

COMP 4107B – Winter 2024

Neural Networks

Course Information

Classroom: In-person (room location is posted on Carleton Central)

Lectures: Tuesdays & Thursdays, 11:30am – 1:00pm

Course Website: <https://brightspace.carleton.ca/d2l/home/220989>

Instructor

Matthew Holden

Contact: matthew.holden@carleton.ca

Office Hours: Tuesdays & Thursdays 1:00pm – 2:00pm (or by appointment)

Office Location: Herzberg Laboratories 5435

Teaching Assistants

TBD

Course Calendar Description

An introduction to neural networks and deep learning. Theory and application of Neural Networks to problems in machine learning. Various network architectures will be discussed. Methods for improving optimization and generalization of neural networks. Neural networks for unsupervised learning.

Prerequisites

(COMP 3105 or SYSC 4415) and (MATH 1104 or MATH 1107)

Topics Covered

- Biological inspiration for neural networks
- Multilayer perceptrons
- Backpropagation
- Implementation in TensorFlow with the Keras API
- Convolutional neural networks
- Recurrent neural networks
- Generalization in neural networks (model capacity, dropout, regularization, weight decay)
- Reinforcement Learning
- Attention-based methods

Learning Objectives

By the end of this course, students should be able to:

- Understand the different architectures of neural networks

- Select appropriate neural networks to solve different types of problems
- Implement and train neural networks using a software library for deep learning
- Analyze the performance of neural networks

Course Format

This course will be in-person. During class, we will have interactive activities such as: discussions, tutorials, demonstrations, examples, exercises, etc. In-person class attendance is very important as students will be responsible for all items discussed in class.

Communication

All announcements for the course will be made through Brightspace. You are responsible for regularly monitoring these announcements. In-person classes may also be used to elaborate on announcements.

Students are requested to ask questions or have discussions about the course or course material during the live classes, during instructor or TA office hours, or on Brightspace. This way, other students may benefit from the discussion. You may not, however, post solutions to the assessments during the live classes or Brightspace. Questions or discussion about your individual situation may be asked by email.

Required Textbook(s) and Other Resources

Recommended textbook:

Ian Goodfellow, Yoshua Bengio & Aaron Courville. Deep Learning. MIT Press (2016).

URL: <https://www.deeplearningbook.org/>

Optional Textbooks:

Aurelien Geron. Hands-On Machine Learning with Scikit-Learn, Keras & Tensorflow. O'Reilly (2022).

ISBN-13: 978-1098125974

Francois Chollet. Deep Learning with Python. Manning Publications (2021).

ISBN-13: 978-1617294433

The course may also use supplementary resources available publicly or through the Carleton Library. Information on accessing these resources will be provided in class or posted on Brightspace.

This course will use Poll Everywhere, Carleton University's tool for in-class polling. See here for details: <https://carleton.ca/edc/pollev/>.

Assessment Scheme

Students will be evaluated in this course according to the following scheme. Details, dates, and submission procedures for each component will be posted on Brightspace.

<i>Component</i>	<i>Weight</i>
Assignments (5)	33%
Quizzes (5)	33%
Project	34%

Assignments

There will be five assignments. Assignments may be theory-based (requiring a written response or calculation), assignments may be implementation-based (requiring an implementation in code), or both theory-based and implementation-based. Implementations must be written in Python 3 and use the TensorFlow library (<https://www.tensorflow.org/>) with the Keras API (<https://keras.io/>). Assignments may be completed individually or in small groups of up to three students.

Quizzes

There will be five quizzes. Each quiz will be 40 minutes in length and take place in-person during regularly scheduled class time. Quizzes are open-book, and you may consult your notes and the textbook during quizzes. You may not use electronic devices (except non-programmable scientific calculators) during quizzes; you may not consult other people during quizzes. Quizzes must be completed individually.

The lowest assignment grade or the lowest quiz grade (not both) will be excluded from the total grade computation. That is, either (1) the best four out of five assignments and five out of five quizzes will count toward your total grade or (2) five out of five assignments and the best four out of five quizzes will count toward your total grade.

Project

Students will complete a project that solves a problem using a neural network. The project will comprise: (1) a project proposal outlining the problem, (2) a project report detailing the work completed, and (3) a live demonstration of the work. Projects may be completed individually or in small groups of up to three students.

Important Considerations

If you are unsure of the expectations regarding academic integrity (e.g. how to use and cite references, how much collaboration with classmates is appropriate), ask your instructor beforehand. 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/>.

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.

References to any material you use but did not originate must be appropriately cited. This includes the use of chatbots (e.g., ChatGPT, Google Bard, Bing Chat), research assistants (e.g., Elicit), and image generators (e.g., Stable Diffusion, Dall-E), etc. Such tools must also be appropriately cited. Failure to reference materials or tools is considered academic misconduct.

For each assignment, the project proposal, and the project report, students may request a 48-hour extension with no questions asked. Submissions within this 48-hour extension period will be accepted without penalty. Late submissions beyond this will not be accepted. This will be strictly enforced. Exceptions to these rules will not be granted except for accommodations provided by university policy. Technical problems do not exempt you from this requirement. Consequently, you are advised to: (1) periodically upload your progress (e.g. upload your progress at least daily) and (2) attempt to submit your final submission well in advance of the due date and time. It is your responsibility to ensure you have submitted the correct materials.

For each assignment, you may be submitting one or more files that contain source code. These files must be written in Python 3, be given the correct filename, and be provided in the specified format. Assignments that are incorrectly named or in the incorrect format will be penalized and may receive a mark of zero. If any of the source code files you submit does not run, it may receive a mark of zero. Furthermore, you are expected to demonstrate good programming practices, and your code may be penalized if it is poorly written. You are also expected to do the necessary preparatory work (i.e. devising an algorithm) before you start coding. You may be asked to present either pseudocode or a flowchart before you will receive any assistance from the instructor or a teaching assistant.

Undergraduate Academic Advisors

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

SCS Computer Laboratory

Students taking a COMP course can access the SCS computer labs. The lab schedule and location 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/tech-support/>. Technical support staff may be contacted in-person or virtually, see this page for details: <https://carleton.ca/scs/tech-support/contact-it-support/>.

University Policies

For information about Carleton's academic year, including registration and withdrawal dates, see [Carleton's Academic Calendar](#).

Academic Accommodations. Carleton is committed to providing academic accessibility for all individuals. Please review the academic accommodation available to students here: <https://students.carleton.ca/course-outline/>.

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 sanctioned with penalties which range from a reprimand to receiving a grade of F in the course, or even being suspended or expelled from the University. Examples of punishable offences include plagiarism and unauthorized collaboration. Any such reported offences will be reviewed by the office of the Dean of Science. More information on this policy may be found on the ODS Academic Integrity page: <https://carleton.ca/registrar/academic-integrity/>.

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. More information and standard sanction guidelines can be found here: <https://science.carleton.ca/students/academic-integrity/>.

Unauthorized 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".