Université d'Ottawa
Faculté de génie

École d'ingénierie et de technologie de l'information

uOttawa

L'Université canadienne
Canada's university

University of Ottawa
Faculty of Engineering

School of Information Technology and Engineering

Tentative Syllabus Learning

ELG 5255- **Applied Machine Learning** **Fall 2023**

General Information

When/Where:	Wednesdays 2:30-5:20pm (LMX 342)
Instructor:	**Hitham Jleed**, *hjleed@uottawa.ca* Office hours: Wednesdays 11:30-12:30 am

Course Description

<catalogue.uottawa.ca> Machine learning is an effective tool to design systems that learn from experience and adapt to an environment. Theory and applications of machine learning to the design of electrical and computer systems, devices and networks by using techniques that utilize statistics, neural computation and information theory. Fundamentals of supervised learning, Bayesian estimation, clustering and unsupervised learning, multivariate, parametric and non-parametric methods, kernel machines, hidden Markov models, multilayer perceptron networks and deep neural networks, ensemble learning and reinforcement learning. Design and testing of machine learning techniques integrated into real-world systems, devices and networks. Guidelines for machine learning experiments, methods for cross-validation and resampling, classifier performance analysis and tools for comparing classification algorithms and analysis of variance to compare multiple algorithms.

Prerequisite:

No official prerequisites are required. However, students are expected to have sufficient knowledge in Probability and Statistics for Engineers.

Anterequisites:

The courses ELG 5255, CSI 5155, IAI 5100, IAI 5101 and MIA 5100 cannot be combined for units.

Programming Environment:

Students are encouraged to learn programming in the course (Python, C++, or MATLAB). Many programming materials given in lecture and homework will be given in Python.

Textbook:

E. Alpaydin, ***"Introduction to Machine Learning,"*** *MIT Press, (3rd Edition)* . The MIT Press, 2014. *Available eBook via UOttawa Library* <link>

References:

- Trevor Hastie, Robert Tibshirani and Jerome Friedman. **The Elements of Statistical Learning**: Data Mining, Inference, and Prediction, 2nd Edition. Springer. 2009. Available free online.
- Christopher Bishop. **Pattern Recognition and Machine Learning**. Springer. 2007. *eBook via UOttawa Library*
- R. F. Mello, M. A. Ponti; "**Machine Learning**: A Practical Approach on the Statistical Learning Theory" Springer, *eBook via UOttawa Library*
- M. Kubat, "**An Introduction to Machine Learning**," Springer, August 2017, *eBook via UOttawa Library*
- Lee, Wei-Meng. **Python Machine Learning**. Wiley, 2019. *eBook via UOttawa Library*

Class Requirements

Grades in graduate school do not matter as much as in undergraduate: what you learn matters. All assignments must handle-in on time. Late assignments are subjected to penalties. The class grade will be based on the following components:

1. Three quizzes -**15 %.** Online quizzes via Brightspace.
2. Assignments - **0%.** The assignments will contain a mix of theoretical and experimental questions. The assignments are not collected or graded. But it is expected that you complete each assignment within a week.
3. A midterm in-class exam - **25%.**
4. Course project - **30%.**
5. **Final Exam 30%**

Course Objectives

By the end of the course, students will learn:

1. how to use theory and application of machine learning to real life problems
2. how to address high dimensionality challenges when working on big data sets
3. how/when to apply supervised learning methods
4. how/when to apply clustering methods

5. how to design machine learning experiments for performance testing
6. how to use methods and tools for resampling, methodology comparison and cross validation.

Course content /Outline

Date	topic	Chapter	Notes
Sep 06	Introduction & Course Outline		
Sep 13	Supervised Learning	Ch2	
Sep 20	Bayesian Decision Theory	Ch3	Quiz #1 in Class
Sep 27	Parametric and multivariate methods	Ch4 &5	
Oct 04	Clustering	Ch7	Project Proposal Due
Oct 11	Decision Trees & Linear Discrimination	Ch 9 &10	Quiz #2 in Class
Oct 18	Kernel Machines	Ch13	
Oct 25	READING WEEK <UOttawa website>		
Nov 01	Midterm Exam & presentations of Projects proposals		
Nov 08	Graphical models & Hidden Markov Models	Ch16 & 15	
Nov 15	Combining Multiple Learners	Ch 17	Quiz #3 in Class
Nov 22	Machine learning experiment design & analysis	Ch 19	Course-Eval UOzone
Nov 29	Project Presentation		Course Project Due
Dec 06	Course review		

Course Project:

Overview: The class project is an opportunity for you to explore an interesting problem of your choice in the context of a real-world data set. Project's details can be found on the last page.

Milestones: There are 2 deliverables in total:

- **Proposal**: A short description of the project, including a title, Andrew ids of the members, and a short description of your proposed project (about a page). Due on 4/10.
- **Final report:** A full academic paper, including problem definition and motivation, background and related work, details of the proposed method, details of experiments and results, conclusion, and future work. 6 pages excluding references and appendix. Due on 29/11.

Academic Integrity is expected from all students participating in this course and academic fraud will not be tolerated. All students should be familiar with the University of Ottawa Academic Integrity WEB site at http://web5.uottawa.ca/mcs-smc/academicintegrity/home.php. Students must familiarize themselves with the codes for academic integrity. Plagiarism and/or any type of

academic misconduct will not be tolerated. Please note that every submitted component must be students' original work including figures and tables used in the reports.

Plagiarism and Academic Fraud

Plagiarism (copying and handing in for credit someone else's work) and other forms of academic fraud are serious academic offences that will not be tolerated. Note that the person providing solutions to be copied is also committing an offence as they are an active participant in the plagiarism. The person copying and the person copied from will be reprimanded equally according to the regulations set by the University of Ottawa. **ChatGPT:** I assume you have all been exposed to discussions regarding the capabilities and impact of ChatGPT on teaching and assessment. ChatGPT became a useful tool in daily workflow. **The use of ChatGPT or similar AI tools in any submission is considered an academic fraud.** In addition, be aware that relying solely on ChatGPT's code is unlikely to be sufficient, as it has been known to be incorrect in certain cases.

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ELG 5255-Course Project

Objective: The primary objective of the course project is to provide students with an opportunity to conduct an original research study in machine learning and writing up it in a paper style format. I anticipate a well-defined idea or task, contextualized within existing literature, followed by its implementation and testing on a chosen dataset. This will require students to code, process data, create figures, gather references, and write a few pages describing your work. Students can undertake this project in pairs. Three students are permitted to participate with special permission. Collaborative efforts in pairs are highly recommended.

The project can be related to your research area (if you have one).

Project's Tips

You are encouraged to utilize any publicly accessible resources, ideas, or code in your project. However, make sure to appropriately cite any material that isn't your original work in your report. This project isn't meant to be a source of pressure; rather, it's an opportunity for you to explore, reflect, innovate, and hopefully enjoy the process! It's advisable to begin with straightforward techniques that function effectively from the start and then expand upon them.

Project submission

It's essential that your submission adheres to a structured paper-writing style. This should comprise an introduction section where you present the importance of your problem and the algorithm, a section detailing your methodology, a section showcasing the experiments you conducted and the results you obtained, and finally a brief conclusion highlighting your work.

1. Writing Format. It is recommend using 12-point Times New Roman font and 1.5 space. You can us the MIT guidance, https://mitcommlab.mit.edu/eecs/commkit/journal-or-conference-paper/

2. Proposal. File's name: (*Proposal_yourLastName_PartnerLastName_group#.pdf*). You are required to submit a concise project proposal. This proposal should outline the concept of your self-chosen project. Please provide a short description of the software you intend to develop, and list 2-3 academic papers you aim to read. Additionally, do Not forget to mention your partner's name.
3. Final report. File's name: (*Finalreport_yourLastName_PartnerLastName_group#.pdf*). This should be maximum 6 pages report.

Marking scheme

Your project will be worth 30% of your final class grade, and will be graded based on:

- Proposal: (Oct. 4th) 1 page (20%)
- Final Report: (Nov 29th) 6 pages (60%)
- Project code (correct, clear, and coherent) (20 %)

Dataset: Some data repositories that could be useful for you project:

UC Irvine Machine Learning Repository — http://www.ics.uci.edu/~mlearn/MLRepository.html.

UCI KDD Repository (Various) — http://kdd.ics.uci.edu/

Protein data bank (Genome) — http://www.rcsb.org/pdb/

Protein structural database (Genome) — http://scop.mrc-lmb.cam.ac.uk/scop/

Cancer classification data (Medical) — http://waldo.wi.mit.edu/MPR/data set ALL AML.html

20 Newsgroups (Text) — http://www.ai.mit.edu/people/jrennie/20 newsgroups/

4 Universities (Text) — http://www.cs.cmu.edu/afs/cs.cmu.edu/project/theo-20/www/data/

Kharwal's GitHub — https://github.com/amankharwal/Website-data/tree/master