Department of Mathematics & Statistics
Concordia University

STAT 385 (MACF 491/MAST 679), Sec. G
Topics in Mathematical & Computational Finance:
Introduction to Neural Networks
Winter 2026

Instructor: Prof. C. Hyndman
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Office Hours: Tuesdays and Thursdays, 13:15-14:30.

Class Schedule: Tuesdays and Thursdays, 14:45-16:00.
Note: There will be a mid-term break from March 2 to March 8.

Texts: There is no required text. The following books, which are available online through the library or noted websites, will be used as references:

Neural networks and deep learning: a textbook, C.C. Aggarwal, 2nd Edition, Springer, 2023. https://concordiauniversity.on.worldcat.org/oclc/1390406271

Deep learning: foundations and concepts, by C.M. Bishop and H. Bishop, Springer, 2024. Available for free online at: https://www.bishopbook.com/ or https://concordiauniversity.on.worldcat.org/oclc/1407315777

Outline: This course is an introduction to the theory of prediction with neural networks. Several applications of neural networks to common problems faced in practice are finally explored. Students will also be exposed to the implementation of methods seen in class; programming assignments use the Python or R programming languages.

Topics covered include:

- Review of predictive analytics and numerical computation concepts
  - Supervised learning, cross-validation, hyperparameters
  - Overflow and underflow
- Feed-forward neural networks
  - Motivation
    - Non-linear predictions
    - Universality property

    - Classification versus regression problems
    - Architecture specification
    - Parameter estimation
        - Objective function
        - Steepest gradient descent
        - Backpropagation, saturation, Hessian computation
        - Parameter initialization strategies
- Advanced estimation topics
    - Adaptive learning rates
    - Regularization
    - Dataset augmentation and noise injection
- Alternative neural network types
    - Recurrent neural networks (RNN)
    - Long-short term (LSTM) neural networks
    - Convolutional neural networks
- Implementations and Applications

Final Exam: It will be scheduled by the Exams Office.

NOTE: Students are responsible for finding out the date and time of the final exam once the schedule is posted by the Examination Office. Any conflicts or problems with the scheduling of the final exam must be reported directly to the Examination Office, **not** to your instructor. It is the Department's policy and the Examination Office's policy **that students are to be available until the end of the final exam period. Conflicts due to travel plans will not be accommodated.**

Evaluation: The total score is determined according to the following rule:
Undergraduate students: assignments (30%), mid-term exam (30%), and final exam (40%).
Graduate students: assignments (20%), mid-term exam (20%), term project (20%), final exam (40%).

If the grading scheme for this course includes graded assignments, a reasonable and representative subset of each assignment may be graded. Students will not be told in advance which subset of the assigned problems will be marked and should therefore attempt all assigned problems.

NOTE: It is the Department's policy that assessments missed for any reason, **including illness**, cannot be made up. If you miss an assessment such as an assignment or in-class presentation **because of illness** *(Short-Term Absence form **required**)* the value of the assessment may be transferred to the final exam.

Programming: Multiple assignment problems will require programming in either R, Python, or an Object-Oriented programming language (C++/Java). If the University provides an appropriate online programming platform (such as Jupyter

notebooks) students may be required to use this platform for programming exercises.

Generative AI: Learners are permitted to make use of technology, including generative artificial intelligence tools, to contribute to their understanding of course materials, under the circumstances outlined below.

While these technologies may prove useful in certain circumstances, they are generally not designed to solve mathematical problems. In many cases, when prompted to solve a mathematical problem, Chat GPT will fail to provide a structured and sound mathematical answer. They also do not necessarily provide accurate calculations in numerical procedures.

To achieve favorable results with generative AI, it is essential to invest time in building knowledge in the target subject and refining prompts, as this enables learners to produce more accurate output while validating its accuracy and relevance to the topic at hand.

Material drawn from ChatGPT or other AI tools must be acknowledged; representing as one's own idea, or expression of an idea, that was AI-generated will be considered an academic offense (on acknowledgement, see below) under the Academic Code of Conduct (see below).

Learners may choose to use generative AI tools as they work through the assignments in this course; this use must be documented in an appendix for each assignment. The documentation should include what tool(s) were used, how they were used, and how the results from the AI were incorporated into the submitted work.

Learners must submit, as an appendix with their assignments and projects, any content produced by an artificial intelligence tool, and the prompt used to generate the content.

In this class, assignments and projects and submitting outputs that contain incorrect information related to class concepts, inappropriate responses to assignment prompts, or details that you are unable to explain or discuss in detail is considered a misuse of generative AI.

Student Services
You may wish to access the many services available to you as a Concordia student. An overview of these resources can be found here: https://www.concordia.ca/students/services.html

Academic Integrity and the Academic Code of Conduct
This course is governed by Concordia University's policies on Academic Integrity and the Academic Code of Conduct as set forth in the Undergraduate Calendar and the Graduate Calendar. Students are expected to familiarize themselves with these policies and conduct themselves accordingly. "Concordia University has several resources available to students to

better understand and uphold academic integrity. Concordia's website on academic integrity can be found at the following address, which also includes links to each Faculty and the School of Graduate Studies: https://www.concordia.ca/conduct/academic-integrity.html" *[Undergraduate Calendar, Sec 17.10.2]*

Behaviour
All individuals participating in courses are expected to be professional and constructive throughout the course, including in their communications.

Concordia students are subject to the Code of Rights and Responsibilities which applies both when students are physically and virtually engaged in any University activity, including classes, seminars, meetings, etc. Students engaged in University activities must respect this Code when engaging with any members of the Concordia community, including faculty, staff, and students, whether such interactions are verbal or in writing, face to face or online/virtual. Failing to comply with the Code may result in charges and sanctions, as outlined in the Code.

Intellectual Property
Content belonging to instructors shared in online courses, including, but not limited to, online lectures, course notes, and video recordings of classes remain the intellectual property of the faculty member. It may not be distributed, published or broadcast, in whole or in part, without the express permission of the faculty member. Students are also forbidden to use their own means of recording any elements of an online class or lecture without express permission of the instructor. Any unauthorized sharing of course content may constitute a breach of the Academic Code of Conduct and/or the Code of Rights and Responsibilities. As specified in the Policy on Intellectual Property, the University does not claim any ownership of or interest in any student IP. All university members retain copyright over their work.

Extraordinary circumstances
In the event of extraordinary circumstances and pursuant to the Academic Regulations the University may modify the delivery, content, structure, forum, location and/or evaluation scheme. In the event of such extraordinary circumstances, students will be informed of the change.