Lectures:

COMP 4107-A (624 SA)
Mon. and Wed. 8:35 am-9:55 am

Instructor:

Tony White
arpwhite at scs.carleton.ca
HP 5354, 520-2600 x2208

Office Hours: Tue. and Thu. 10:00 am-11:30 am

Teaching Assistants:

The TA(s) for this course will be in HP 5356 during stated office hours.

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<th>Name</th>
<th>Office Hours</th>
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Announcements:

- Please use COMP 4107 in the subject line of any email.

Course Description:

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

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 modelling using TensorFlow
11. Genetic algorithms and particle swarm optimization for neural network learning
12. Hyperparameter optimization
13. Applications of feedforward neural networks in pattern classification
14. Hopfield neural networks
15. Radial Basis Function (RBF) neural networks
16. Self-organizing neural networks (SOM)
17. Modelling 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
23. Restricted Boltzmann Machines (RBMs)
24. Applications of RBMs in Recommender systems and related domains

Prerequisites:

COMP 2404, 2804 and one of MATH 1104 or MATH 1107

Course Objectives:

Short Description

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.

Long Description

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:

**Lectures:**

**Assignments:**

**Software:**

Students will be required to use [TensorFlow](https://www.tensorflow.org) during this course. Early assignments will use Python.

**Assignment Submission:**

There will be 4 assignments in this course which will be available on the course web page and through cuLearn. All assignments are counted towards the final grade. Assignments and project are submitted in pairs.

**Marking Scheme:**

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<tbody>
<tr>
<td>Assignments (4)</td>
<td>40%</td>
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<tr>
<td>Midterm</td>
<td>15%</td>
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<tr>
<td>Final</td>
<td>20%</td>
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<td>Project</td>
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In order to pass the course a student must receive a passing grade on the assignments + midterm AND the project + final.

**Course Web Page:**

As well as being announced in class, all important information, such as course news, assignments, TA hours, instructor office hours, will be available on the course web page. It is the student's responsibility to check this web page for new information *regularly.*

**Collaboration Policy**

Collaborating outside of your team on assignments is strictly disallowed. Your team must complete the work. If you need help, please see a TA or your instructor. Posting assignment solutions on discussion boards before the due date and time is also prohibited.
**SCS Computer Accounts**

Any student taking an SCS course qualifies to have an SCS account. SCS accounts can be created at the following URL: http://www.scs.carleton.ca/newacct. SCS students can access one of the designated labs for your course. The labs are operational 7 days a week 24 hours per day, please be advised that the building will be closed overnight, Mon. - Fri. 23:00 - 8:00 and on weekends from 17:00 - 8:00. Technical support is available in room HP5161 Monday to Friday from 9:00 until 17:00. All SCS account related information is accessible at the following URL: http://www.scs.carleton.ca/nethelp.

**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 the Writing Tutorial Services.

**University Policies**

**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. Some examples of offences are: plagiarism and unauthorized co-operation or collaboration. Information on this policy may be found in the Undergraduate Calendar.

**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.

**Requests for Academic Accommodation**

You may need special arrangements to meet your academic obligations during the term. For an accommodation request, the processes are as follows:

**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 the Equity Services website: carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf

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 the Equity Services website: carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf

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. carleton.ca/pmc

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 is 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. carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf

For more information on academic accommodation, please contact the departmental administrator or visit: students.carleton.ca/course-outline

Medical Certificate

The following is a link to the official medical certificate accepted by Carleton University for the deferral of final examinations or assignments in undergraduate courses. To access the form, please go to www.carleton.ca/registrar/forms