UNIVERSITY OF TORONTO

MIE1517 ***Introduction to Deep Learning*** ***Winter, 2024***

SYLLABUS

Instructor:

Sinisa Colic
E-mail: sinisa.colic@utoronto.ca
Office Hours: 4:10-5:00pm Tue and Wed in MC314 (or by appointment)

Lectures: 3 hours per week
Assignment/Project Support: 2 hours per week

Course Description:

This course will provide an overview of deep learning techniques with engineering applications. Topics covered include: neural network architectures (CNNs, RNNs, and more.); model training and regularization; data augmentation; transfer learning; generative models; Ethics and fairness will play a prominent role in the course discussions. The course will follow an applied approach through several skill building assignments and a team-based project.

Course Goals:

- Understand basic principles of artificial neural networks.
- Understand advances that have enabled modern deep neural networks (regularization, optimization, autodifferentiation, GPU-based parallelization, novel architectural formalisms).
- Understand deep network architectures for sequential data processing (e.g., recurrent networks for speech or text), multidimensional data processing (e.g., convolutional networks for images), and generating new data (e.g., autoencoders and generative adversarial networks).
- Understand various methods for benchmarking and evaluation of predictive models as well as diagnosing and explaining predictions.
- Apply the above principles and tools such as Python, NumPy, Matplotlib and PyTorch to a variety of data-driven engineering application use cases.
- Understand and appreciate the ethical implications of machine learning
- Learn how to lead successful machine learning projects.

Course Material:

You will need to log into Quercus to gain access to course material, and obtain regular course information (e.g., downloading lecture materials, lab handouts, project information, etc.), submit work, receive grade/feedback and email announcements. This can be done with your UTORid at: https://q.utoronto.ca/.

The course will make use of Piazza as a discussion board. This should be the first place you go to for any questions as the instructor and the TAs will be actively monitoring the discussion board. Piazza access and guidelines will be covered in the first lecture.

Optional Textbook:

There is no textbook required for the course. Lecture notes and any recommended readings will be posted each week.

The following text may be helpful:

- Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Ed. by Aurélien Géron (uses tensorflow instead of PyTorch)

Evaluation:

- **Assignments** total: 40%
- **Midterm Assessment** total: 10%
- **Project** (demonstration, presentation, and written reports) total: 25%
- **Final Assessment*** total: 25%
- **Bonus Course Participation^** total: (3%)

*The Final Assessment is mandatory and will result in course grade of incomplete (INC) assigned on the transcript if not attempted.

^There will be an additional course participation bonus of up to 3% that will be added to the grades of the top student contributors to the Piazza discussion board. Contributions will be evaluated based on the quantity and quality of the questions asked and answered.

Assignment Schedule:

A key part of the learning in this course are the hands-on programming assignments. There are 4 assignments, all due in the first half of the course. All assignments are to be completed individually. The weighting of the assignments is as following:

Assignment	Weight	Scheduled For
A1 – Linear Models	10%	approx. Week 2
A2 – Convolutional Models	10%	approx. Week 4
A3 – Generative Models	10%	approx. Week 6
A4 – Sequential Models	10%	approx. Week 8

Assignment due dates will be provided on the course website.

Project Schedule:

The project in this course will require students to implement a major piece of software that makes use of the material of the course to develop a machine learning application. It is a substantial focus of the second half of this course. The project will be done in teams of three to four and will account for **25%** of the final grade. There are several phases and specific deadlines of the project, with several interim deliverables:

Component	Weight	Deadline
Team Formation	1%	approx. Week 3
Project Selection and Approval	1%	approx. Week 5
Progress Report	3%	approx. Week 9
Presentation and Demonstration	10%	approx. Week 11
Project Final Submissions	10%	approx. Week 12

Project due dates will be provided on the course website (i.e. Quercus).

POLICIES & STATEMENTS

Late Work Policy:

There is a penalty-free grace period of one hour past the deadline. Any work that is submitted between 1 hour and 24 hours past the deadline will receive a 20% grade deduction. No other late work is accepted. Quercus submission time will be used, not your local computer time. You can submit your labs as many times as you want before the deadline, so please submit often and early.

Accessibility:

The University of Toronto and your instructors are committed to accessibility. If you require accommodations, or there is anything course-related we can do to help, please get in touch.

Academic Integrity:

The University of Toronto expects you to be a full member of the academic community and to observe the rules and conventions of academic discourse. In particular, all of the work you submit must be your own and your work must not be submitted by someone else. Plagiarism is a form of academic fraud, and the department uses software that compares submissions for evidence of similarity. The full text of the policy that governs Academic Integrity at U of T (the \Code of Behaviour on Academic Matters") can be found at:

www.governingcouncil.utoronto.ca/policies/behaveac.htm

Please don't cheat. It is unpleasant for everyone involved, including us. Here are a couple of general guidelines to help you avoid plagiarism:

- Never look at another student's homework. Never show another student your solution. This applies to all drafts of a solution and to incomplete and even incorrect solutions.
- Keep discussions with other students focused on *concepts* and *examples*. Any code or solutions that you submit should be yours alone.
- Do not post any of your assignment questions in a private or public online discussion forum or website in order to solicit solutions from others.

Note that, under the University of Toronto code of conduct, a person who supplies an assignment to be copied will be penalized in the same way as the one who makes the copy. We will use software to detect copying that is quite sophisticated and so is difficult to defeat.

University's Plagiarism Detection Tool:

Normally, students will be required to submit their course essays to the University's plagiarism detection tool for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the tool's reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of this tool are described on the Centre for Teaching Support & Innovation website (https://uoft.me/pdt-faq).

Video Privacy Considerations:

This course, including your participation, may be recorded using video and/or audio. Course videos and materials belong to your instructor, the University, and/or other sources depending on the specific facts of each situation and are protected by copyright. Do not download, copy, or share any course or student materials or videos without the explicit permission of the instructor.

For questions about recording and use of videos in which you appear please contact your instructor.

Statement on Inclusivity

You belong here. The University of Toronto Engineering commits to all students, instructors, staff, alumni and partners that you can learn, create and participate in a welcoming, healthy and respectful environment. In this class, the participation and perspectives of everyone is invited and encouraged. The broad range of identities and intersections of identities within an inclusive team environment will help you achieve academic success.

You are not alone. You are invited to talk to anyone in the Faculty that you feel comfortable approaching, including your professor, teaching assistant, academic advisor, any staff member, the Engineering Equity Diversity & Inclusion Action Group, a culture or identity club or group, or a U of T Equity Office.

Department Administrators: https://gradstudies.engineering.utoronto.ca/grad-admins/
Engineering Equity, Diversity & Inclusion Action Group & Clubs: www.uofteng.ca/edi U of T Equity Offices: https://hrandequity.utoronto.ca/inclusion/equity-offices/

You have rights under the Ontario Human Rights Code that protect you against all forms of harassment or discrimination, including but not limited to acts of racism, sexism, Islamophobia, anti-Semitism, homophobia, transphobia, ableism and ageism. Engineering denounces unprofessionalism or intolerance of any kind, whether in person or online, on or off-campus. If you experience or witness any of these behaviours, please tell someone so we can help with resources and resolution. Engineering takes these reports extremely seriously.

Phone: 416.946.3986
Email: disclosure.engineering@utoronto.ca
Submit confidential disclosure form: www.uofteng.ca/disclosure
Ontario Human Rights Code: https://www.ohrc.on.ca/en/students%E2%80%99-handouts/fact-sheet-1-ontario-human-rights-code

Mental Health and Well-Being

As a student, you may experience challenges that can interfere with learning, such as strained relationships, increased anxiety, substance use, feeling down, difficulty concentrating and/or lack of motivation, financial concerns, family worries and so forth. These factors may affect your academic performance and/or reduce your ability to participate fully in daily activities. Everyone feels stressed now and then – it is a normal part of university life. Some days are better than others, and there is no wrong time to reach out. There are resources for every situation and every level of stress.

There are many helpful resources available through your College Registrar or through Student Life (http://studentlife.utoronto.ca and http://www.studentlife.utoronto.ca/feeling-distressed). An important part of the University experience is learning how and when to ask for help. Please take the time to inform yourself of available resources.

Religious Accommodations

As a student at the University of Toronto, you are part of a diverse community that welcomes and includes students and faculty from a wide range of cultural and religious traditions. For my part, I will make every reasonable effort to avoid scheduling tests, examinations, or other compulsory activities on religious holy days not captured by statutory holidays. Further to University Policy, if you anticipate being absent from class or missing a major course activity (such as a test or in-class assignment) due to a religious observance, please let me know as early in the course as possible, and with sufficient notice (at least two to three weeks), so that we can work together to make alternate arrangements.

Acknowledgment of Traditional Land

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

Tentative Course Schedule

	Section	Date		Time	Location	Topics
Week 1	*LEC02*	Tuesday	9-Jan	1 - 4 pm	RS 208	**Course and Project Introduction**
	LEC01	Wednesday	10-Jan	1 - 4 pm	RS 208	deep learning, project expectations, etc.
	All	Monday	15-Jan	6 - 8 pm	Zoom	Special Session - Team Fromation and Project Suggestions
Week 2	*LEC02*	Tuesday	16-Jan	1 - 4 pm	RS 208	**Neural Networks Part 1**
	LEC01	Wednesday	17-Jan	1 - 4 pm	RS 208	fully-connected architecture, nonlinearity, etc.
	All	Monday	22-Jan	6 - 8 pm	Zoom	Support Session - Assignment 1 and Project
	All	Thursday	25-Jan	6 - 8 pm	Zoom	
Week 3	*LEC02*	Tuesday	23-Jan	1 - 4 pm	RS 208	**Neural Networks Part 2**
	LEC01	Wednesday	24-Jan	1 - 4 pm	RS 208	training, hyperparameters, optimization, etc.
	All	Monday	29-Jan	6 - 8 pm	Zoom	Support Session - Assignment 1 and Project
	All	Thursday	1-Feb	6 - 8 pm	Zoom	
	Team Formation Due (Tuesday, Jan 30 at 11pm)					
Week 4	*LEC02*	Tuesday	30-Jan	1 - 4 pm	RS 208	**Convolutional Neural Networks Part 1**
	LEC01	Wednesday	31-Jan	1 - 4 pm	RS 208	computer vision, convolutions, pooling, etc.
	All	Monday	5-Feb	6 - 8 pm	Zoom	Support Session - Assignment 2 and Project
	All	Thursday	8-Feb	6 - 8 pm	Zoom	
Week 5	*LEC02*	Tuesday	6-Feb	1 - 4 pm	RS 208	**Convolutional Neural Networks Part 2**
	LEC01	Wednesday	7-Feb	1 - 4 pm	RS 208	deep architecturs, transfer learning, object detection, etc.
	All	Monday	12-Feb	6 - 8 pm	Zoom	Support Session - Assignment 2 and Project
	All	Thursday	15-Feb	6 - 8 pm	Zoom	
	Project Selection Due (Tuesday Feb 13 at 11pm)					
Week 6	*LEC02*	Tuesday	13-Feb	1 - 4 pm	RS 208	**Generative Neural Networks Part 1**
	LEC01	Wednesday	14-Feb	1 - 4 pm	RS 208	unsupervised learning, autoencoders, etc.
Reading Week	No Classes Feb 19 - 23					
Week 6 Con't	*All*	Monday	26-Feb	6 - 8 pm	TBD	**Midterm**
	All	Thursday	1-Mar	6 - 8pm	Zoom	Support Session - Assignment 3 and Project
Week 7	*LEC02*	Tuesday	27-Feb	1 - 4 pm	RS 208	**Generative Neural Networks Part 2**
	LEC01	Wednesday	28-Feb	1 - 4 pm	RS 208	generative adversarial networks, adversarial learning, etc.
	All	Monday	4-Mar	6 - 8 pm	Zoom	Support Session - Assignment 3 and Project
	All	Thursday	7-Mar	6 - 8 pm	Zoom	
Week 8	*LEC02*	Tuesday	5-Mar	1 - 4 pm	RS 208	**Recurrent Neural Networks Part 1**
	LEC01	Wednesday	6-Mar	1 - 4 pm	RS 208	word embeddings, recurrent neural networks, etc.
	All	Monday	11-Mar	6 - 8 pm	Zoom	Support Session - Assignment 4 and Project
	All	Thursday	14-Mar	6 - 8 pm	Zoom	
	Progress Report Due (Tuesday, Mar 12 at 11pm)					
Week 9	*LEC02*	Tuesday	12-Mar	1 - 4 pm	RS 208	**Recurrent Neural Networks Part 2**
	LEC01	Wednesday	13-Mar	1 - 4 pm	RS 208	long-short term memory, generative RNNs, etc.
	All	Monday	18-Mar	6 - 8 pm	Zoom	Support Session - Assignment 4 and Project
	All	Thursday	21-Mar	6 - 8 pm	Zoom	
Week 10	*LEC02*	Tuesday	19-Mar	1 - 4 pm	RS 208	**Transformers**
	LEC01	Wednesday	20-Mar	1 - 4 pm	RS 208	language models, attention mechanisms, BERT, GPT etc.
	All	Monday	25-Mar	6 - 8 pm	Zoom	Support Session - Project
	All	Thursday	28-Mar	6 - 8 pm	Zoom	
Week 11	*LEC02*	Tuesday	26-Mar	1 - 4 pm	RS 208	**Final Lecture**
	LEC01	Wednesday	27-Mar	1 - 4 pm	RS 208	deep learning case studies, ethics, fairness, and future of AI
	Presentation Due (Sunday, Mar 31 at 11:00pm)					
	All	Monday	1-Apr	6 - 9 pm	TBD	**Project Presentations and Discussions**
	All	Tuesday	2-Apr	1 - 4 pm	TBD	(additional time may be required)
Week 12	*All*	Wednesday	3-Apr	1 - 4 pm	TBD	**Final Exam**
	Project Submission Due (Friday, Apr 5 at 11pm)					