# COMP 4107 for Winter 2021

Neural Networks

**Course Outline**

---

## Course Information

Instructor: Alan Tsang (https://people.scs.carleton.ca/~alantsang/)
Contact: Alan.Tsang@carleton.ca
Course Website: https://carleton.ca/culearn/
Lectures: Tuesdays & Thursdays, 8:35 – 9:55 (online)
Office Hours: Tuesdays only, 9:55 – 10:25 (online)

> *Office hours will take place on Zoom after Tuesday classes. If the Zoom link is not live, contact the instructor by email or Discord. Emails and Discord messages during this hour will be replied to promptly.*

Last Revised: 2021-01-03

## Teaching Assistants

A list of teaching assistants and their office hours will be posted once the course starts.

---

## Course Calendar Description

Theory and application of neural networks to problems in machine learning. Topics include biological models, perceptron and other neuron types; feedforward, recurrent and other architectures; learning algorithms and applications in pattern recognition and sequence prediction.

**Format**: Blended
**Prerequisites**: COMP 2404, COMP, 2804, and one of MATH 1104 or MATH 1107

## Course Objectives

The principal objective for this course is to have students understand the principles underlying neural networks and how they can be used for the creation of intelligent systems.

This course allows assumes no background in machine learning. Upon completion, a student will be able to:

1. Select a neural network architecture appropriate to a supervised or unsupervised learning task
2. Design a feature set appropriate to the machine learning task chosen

3. Use a neural network training algorithm to develop an intelligent system for the chosen domain
4. Implement the neural network design using the TensorFlow framework
5. Use simple statistics and a testing methodology to assess the effectiveness of the system developed
6. Visualize and analyze the performance of a neural network design using TensorFlow tools

Assignments will be application-centered and test a student's understanding of the material presented during the lectures.

# Textbooks (Not Mandatory):

- Ian Goodfellow, Vashya Bengio and Aaron Courville, Deep Learning. Online at: deeplearningbook.org
- Aurélien Géron, Hands-on Machine Learning with Scikit-Learn and TensorFlow
- Useful web site: Deep Learning for Java

Content is also provided through web links associated with each lecture prefixed by the tag **READING:**

## Software

Students will be required to use TensorFlow during this course. Early assignments will use Python.

# Course Format and Assessments

The course has **two synchronous sessions every week** over Zoom. Links will be posted on cuLearn. Attendance in all sessions is recommended but not mandatory.

The assessments in the course will be based on a combination of individual assignments and a final project to be completed in groups of 2 or 3 where you will implement, train, and test a neural network using a dataset of your choice. You will then write up your results in the format of a conference paper and submit your trained network for evaluation. A group selection activity on cuLearn is available for those who wish to form their own groups.

# Inquiries

If you have a question (ex: clarification on readings, discussion about something said during class, questions about assignments), you should **post them to cuLearn or Discord** so your classmates can benefit from the discussion. If the question is about your assessments or situation, you may email the instructor or leave a message on Discord.

# COMP 4107 for Winter 2021

Neural Networks

Please **add COMP 4107 in your email subjects** to ensure they are prioritized. Do not post code or assignment answers in the open or in course discussions. Questions about assessments **will not be answered with 24 hours** of the due date.

You may also schedule an appointment by emailing the instructor or assigned TAs.

## Topics Covered

| | |
|---|---|
| 1 | Review of linear algebra |
| 2 | Review of elementary probability and calculus |
| 3 | Simple statistics and measures used for machine learning |
| 4 | Concepts in machine learning |
| 5 | Biological models of neurons |
| 6 | Hebbian learning |
| 7 | Perceptron and multi-layer perception (MLP) |
| 8 | Learning for neural networks: the backpropagation algorithm |
| 9 | Feedforward neural networks |
| 10 | Neural network modeling using TensorFlow |
| 11 | Genetic algorithms and particle swarm optimization for learning |
| 12 | Hyperparameter optimization |
| 13 | Applications of feedforward neural networks in classification |
| 14 | Hopfield neural networks |
| 15 | Radical Basis Functions (RBF) neural networks |
| 16 | Self-organizing neural networks (SOM) |
| 17 | Modeling sequences: recurrent neural networks |
| 18 | Long short term memory (LSTM) neural networks |
| 19 | Applications of LSTM neural networks |
| 20 | The feature problem: spatial invariance |
| 21 | Convolutional neural networks (CNNs) |
| 22 | Applications of CNNs in image analysis |

Other important dates and deadlines can be found here.

# COMP 4107 for Winter 2021

Neural Networks

## Assessment Scheme

| | |
|---|---|
| 50%* | Final Project |
| 50% | Assignments |

* Grade is shared with your group of 2-3 students

## Late Policy

All assignments and the final project may be submitted up to 48 hours late, with **no late penalty**.

This policy accommodates unexpected circumstances such as technical and personal issues; therefore, no additional extensions will be granted (excepting accommodations provided by university policy). Submissions are handled electronically via cuLearn and items submitted after the extended deadline (by even one minute) will not be accepted.

## Writing and Academic Integrity

This course includes significant written evaluation components. This may be the first time you have written long form prose in a while. Nonetheless, clear and concise written communication are a valuable skill for computer scientists. Marks will be deducted for grammar, spelling, and punctuation errors, and other mangled misuse of language. You are expected to follow academic integrity guidelines, particularly the section on plagiarism. Plagiarism is often *very obvious* to the marker. Don't do it!

Other academic boilerplate:
*If you are unsure of the expectations regarding academic integrity (how to use and cite references, how much collaboration with lab- or classmates is appropriate), ASK your instructor. Sharing assignment or quiz specifications or posting them online (to sites like Chegg, CourseHero, OneClass, etc.) is considered academic misconduct. You are never permitted to post, share, or upload course materials without explicit permission from your instructor. Academic integrity offences are reported to the office of the Dean of Science. Penalties for such offences can be found on the ODS webpage: https://science.carleton.ca/academic-integrity/.*

# COMP 4107 for Winter 2021

Neural Networks

## Undergraduate Academic Advisor

The Undergraduate Advisor for the School of Computer Science is available in Room 5302C HP; by telephone at 520-2600, ext. 4364; or by email at undergraduate_advisor@scs.carleton.ca. The undergraduate advisor can assist with information about prerequisites and preclusions, course substitutions/equivalencies, understanding your academic audit and the remaining requirements for graduation. The undergraduate advisor will also refer students to appropriate resources such as the Science Student Success Centre, Learning Support Services and Writing Tutorial Services.

## SCS Computer Laboratory

SCS students can access one of the designated labs for your course. The lab schedule can be found at: https://carleton.ca/scs/tech-support/computer-laboratories/. All SCS computer lab and technical support information can be found at: https://carleton.ca/scs/technical-support/. Technical support is available in room HP5161 Monday to Friday from 9:00 until 17:00 or by emailing support@scs.carleton.ca.

---

### University Policies

For information about Carleton's academic year, including registration and withdrawal dates, see Carleton's Academic Calendar.

**Pregnancy 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, visit Equity Services.

**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, visit Equity Services.

**Academic Accommodations for Students with Disabilities** If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or pmc@carleton.ca for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the Paul Menton Centre website.

**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 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: 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 the policy.

**Student Academic Integrity Policy.** Every student should be familiar with the Carleton University student academic integrity policy. A student found in violation of academic integrity standards may be awarded penalties which range from a reprimand to receiving a grade of *F* in the course or even being expelled from the program or University. Examples of punishable offences include: plagiarism and unauthorized co-operation or collaboration. Information on this policy may be found here.

**Plagiarism.** As defined by Senate, "plagiarism is presenting, whether intentional or not, the ideas, expression of ideas or work of others as one's own". Such reported offences will be reviewed by the office of the Dean of Science.

**Unauthorized Co-operation or Collaboration.** Senate policy states that "to ensure fairness and equity in assessment of term work, students shall not co-operate or collaborate in the completion of an academic assignment, in whole or in part, when the instructor has indicated that the assignment is to be completed on an individual basis". Please refer to the course outline statement or the instructor concerning this issue.

---

## Acknowledgements

This course uses course materials devised by Professor Tony White.