recordings will be used for educational purposes related to this course, including evaluations. The recordings may be disclosed to other individuals participating in the course for their private or group study

purposes. Please contact the instructor if you have any concerns related to session recordings. Participants in this course are NOT permitted to record the sessions, except where recording is an approved accommodation,or the participant has the prior written permission of the instructor.

COURSE CONTENT

The lecture notes and online lecture videos are copyrighted to the instructor and legally protected. Do not post these videos and lecture notes on any other website or online forums. The recording of the live/synchronous sessions of the course without the permission from the instructor is prohibited. The illegal posting and sharing of the copyrighted course content could be subjected to legal actions.

CHEATING, PLAGIARISM/ACADEMIC OFFENCES

Academic integrity is an essential component of learning activities. Students must have a clear understanding of the course activities in which they are expected to work alone (and what working alone implies) and the activities in which they can collaborate or seek help; see information above under "Assessments" and ask instructor for clarification if needed. Any unauthorized forms of help-seeking or collaboration will be considered an academic offense. University policy states that cheating is an academic offence. If you are caught cheating, there will be no second warning. Students must write their essays and assignments in their own words. Whenever students take an idea or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence. Academic offences are taken seriously and attended by academic penalties which may include expulsion from the program. Students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence (see Western's scholastic discipline regulations for graduate students).

SYNCHRONOUS LEARNING ACTIVITIES

Students are expected to participate in synchronous learning activities as outlined in the course syllabus and/or described by the instructor. If you have issues that will impede your ability to participate in synchronous activities, please discuss with the course instructor at the beginning of the course.

CONDUCT

Students are expected to follow proper etiquette during synchronous and asynchronous activities to maintain an appropriate and respectful academic environment. Any student who, in the opinion of the instructor, is not appropriately participating in the in-person, synchronous and asynchronous learning activities and/or is not following the rules and responsibilities associated with the in-person/online learning activities, will be reported to the Associate Dean (Graduate) (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean (Graduate), the student could be debarred from completing the assessment activities in the course as appropriate.

HEALTH/WELLNESS

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several health and wellness related services (remotely accessible) to help you achieve optimum health and engage in healthy living while

pursuing your graduate degree. Information regarding health- and wellness-related services available to students may be found at http://www.health.uwo.ca/.

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at
http://www.health.uwo.ca/mental_health/resources.html
https://www.uwo.ca/health/psych/index.html

SICKNESS

Students should immediately consult with the Instructor (for a particular course) or Associate Chair (Graduate) (for a range of courses) if they have problems that could affect their performance. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal. Obtaining appropriate documentation (e.g., a note from the doctor) is valuable when asking for accommodation due to illness.

ACCESSIBLITY

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at 661-2111 x 82147 or http://academicsupport.uwo.ca/accessible_education/index.html, for any specific question regarding an accommodation.