ECE 718
Special Topics in Computation
Machine Learning: An Introduction

COURSE OUTLINE

Please refer to course website for updated information.

CALENDAR DESCRIPTION

Linear methods for regression and classification, nearest neighbours, decision trees, bias-variance trade-off, neural networks (including deep neural nets and convolutional nets), support vector machines, ensemble methods, clustering, principal component analysis, basics of reinforcement learning, including Monte Carlo, temporal-difference learning, SARSA (state-action-reward-state-action), Q-learning, policy-gradients methods.

SCHEDULE And MODE OF DELIVERY

The material for this course will be delivered in person if the McMaster University policy permits. Otherwise, the material will be delivered through a mixture of online videos, textbook readings, live online lectures and tutorials (which are also recorded), and virtualized laboratories and projects. The platform will be Microsoft Teams.

Lecture:
Tuesday 10:30 a.m. – 12:20 p.m.
Friday 2:30 p.m. – 4:20 p.m.

INSTRUCTOR

Dr. Sorina Dumitrescu
Email: dumitrs@mcmaster.ca
Office: ITB-A222
Phone: 905-525-9140 ext. 26486
Office Hours: TBA

Please note that during the university closures due to Covid-19 in the Fall Term, instructors will not be in their offices. Please see the course website for clarification on their availability.

COURSE WEBSITE

http://avenue.mcmaster.ca

COURSE OBJECTIVES

By the end of this course, students should be able to demonstrate an understanding of the most common machine learning approaches and their underlying principles.

ASSUMED KNOWLEDGE

Programming in Python; linear algebra: basic matrix operations; calculus: computation of derivatives; probability and statistics: understanding of probability, conditional probability, expectation, correlation, mean, variance, covariance.

COURSE MATERIALS

Textbooks:
No required textbook

Recommended Reading:

[1] Kevin P. Murphy, Machine Learning: A probabilistic perspective, The MIT Press, 2012.
[2] T. Hastie, R. Tibshirani, and J. Friedman, The Elements of Statistical Learning, 2nd Ed., Springer, 2009 (ISBN 9780387848570).
[3] C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006 (ISBN 9780387310732).
[4] M. Mohri, A. Rostamizadeh, and A. Talwalkar, Foundations of Machine Learning, 2nd Ed.,The MIT Press, 2018 (ISBN 9780262039406).
[5] I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning, The MIT Press, 2016 (ISBN 9780262035613).
[6] R. S. Sutton and A. G. Barto, Reinforcement Learning: An Introduction, 2nd Ed., The MIT Press, 2018 (ISBN 9780262039246).

COURSE OVERVIEW

Week	Topic
1	Overview of Machine Learning.
2	Linear Regression. Decision Theory. Maximum Likelihood and MAP Estimation.
3	Classification. Logistic regression.
4	Nearest neighbours. Gaussian discriminant analysis. Naive Bayes.
5	Discriminative versus generative classifiers. Decision trees.
6	Bias-Variance trade-off. Ensemble methods (boosting and bagging). Random forests.
7	Support vector machines. Neural networks (perceptron, neural nets, deep neural nets, backpropagation)
8	Convolutional neural nets. Generative adversarial networks.

9	Autoencoders. K-means clustering.
10	Principal component analysis. Gaussian mixture models and the EM algorithm.
11	Introduction to sequential decision making. Markov Decision Processes. Value functions and Bellman equations. Value Iteration algorithm.
12	Temporal-difference learning. SARSA and Q-learning. SARSA with function approximation.
13	Policy-gradient methods.

At certain points in the course it may make good sense to modify the schedule. The instructor may modify elements of the course and will notify students accordingly (in class, on the course website).

ASSESSMENT

Component	Weight	Due Date
Assignments	40%	TBA
Project	20%	TBA
Midterm	20%	TBA
Final Exam	20%	TBA
Total	100 %	

No make-up midterm tests will be granted. Weight of a missed midterm test will be transferred to final exam.

CONDUCT EXPECTATIONS

As a McMaster graduate student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

ACADEMIC ACCOMMODATIONS OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf.

www.eng.mcmaster.ca/ece