Course Outline

School:	Eng. Tech. & Applied Science
Department:	Information and Communication Engineering Technology (ICET)
Course Title:	Deep Learning
Course Code:	COMP 263
Course Hours/Credits:	56
Prerequisites:	COMP 258
Co-requisites:	N/A
Eligible for Prior Learning, Assessment and Recognition:	Yes
Originated by:	Ilia Nika, Mehrdad Tirandazian
Current Semester:	Fall 2022
Approved by:	ppesikan c/o

Chairperson/Dean

Students are expected to review and understand all areas of the course outline.

Retain this course outline for future transfer credit applications. A fee may be charged for additional copies.

This course outline is available in alternative formats upon request.

Acknowledgement of Traditional Lands

Centennial is proud to be a part of a rich history of education in this province and in this city. We acknowledge that we are on the treaty lands and territory of the Mississaugas of the Credit First Nation and pay tribute to their legacy and the legacy of all First Peoples of Canada, as we strengthen ties with the communities we serve and build the future through learning and through our graduates. Today the traditional meeting place of Toronto is still home to many Indigenous People from across Turtle Island and we are grateful to have the opportunity to work in the communities that have grown in the treaty lands of the Mississaugas. We acknowledge that we are all treaty people and accept our responsibility to honor all our relations.

Course Description

This course builds on the artificial neural networks course. Students will be introduced to deep neural networks. Coursework will emphasize convolutional neural networks (CNNs), Sequence Modeling with Recurrent and Recursive Nets, Variational Autoencoders, Deep Generative Models, Representation Learning and Knowledge Transfer, Attention mechanisms and Transformers. Self-supervised learning will also be explored. Students will gain hands-on experience by using Keras and TensorFlow for building and applying deep learning models to image recognition, speech recognition, language translation, and other problems, using real-world datasets.

Program Outcomes

Successful completion of this and other courses in the program culminates in the achievement of the Vocational Learning Outcomes (program outcomes) set by the Ministry of Colleges and Universities in the Program Standard. The VLOs express the learning a student must reliably demonstrate before graduation. To ensure a meaningful learning experience and to better understand how this course and program prepare graduates for success, students are encouraged to review the Program Standard by visiting http://www.tcu.gov.on.ca/pepg/audiences/colleges/progstan/. For apprenticeship-based programs, visit http://www.collegeoftrades.ca/training-standards.

Course Learning Outcomes

The student will reliably demonstrate the ability to:

1. Differentiate between Deep Learning and Classical Nets.
2. Analyze various regularization and optimization techniques used in deep neural networks.
3. Build and train CNN and RNN models for a real-world application.
4. Use Autoencoders and Knowledge Transfer for creating efficient learning representations.
5. Apply Deep Generative Models to train deep neural networks to model the distribution of training samples.
6. Use Generative neural networks to create synthetics data.
7. Discuss various Deep Learning architectures such as transformers that achieve faster training time.
8. Evaluate the most recent Deep Learning algorithms and their practical applications for solving real world problems.

Essential Employability Skills (EES)

The student will reliably demonstrate the ability to*:

1. Communicate clearly, concisely and correctly in the written, spoken, and visual form that fulfills the purpose and meets the needs of the audience.
4. Apply a systematic approach to solve problems.
5. Use a variety of thinking skills to anticipate and solve problems.
10. Manage the use of time and other resources to complete projects.

**There are 11 Essential Employability Skills outcomes as per the Ministry Program Standard. Of these 11 outcomes, the following will be assessed in this course.*

Global Citizenship and Equity (GC&E) Outcomes

N/A

Text and other Instructional/Learning Materials

Text Book(s):

Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016, Online at deeplearningbook.org.

Géron, Aurélien. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, SecondEdition, 2019, Published by O'Reilly Media, Inc, available on O'Reilly

Atienza, Rowel, Advanced Deep Learning with TensorFlow 2 and Keras - Second Edition, by Packt Publishing, Release Date: February 2020, available on O'Reilly.

Nielsen, Michael. Neural Networks and Deep Learning, 2019, http://neuralnetworksanddeeplearning.com/

Online Resource(s):

Internet Related Resources

Material(s) required for completing this course:

Prescribed Text Books and Lecture Notes

Custom Courseware:

N.A.

Evaluation Scheme

- Lab Assignment 1: CNNs and RNNs
- Lab Assignment 2: Autoencoders and Transfer Learning
- Lab Assignment 3: Variational Autoencoders
- Lab Assignment 4: Generative Adversarial Networks and other Generative Models
- Midterm Examination: Hands-On Test 1

- Group Project: Developing an intelligent Application that applies Deep Learning to solve a real world problem.

Evaluation Name	CLO(s)	EES Outcome(s)	GCE Outcome(s)	Weight/100
Lab Assignment 1	1, 2, 3	4, 5		10
Lab Assignment 2	4	4, 5		10
Lab Assignment 3	4	4, 5		15
Lab Assignment 4	5, 6	4, 5		15
Midterm Examination	1, 2, 3, 4, 5	1, 4, 5, 10		25
Group Project	1, 2, 3, 4, 5, 6, 7, 8	1, 4, 5, 10		25
Total				100%

If students are unable to write a test they should immediately contact their professor or program Chair for advice. In exceptional and well documented circumstances (e.g. unforeseen family problems, serious illness, or death of a close family member), students may be able to write a make-up test.

All submitted work may be reviewed for authenticity and originality utilizing Turnitin®. Students who do not wish to have their work submitted to Turnitin® must, by the end of the second week of class, communicate this in writing to the instructor and make mutually agreeable alternate arrangements.

When writing tests, students must be able to produce official Centennial College photo identification or they may be refused the right to take the test or test results will be void.

Tests or assignments conducted remotely may require the use of online proctoring technology where the student's identification is verified and their activity is monitored and/or recorded, both audibly and visually through remote access to the student's computer and web camera. Students must communicate in writing to the instructor as soon as possible and prior to the test or assignment due date if they require an alternate assessment format to explore mutually agreeable alternatives.

Student Accommodation

The Centre for Accessible Learning and Counselling Services (CALCS) (http://centennialcollege.ca/calcs) provides programs and services which empower students in meeting their wellness goals, accommodation and disability-related needs. Our team of professional psychotherapists, social workers, educators, and staff offer brief, solution-focused psychotherapy, accommodation planning, health and wellness education, group counselling, psycho-educational workshops, adaptive technology, and peer support. Walk in for your first intake session at one of our service locations (Ashtonbee Room L1-04, Morningside Room 190, Progress Room C1-03, The Story Arts Centre Room 285, Downsview Room 105) or contact us at calcs@centennialcollege.ca, 416-289-5000 ext. 3850 to learn more about accessing CALCS services.

Use of Dictionaries

- Any dictionary (hard copy or electronic) may be used in regular class work.

Program or School Policies

N/A

Course Policies

N.A.

College Policies

Students should familiarize themselves with all College Policies that cover academic matters and student conduct.

All students and employees have the right to study and work in an environment that is free from discrimination and harassment and promotes respect and equity. Centennial policies ensure all incidents of harassment, discrimination, bullying and violence will be addressed and responded to accordingly.

Academic Honesty

Academic honesty is integral to the learning process and a necessary ingredient of academic integrity. Forms of academic dishonesty include cheating, plagiarism, and impersonation, among others. Breaches of academic honesty may result in a failing grade on the assignment or course, suspension, or expulsion from the college. Students are bound to the College's AC100-11 Academic Honesty and Plagiarism policy.

To learn more, please visit the Libraries information page about Academic Integrity https://libraryguides.centennialcollege.ca/academicintegrity and review Centennial College's Academic Honesty Module: https://myappform.centennialcollege.ca/ecentennial/articulate/Centennial_College_Academic_Integrity_Module_%202/story.html

Use of Lecture/Course Materials

Materials used in Centennial College courses are subject to Intellectual Property and Copyright protection, and as such cannot be used and posted for public dissemination without prior permission from the original creator or copyright holder (e.g., student/professor/the College/or third-party source). This includes class/lecture recordings, course materials, and third-party copyright-protected materials (such as images, book chapters and articles). Copyright protections are automatic once an original work is created, and applies whether or not a copyright statement appears on the material. Students and employees are bound by College policies, including AC100-22 Intellectual Property, and SL100-02 Student Code of Conduct, and any student or employee found to be using or posting course materials or recordings for public dissemination without permission and/or inappropriately is in breach of these policies and may be sanctioned.

For more information on these and other policies, please visit www.centennialcollege.ca/about-centennial/college-overview/college-policies.

Students enrolled in a joint or collaborative program are subject to the partner institution's academic policies.

PLAR Process

This course is eligible for Prior Learning Assessment and Recognition (PLAR). PLAR is a process by

which course credit may be granted for past learning acquired through work or other life experiences. The PLAR process involves completing an assessment (portfolio, test, assignment, etc.) that reliably demonstrates achievement of the course learning outcomes. Contact the academic school to obtain information on the PLAR process and the required assessment.

Semester:	Fall 2022	Professor Name:	See eCentennial course shell
Section Code:	ALL	Contact Information:	See eCentennial course shell
Meeting Time & Location:	See myCentennial timetable	Delivery Method:	See myCentennial timetable

Topical Outline (subject to change):

Week	Topics	Readings/Materials	Weekly Learning Outcome(s)	Instructional Strategies	Evaluation Name and Weight	Evaluation Date
1	Course Overview Introduction Deep Learning	Deep Learning book chapter 6, 7, 8 PPT slides	Analyze Deep Feedforward Networks Summarize regularization techniques for Deep Learning Summarize Optimization techniques for Training Deep Models	Interactive Lecture Demonstration Lab Session		
2	Review of Convolution Neural networks (CNNs)	Deep Learning book chapter 9 PPT slides TensorFlow tutorial	Review convolution, pooling, and discuss the variants of convolution functions widely used in practice. Analyze the architecture of CNNs and apply them to real world applications.	Interactive Lecture Demonstration Lab Session		
3	Review of Sequence Modeling and Recurrent Neural Networks Recursive Nets	Deep Learning book chapter 10 PPT slides Recurrent Neural Networks (RNN) with Keras – TensorFlow tutorial	Review RNNs and summarize main concepts. Explain computation graphs. Explain bidirectional RNNs. Discuss encoder-decoder sequence-to-sequence architectures. Discuss Recursive Neural Networks. Discuss Long Short-Term Memory and other Gated RNNs. Apply deep RNNs to sequence modeling problems.	Interactive Lecture Demonstration Lab Session	Lab Assignment 1: CNNs and RNNs	9/25/2022
4	Autoencoders	Deep Learning book chapter 14 Hands-On Machine	Explain autoencoders and discuss various types including undercomplete, sparse, regularized and denoising autoencoders.	Interactive Lecture Demonstration Lab Session		

Week	Topics	Readings/Materials	Weekly Learning Outcome(s)	Instructional Strategies	Evaluation Name and Weight	Evaluation Date
		Learning with Scikit-Learn, Keras, and TensorFlow, SecondEdition, chapter 17 TensorFlow tutorial UFLDL tutorial	Explain Convolutional and Recurrent Autoencoders. Explain stochastic encoders and decoders. Apply autoencoders to denoising and anomaly detection problems.			
5	Representation Learning Knowledge Transfer and Learning How to Learn	Deep Learning book 15 Sebastian Ruder's article TensorFlow tutorial	Explain the meaning of representation learning. Discuss the use of representations for transferring knowledge of tasks for which few or no examples are given but a task representation exists. Argue about the reasons for the success of representation learning. Apply knowledge transfer to image classification tasks by using transfer learning from a pre-trained network.	Interactive Lecture Demonstration Lab Session	Lab Assignment 2: Autoencoders and Transfer Learning	10/09/2022
6	Deep Generative models Group project announced	Deep Learning book, Chapter 20 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, SecondEdition, chapter 16 pathmind tutorial scikit-learn tutorial	Explain Boltzmann Machines Explain Restricted Boltzmann Machines Explain Deep Belief Nets. Describe deep Boltzmann machines and convolutional Boltzmann machines. Apply Restricted Boltzmann Machines for digit classification	Interactive Lecture		
7	Variational Autoencoders	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, SecondEdition, chapter 17	Define Variational Autoencoders (VAEs). Discuss the use of VAEs in generative modeling. Compare VAEs with Autoencoders and	Interactive Lecture Demonstration Lab Session	Hands-On Test 1	

Week	Topics	Readings/Materials	Weekly Learning Outcome(s)	Instructional Strategies	Evaluation Name and Weight	Evaluation Date
		Deep Learning book 20 TensorFlow tutorial	Boltzmann machines, and state the advantages. Train a Variational Autoencoder (VAE) on the MNIST dataset. Use VAE to generate Fashion MNIST Images.			
8	Generative Adversarial Neural Networks	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, SecondEdition, chapter 17 Deep Learning book 20 TensorFlow tutorial	Define Generative Adversarial Neural Networks (GANs). Differentiate between the generator and discriminator. Formulate and explain the learning algorithm. Discuss the selection of model architecture, and hyperparameters. Compare VAEs and GANs.	Interactive Lecture Demonstration Lab Session	Lab Assignment 3: Variational Autoencoders	10/30/2022
9	Deep Convolutional GANs,(DCGANs), and other Generative Models.	TensorFlow, SecondEdition, chapter 17 Deep Learning book 20 TensorFlow tutorial	Discuss the use of a convolutional structure for the generator network. Describe Auto-Regressive Networks and Generative Stochastic Networks. Evaluate generative models. Use GABs to generate synthetic data. Generate images of handwritten digits using a Deep Convolutional Generative Adversarial Network.	Interactive Lecture Demonstration Lab Session		
10	Attention Mechanisms, Memory Networks & Transformers	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, SecondEdition, chapter 16	Describe the Attention mechanism. Discuss the use of attention mechanism by transformers for creating smarter representations. Describe various architectures for	Interactive Lecture Demonstration Lab Session	Lab 4: Generative Adversarial Networks and other Generative Models	11/13/2022

Week	Topics	Readings/Materials	Weekly Learning Outcome(s)	Instructional Strategies	Evaluation Name and Weight	Evaluation Date
		TensorFlow tutorial Pathmind tutorial	transformers. Train a transformer model to translate form one specific language to English.			
11	Training and Deploying TensorFlow Models at Scale	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, SecondEdition, chapter 19	Discuss TensorFlow model deployment . Deploy models to TF Serving and Google Cloud AI platform. Deploy models to mobile apps, embedded devices, and web apps. Use GPUs to Speed Up Computations. Train models across multiple devices.	Interactive Lecture Demonstration Lab Session		
12	Self-supervised learning	Ian Lecun's talks Andrew Zisserman's slides Keras tutorial	Explain self-supervised learning Build and train a model to contrast between two different versions of the same image.	Interactive Lecture Demonstration Lab Session		
13	Recent Applications of Deep Learning	Deep Learning resources	Recent Applications of Deep Learning	Class discussion		
14	Project Deliverables and Class Presentations	All the Course Materials from Week 1 to Week 13	Project Deliverables and Class Presentations	Project Deliverables and Class Presentations		