Carleton UNIVERSITY
Canada's Capital University

Department of Mechanical and Aerospace Engineering
Faculty of Engineering and Design
Outline - Fall (September - December) 202X

MECH 4XXX - Machine Learning Theory and Applications

A: Instructor Information & Office Hours

Instructor	**Dr. Hashim Mohamed, P.Eng.**		
Location	ME 3244	**Web**	https://carleton.ca/hhashim/
Phone	613-520-2600 ext. 1224	**Email**	Hashim.Mohamed@carleton.ca

Office hours Day (In Person: XX.XX AM - XX.XX AM) & Day (Online: XX.XX PM - XX.XX PM)

B: Lectures and Tutorials Schedule/Location

Section	Component	Days	Start Time	End Time	Location
001	LEC	XX	XX.XX AM	XX.XX AM	ME XXX

C: Course Description

In this course, students are introduced to the concepts of developing Machine Learning (ML) models with an objective of modeling/solving real-worl problems. The students will be introduced to classification including supervised and unsupervised ML methods. Different ML approaches will be used to develope environments able to interpret real-world problems using real-world datasets. Students will explore open source Python-based libraries for solving regression problems (linear and nonlinear), classification, clustering, and dimensionality reduction problems. Also, students will learn how to build deep-learning environments including Convolutional Neural Networks (CNNs). Working with open source Python-based librarie and real-world datasets will enable students to gain hands-on experience in understanding and solving complex problems leveraging various machine learning and deep learning algorithms.

D: Prerequisites and Prior knowledge

- Students should be able to program in python.
- Students should be familiar with basic statistics knowledge and probability.
- Students should be familiar with linear algebra, matrix manipulation, and differential equations.
- Data structures and sorting algorithms (e.g., SYSC 2100: Algorithms and Data Structures) will be helpful in this course, but not mandatory.

E: Learning Outcomes

After completing this course, the students will have the ability to:

LO1. Understand and apply supervised learning and unsupervised learning algorithms.

LO2. Train and test ML algorithms using different Python-based programming libraries (e.g., Scikit-Learn, TensorFlow, and Keras).

LO3. Optimize the parameters of ML algorithms.

LO4. Understand common ML challenges such as under-fitting and over-fitting.

LO5. Work on groups to formulate, design, and apply ML methods on a real-world problem tested using real-world datasets.

F: Texts/Materials

[B1] F. Chollet. Deep learning with Python. Simon and Schuster, 2021.

G: Outline of the Main Course Topics

Topics & Week

Topic	Week	Due
Fundamentals of machine learning	1	
Classification	2	
Training Models	3	HW1
Support Vector Machines	4	
Decision Trees	5	
Ensemble Learning and Random Forests	6	
Dimensionality Reduction	7	HW2
Unsupervised Learning Techniques	8	
Introduction to Artificial Neural Networks	9-10	HW3
Training Neural Networks	10	
CNN with TensorFlow and Keras	11-12	
Research Ethics, Training Challenges, and Possible Solutions	13	HW4
Term project & report (presentation)	14	⇐

Term Project and Report

- Project / term report should be done in a group of three to five students.

I: Course Evaluation

Type of Evaluation	Percentage (%)
Labs and homework computer projects	20%
Term project & report	20%
Midterm	20%
Final exam	40%

Overview: Term Project Report

A student group (3 to 5 students) will select one of the projects uploaded on Brightspace. To successfully complete the Term Project students will complete the following steps:

1. Conduct a literature survey for the selected problem and summarize it in writing. (10%)
2. Formulate the problem. (10%)
3. Implement one or multiple of machine learning approaches to solve the problem. (20%)
4. Write a methodology section and list the implementation steps. (20%)
5. Present in writing the simulation results, comparison to existing literature solutions, and helpful discussion. (10%)
6. Write a conclusion. (10%)
7. Presentation. (20%)

Template of the project report will be provided on the course website.

Homework

There are 3 equally weighted homework assignments. The homework submitted after the deadline will receive a mark of **ZERO**.

- It is your responsibility to keep up-to-date backups of course files, project files, and homework files in case of system crashes or inadvertently erased files. Please keep disk copies of all the handed in material, as well as the actual graded homework, to avoid any lost homework or errors in recording marks.
- All the effort will be made to have the homework marked and handed back within 2 weeks after the hand-in date.
- The purpose of the homework assignments is for you to practice different machine learning techniques and apply the theory presented in course lectures.
- Any requests for an adjustment to the homework marks must be made within 2 weeks after the hand-back day. All homework marks are considered final after that date.

J: Course Management and Website

- The **MECH 4XXX** course uses the Online **Brightspace** system (https://brightspace.carleton.ca/). The course full name on **brightspace.carleton.ca** is **MECH 4XXX - Machine Learning Theory and Applications**.
- Course material and class information will be posted on this website. You are responsible for frequently checking the course page for updates.
- **Brightspace:** course info, lecture material, and homework assignments and helpful notes for homework solutions will be posted on the **MECH 4XXX** Brightspace site.

K: Exam Schedule

Final exam:

- Location: TBA.