Western University Faculty of Engineering Department
of Electrical and Computer Engineering

ECE 9039/9309: Machine Learning

Winter 2024

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.

Prerequisite Courses & Knowledge

- ECE 9063: Data Analytics Foundations
- **Or** 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 the Electrical and Computer Engineering Program, and if capacity permits, to any student who 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.

Contingency Plan for Pivoting to 100% Online Learning
In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, all remaining course content will be delivered entirely online, either synchronously (i.e., at times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will not change. Any remaining assessments will also be conducted online as determined by the course instructor.

If the course needs to be moved online, any remaining exams will be conducted using a remote proctoring service. By taking this course, you are consenting to the use of this software based service and acknowledge that you will be required to provide personal information (including some biometric data) and that the session will be recorded. Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. More information about this remote proctoring service, including technical requirements, is available on Western's Remote Proctoring website at: https://remoteproctoring.uwo.ca.

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 Note*

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)
- Unsupervised Learning (Clustering & Principal Component Analysis)
- Decision Tree - based models
- Introduction to :
  - Neural Networks & Deep Learning Models
  - Reinforcement Learning
  - Federated Learning
  - Generative AI
- Hyperparameter Optimization and Fairness
- Machine Learning Workflow:
  - Feature selection
  - Algorithms Evaluation
  - Variance: Test set, cross-validation, bootstrap
  - Bias: Confounding, causal inference
  - Performance Measures

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.
- Understand 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
Final Exam			30%
Programming Assignments			20%
Attendance			2%
Quizzes			8%
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 2024.

Final Exam

The final exam will be in both "closed-book" and "open-book & open-web" structures. It will cover the concepts from the entire course and will include practical components. In the "open book & open web" part, each student will need a laptop/computer to complete the 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 "open book & open web" means that students can access any notes and documents on the web. Electronic communication with other people inside or outside the classroom is prohibited. Using AI chatbots is NOT allowed and will be counted as cheating or plagiarism. The exam will be conducted in person unless COVID-19 resurgence necessitates using remote proctoring system. 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 due date. Late assignment submissions will be penalized as follows:
- 24 hours late: 20% reduction (the percentage is calculated from the maximum possible grade).
- 48 hours late: 40% reduction
- Submissions more than 48 hours late will not be accepted.

Note
- **No coursework will be accepted after the last day of classes or after any assignment grades are released**.
- If a student misses a course work due to extenuating circumstances, make sure to contact the instructor as soon as possible. Depending on the nature of the circumstances or weight of the missed work, the student may need to submit a request for academic consideration through a Kuali form along with supporting documentation by following the link below:

Unauthorized missed coursework will receive a grade of ZERO.
- Any submission for any course component **by email** will NOT be accepted.

Passing the Course

The following rules are designed to ensure that students progressing in honors programs, and those planning to take further CS courses, meet certain minimum standards:
- To be eligible to receive an overall grade of 60% or higher in the course, a student must receive a weighted average of at least 55% on the exams and a weighted average of at least 65% on the assignments and project. If these conditions are not met, the maximum mark that you will receive is 58%.

Email Policy

The following are general email policy terms of communications:
- Your email subject should include "ECE 9039/9309" in the title.
- The course-related emails are normally checked during the business hours and will be replied within 72 hours. Please do not expect any response on weekends or after 5:00 pm on a typical weekday.
- Remember, email is one official means of communication between the students and the course instructor. As with all official University communications, it is the student's responsibility to ensure that time-critical email is accessed, read, and acted upon promptly.
- If a student chooses to forward a university email to another email mailbox, it is that student's responsibility to ensure that the alternate account is viable.
- It is a violation for any user of official university email addresses to impersonate a university officer, faculty member, staff, or student body, in line with the University's "Code of Computer User Conduct" and relevant federal and state legislation.

Recording Online Activities

If there are any remote learning sessions for this course, they 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 permission from the instructor is prohibited. The illegal posting and sharing of the copyrighted course content could be subjected to legal action.

Cheating, Plagiarism & Academic Offenses

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 the information above under "Assessments" and ask the 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 offense. 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.

Accessibility

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 questions regarding accommodation.

Technical Requirements to Take this Course

- A computer or tablet able to run a recent version of a web browser, and necessary software packages used during the course.
- A webcam and microphone in case the course delivery needs to be moved online, and
- Reliable high-speed internet connection

In addition to the above requirements associated with this course, you should also possess a set of computer skills that include installing software, security, and virus protection on your computer, managing files/folders on your computer, using the internet using a web browser, write, compile, debug, and execute your assignments' codes.

Misc. Items

- Do not share!!!, the program(code)/ assignment submitted must be written on your own or referenced.
- **No lame excuses**. Please, even when they are true, they are still lame.
- **No extra work** in the next semester is given to improve your grade. The given grades are final.

Good Luck!