Carleton University

Department of Systems and Computer Engineering

SYSC 5108 ***Deep Learning*** ***Winter 2022***

Course Outline

Instructor:
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Office Hours
TBD

Calendar Description
The course covers a variety of deep learning techniques with rigorous analysis and practical implementations. Deep supervised and unsupervised learning. Deep reinforcement learning. Directed and undirected probabilistic models. Representation learning. Monte Carlo methods and deep generative models. Implementations and case studies.

Prerequisites
Undergraduate probability and statistics; Programing experience in Python is recommended.

Course Objectives
The goal of the course is to provide a comprehensive coverage on modern machine learning theories and techniques. Emphasis is placed on the understanding of the analytical backgrounds of various models and hands-on experience of implementing and running machine learning algorithms. The course includes a brief overview of probability theory.

Text: I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning, MIT Press, 2016

References:

T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, Springer, Second Edition, 2008

S. Marsland, *Machine Learning: An Algorithm Perspective*, Chapman and Hall/CRC, 2014

S. Raschka and V. Mirjalili, *Python Machine Learning*, Packt Publishing, 3rd Edition, 2019

L. Graesser and W. L. Keng, *Foundations of Deep Reinforcement Learning: Theory and Practice in Python*, Pearson Education 2020

H. Perros, *Computer Simulation Techniques: The definitive introduction!*
https://people.engr.ncsu.edu/hp/files/simulation.pdf

Marking Scheme

Attendance	10%
Participation	10%
Assignments	10%
Project	40%
Final Exam	30%

Course Outline

Breakdown of Course Requirements

1. Projects can be done in teams.
2. Each team can have at most two students.
3. Each project will include two deliverables: one in presentation, on in final report.
4. Students can select any application area for project.
5. Project must use at least one deep learning algorithm.
6. Project must present performance results with adopted deep learning algorithm.

e-Proctoring

Please note that tests and examinations in this course will use a remote proctoring service provided by Scheduling and Examination Services. You can find more information at https://carleton.ca/ses/e-proctoring/

Deadline Policy

A minimum of one week, but normally ten days, will be allowed for completion of all assignments. Late assignments will not be accepted. All assignments shall be submitted online.

Class Schedule

1:05pm-2:25pm, Tuesday and Thursday, Online.

Checking Marks:

Lists of term marks will be posted on dates to be announced. It is each student's responsibility to check that marks are correct or report any errors by the specified deadline.

Course Schedule:

Week 1: Introduction to machine learning and deep learning. Definition, taxonomy, and history. Traditional machine learning. Linear regression, basis expansion. Classification, K nearest neighbor, SVM. Regularization and capacity.

Week 2: Statistical machine learning basics. Maximum likelihood estimator. Logistic regression model. Stochastic optimization.

Week 3: Introduction to deep learning. Deep feedforward networks. Regularization methods. Adaptive learning rates and initialization strategies.

Week 4: Special neural networks, CNN, RNN, LSTM. Practical methodology, hyper-parameter selection, distributed implementation.

Week 5: Unsupervised learning basics, K-means, the EM algorithm, PCA.

Week 6: Structured probabilistic models, directed and undirected models. Markov Chain. Monte Carlo methods, MCMC. Linear factor models, sparse coding.

Week 7: Autoencoders, denoising autoencoder (DAE), contractive autoencoder (CAE). Representation learning.

Week 8: Reinforcement learning. Dynamic programming. Q-learning.

Week 9: Partition function, contrastive divergence (CD), stochastic maximum likelihood (SML), pseudolikelihood, importance sampling.

Week 10: Approximate inference, evidence lower bound (ELBO), maximum a posteriori (MAP) inference, variational inference.

Week 11: Deep generative network, RBM, DBN, DBM, generative adversarial networks (GAN).

Week 12/13: Student project presentations. Review.

General Regulations

Student Responsibility: It is the student's responsibility to remain informed of all rules, regulations and procedures required by their program and by the Faculty of Graduate and Postdoctoral Affairs. Ignorance of regulations will not be accepted as a justification for waiving such regulations and procedures.

Academic Integrity: Students should be aware of their obligations with regards to academic integrity. Please review the information about academic integrity at: https://carleton.ca/registrar/academic-integrity/. This site also contains a link to the complete Academic Integrity Policy that was approved by the University's Senate.

Plagiarism: Plagiarism (copying and handing in for credit someone else's work) is a serious instructional offense that will not be tolerated.

Deferred Term Work : Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor and in all cases this must occur no later than three (3.0) working days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. For more information, see the current *Graduate Calendar, Academic Regulations of the University, Section 9.3.*

Academic Accommodation: You may need special arrangements to meet your academic obligations during the term. You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at http://www.carleton.ca/equity/ For an accommodation request, the processes are as follows:

- **Pregnancy or Religious obligation**: Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as

soon as possible after the need for accommodation is known to exist. For more details see https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf

- **Academic Accommodations for Students with Disabilities**: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your ***Letter of Accommodation*** at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (*if applicable*). **Requests made within two weeks will be reviewed on a case-by-case basis.** After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (www.carleton.ca/pmc) for the deadline to request accommodations for the formally-scheduled exam (*if applicable*).
- **Survivors of Sexual Violence:** As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/sexual-violence-support/.
- **Accommodation for Student Activities:** Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf

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Health and Safety: Every student should have a copy of our Health and Safety Manual. A PDF copy of this manual is available online: http://sce.carleton.ca/courses/health-and-safety.pdf

Students from the University of Ottawa: You can request to have access to cuLearn: please see http://gradstudents.carleton.ca/forms-policies/