ECO482H1F, section L0101

Machine Learning Applications in Macroeconomic Finance

University of Toronto

Department of Economics

Fall 2025

Instructor: Marlène KOFFI

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Office Hours (Online unless otherwise specified; office GE311):

- Tuesdays: 3:10 pm-4:10 pm

Teaching Assistant (TA):

- Main TA: Seyedsalehi Seyedmohammadhossein (m.seyedsalehi@mail.utoronto.ca)

TA office hours (Room TBD):

Thursdays at 5:00 PM.

Overview

This course is an introductory course to different concepts and techniques related to Machine Learning, focusing mainly on Macro-finance applications. In the first part of the course, we will review supervised and unsupervised learning methods. In the second part, we will discuss various macro-finance concepts, where machine learning is becoming increasingly common. Therefore, the course's objective is to provide students with the basics of machine learning so that they can solve economic issues using these techniques and be prepared for more advanced machine learning courses.

Course delivery

Lectures are held on Mondays from 2:10 p.m. to 4:00 p.m. (Toronto time) in room WW121. However, this course might have some online components. The lectures may be a combination of online and in-person lectures. In case we adopt the online mode for a given lecture, you will be notified via Quercus.

All course materials will be posted on Quercus. I recommend you check it regularly.

Students are expected to attend all class sessions and actively participate in discussions and activities. Please bring your laptop to class so you can practice coding when we do.
If the university suggests so, you are also strongly encouraged and requested to wear a mask during in-person classes, tutorials, and data camp.

Online course: This course is designed to be interactive, mimicking an in-person session as closely as possible when we are online. Therefore, students must have a usable microphone and are encouraged to activate their camera. For the presentations, the presenters are required to activate their cameras.

Tutorials

Tutorials are usually on Mondays from 4:10 pm to 5:00 pm.

They are intended to be in-person as well. But we will follow the public health recommendation and switch to an online mode as needed.

When in-person, the room for the course is WW 121. Please bring your laptop during those sessions so you can practice coding.

Each tutorial will be an opportunity to revise a method, correct exercises, make applications, ask questions, etc.

Note that, due to our three-hour class and tutoring schedule, we may need to reallocate time as necessary to accommodate more class time, additional tutoring, or remodeling. You will be notified when this is the case.

Data Camp

Data Camp is biweekly and on Thursday at 4:00 PM (online).

This is intended to foster overall learning in the class. The camp's objective will be to provide you with an additional learning resource and space, where the TA will give extra Python classes (to complement the traditional tutorials). The TA will answer any coding questions or issues you may have (assignments, projects,...). Please bring your laptop during those sessions so you can practice coding. The data camp is not a substitute for the tutorials. It is just an additional resource (as an office hour could be) to improve your learning.

Time zone

All times posted will be in local Toronto time. If you are in a different time zone for some reason, please make sure you know Toronto time in relation to your time zone. Errors in calculations are not an acceptable reason to miss deadlines.

Evaluation

Task	Weight	(Due) Date
Class Participation	10%	Every Wednesday Lecture
Assignments (2)	25%	• October 12 (before 23:59 EST) • November 9 (before 23:59 EST)
Research Project (Group Work) • Part 1: Submission of ideas • Part 2: Final submission	 • 15% • 20%	 • October 26 (before 23:59 EST) • December 2 (before 23: 59 EST)
Final Exam	30%	Final Assessment Period

Class Participation:

Participation marks will be based on the individual degree of engagement throughout the course. These are based on your attendance at lectures, live questions, group work during class, and questions in the chat during the course (in the online format). You are also encouraged to use the discussion platform in Quercus. We might also use the Quizzes section in Quercus. I will keep track of all those interactions during the course.

Assignments:

Assignments are usually posted one to two weeks in advance. Late assignments will receive a grade of zero (see late policy).

You will have to upload the assignments via Quercus.

Assignments will also provide an opportunity to explore concepts that we won't have time to cover in class through exercises that utilize the tools you're already familiar with.

Assignments are individual. You can help each other, but each student will have to submit their own "copy" and their own "code" in conformity with the Student Academic Integrity Code (See below).

Research Project:

You should work in **a group of 3**. Groups with fewer than 3 members will receive a penalty, and their grades will be downgraded by 10 percentage points unless this is an exogenous shock (i.e., one member drops the course). If the number of students in the class is not a multiple of 3, one or two groups will have fewer than 3 members. In the event of a tie, we will randomly choose which group should split or merge. If the group members do not comply with the randomization results, they will incur a penalty.

You should produce original work using the **methods seen in class**. Students could go beyond what we have seen in class if they want. However, all projects should contain at least the tools seen in class. Otherwise, it will be considered off-topic, and the maximum penalty will be applied.

You need to find a relevant question and apply machine learning tools to answer that question. You will be judged on your originality, the relevance of the project, the results obtained, and the integration of comments and criticisms.

In the first part of the project- Submission of the ideas- you will have to submit a set of 7 slides presented as follows:

- Slide 1: Title of the project, Group members' names, Utorid, and email address.
- Slide 2: Motivation of the topic
- Slide 3: Main research question and sub-research questions
- Slide 4: Hypothetical answer to the research questions and Contribution
- Slide 5: Method you plan to use
- Slide 6: Short Literature review with three key papers. For each paper, show the similarities and the differences between your work and the paper.
- Slide 7: Data description and some descriptive statistics

This step will be beneficial for you and prepare you to present using key points. The slides should not be overloaded; they should be readable and clear. All these details will be considered for your grade. I will post some parts of Jesse Shapiro's slides on how to present the slides for a talk.

In the second part, which presents the final submission, you must make a report (no more than 10 pages) that will take into account the potential remarks that you will have obtained during the submission of the ideas and will be articulated as follows:

- Introduction (Motivation, research questions, answer to the research question, contribution, literature, …)
- Data and Methodology
- Results
- Conclusion

Writing guidelines for the final submission:

- Font 12;
- 10 pages, including graphs and tables; references could be outside of the 10 pages;
- You can have the first page with the title, your names, UTorid, and emails not included in the 10 pages;
- Double spacing.

You will present your final project in front of the whole class. This is compulsory and counts for 70% of your grade.

Please note that those who use Kaggle will be heavily penalized because, besides data, Kaggle also provides codes related to the exploration and analysis of that data.

Final Exam

The final will be governed by the University's rules for final assessment. It is an open-book exam, i.e., you can print all the materials we have discussed in class and posted on Quercus. This includes slides, papers, books, and your notes on the slides. You are not allowed to print any random materials you will find on the internet. If you do so, this will be considered an academic infringement, and the penalty policy in such a case will be applied.

Important Note: You are expected to work on the final exam by yourself, proctored or not. You may not use unauthorized aids or communicate with others about the test.

Late penalty:

All the evaluations are due at the "Due Date" indicated in the table.

Late assignments will receive a grade of zero unless a valid reason for absence is provided and you notify the instructor (copying the TA) before the day of the due date.

Late research projects will be downgraded by 10 percentage points per day of delay.

If you do not take the final exam within the specified windows, you will receive a score of zero unless otherwise notified by the administration.

Missed Work Policy

Missed work will not be accepted due to technical difficulties, confusion about deadlines, internet or hardware problems, or submission errors (e.g., sending the wrong file, incomplete files, or missing sections of an assignment).

Course Material

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning (Vol. 112, p. 18). New York: springer. (JWHT).

Sarkar, D. (2016). Text Analytics with Python.

Others

Bird, S., Klein, E., & Loper, E. (2009). Natural language processing with Python: analyzing text with the natural language toolkit. " O'Reilly Media, Inc.".

Start with Python

Guido, S., & Müller, A. (2016). Introduction to machine learning with python (Vol. 282). O'Reilly Media.

Software

All machine learning programming activities in this course will use only Python software. Python is a free software. All students are required to install it on their machine.

Topics and Required Readings

Part 1: Introduction to Machine Learning

- **Chapter 1:** Introduction

  JWHT, Chapter 2

- **Chapter 2:** Basic notions of Machine Learning and Natural Language Processing

  JWHT, Chapter 2; Sarkar, D. (2016) Chapter 3

Part 2 : Algorithmic Prediction

- **Chapter 3:** Classifier Part 1: Logistic, k-nearest neighbors, Naïve Bayes classifier

  JWHT, Chapter 4

- **Chapter 4:** Classifier Part 2: Trees-based Methods

  JWHT, Chapter 8

- **Application 1**: Financial crisis
  - Manasse, P. and Roubini, N., 2009, "Rules of thumb for sovereign debt crises", Journal of International Economics, Volume 78, Issue 2.
  - Badia, Marialuz Moreno, et al. "Debt is not free." Journal of International Money and Finance 127 (2022): 102654.
- **Application 2**: Delinquency risk
  - Fuster, Andreas, et al. "Predictably unequal? The effects of machine learning on credit markets." The Journal of Finance 77.1 (2022): 5-47.
- **Application 3 :** Forecasting and nowcasting

Part 3 : Natural Language Processing

- **Chapter 5:** Textual Analysis Part 1: Feature Engineering Model

  Sarkar, D. (2016) Chapter 4

- **Application 4:** Uncertainty and Risk
  - Alexopoulos, Michelle, and Jon Cohen, "The Power of Print: Uncertainty Shocks, Markets, and the Economy," International Review of Economics and Finance, 40 (2015), 8–28.
  - Baker, S. R., Bloom, N., & Davis, S. J. (2016). Measuring economic policy uncertainty. The quarterly journal of economics, 131(4), 1593-1636.
- **Application 5:** Intangible asset and Technology
  - Kelly, Bryan, et al. "Measuring technological innovation over the long run." American Economic Review: Insights 3.3 (2021): 303-320.

- **Chapter 6:** Sentiment Analysis

  Sarkar, D. (2016) Chapter 9

- **Application 6:** Prediction of Financial Return
  - Tetlock, P. C. (2007). Giving content to investor sentiment: The role of media in the stock market. The Journal of Finance, 62(3), 1139-1168.
  - Loughran, Tim, and Bill McDonald. 2011. "When Is a Liability Not a Liability? Textual Analysis, Dictionaries, and 10-Ks." Journal of Finance 66 (1): 35–65.
  - Cao, Sean, et al. "How to talk when a machine is listening: Corporate disclosure in the age of AI." The Review of Financial Studies 36.9 (2023): 3603-3642.

- **Chapter 7:** Textual Analysis Part 2: Topic Modelling

  Sarkar, D. (2016) Chapter 6

- **Application 7:** Central Bank and Prediction

- Hansen, Stephen, Michael McMahon, and Andrea Prat. 2018. "Transparency and Deliberation within the FOMC: A Computational Linguistics Approach." Quarterly Journal of Economics 133 (2): 801–70.

- **Going beyond:**
  - Alexopoulos, Michelle, et al. "More than words: Fed Chairs' communication during congressional testimonies." Journal of Monetary Economics 142 (2024): 103515.

Important notices:
(1) The schedule is tentative and may be adjusted depending on the length of some chapters compared to others.
(2) We may have to skip some applications if we are short on time.
(3) It is compulsory to read the required materials before class.
(4) In the machine learning literature, each chapter that we see can constitute a course in itself. We will then not approach all these themes exhaustively but rather make a synthesis. We will keep it practical for you to use these methods easily.

(5) Please save the date of December 1st as the date for the presentation of the final project. We might use some time for either a presentation of the first part of the research project or a discussion with each group regarding the submission during office hours or during class. You will be notified.

Email Policy

The use of email should be restricted to private matters or to notify of problems (e.g., broken links, typos, etc.).
I will answer questions about course materials in person during lectures or office hours.

- First ask the Teaching Assistant.
- For e-mails asking for a reply, if I can answer briefly (e.g., requiring a one-sentence reply), then I will reply within three business days. If a response requires more detail, then class, tutorial, or office hours are the more appropriate forum;
- I will not respond to emails that request information that can be found on Quercus or the syllabus.
- Please also note that requesting marks, or the solutions to problem sets or midterm questions by email is not appropriate.

Finally, students must also send emails using their University of Toronto email address. The subject of the email should include the course number and the UTORid.

Academic Integrity

Academic integrity is essential to pursuing learning and scholarship in a university, and ensuring that a degree from the University of Toronto is a strong signal of each student's academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's *Code of Behaviour on Academic Matters* (http://www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/ppjun011995.pdf) outlines the behaviors that constitute academic dishonesty and the processes for addressing academic offenses. Potential offenses include, but are not limited to:

In papers and assignments:

- Using someone else's ideas or words without appropriate acknowledgment.
- Submitting your own work in more than one course without the permission of the instructor in all relevant courses
- Making up sources or facts
- Obtaining or providing unauthorized assistance on any assignment

On tests and exams:

- Using or possessing unauthorized aids
- Looking at someone else's answers during an exam or test
- Misrepresenting your identity

In academic work:

- Falsifying institutional documents or grades
- Falsifying or altering any documentation required by the University, including (but not limited to) doctor's notes

All suspected cases of academic dishonesty will be investigated following procedures outlined in the *Code of Behaviour on Academic Matters*. Please have a look at these sections on Perils and Pitfalls https://www.academicintegrity.utoronto.ca/perils-and-pitfalls/ and Smart Strategies https://www.academicintegrity.utoronto.ca/smart-strategies/. Also, see the U of T writing support website at https://writing.utoronto.ca/. We may use Turnitin or Ouriginal for the final submission of the research project. More details will be given during class.

University disclaimer concerning Turnitin:

"Normally*, students will be required to submit their course essays to Turnitin.com for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the Turnitin.com reference database, where they*

will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com website."

Class Materials Policy:

Class materials are subject to the University's policy on intellectual property. Without the instructor's explicit permission, it is strictly forbidden to copy, share, or distribute any class materials, except for the current academic use purpose.

Code of Conduct in an online environment

- The first thing to recall is that we are in a learning environment. Mistakes, discussions, exchange of ideas, etc., are acceptable as long as they are made in total respect for the person and individuality.
- Please mute yourself unless you need to talk for the class's benefit (ask a question, answer a question, etc.).
- To avoid unpleasant interruptions, when you want to ask a question, please use the chat function or wait for the time allowed to do so. As you will notice, I frequently ask if there are any questions. When asked, you are welcome to unmute yourself and ask any question you may have.
- Again, I make a point of honor to have a respectful environment during class. So please, respect your peers. Use proper and respectful language and refrain from any insults, threats, or bad jokes.
- Finally, adhere to the same standards as you would in the classroom.

Academic Accommodations

The University is committed to accessibility. If a student requires accommodations for a disability or has any accessibility concerns about the course, please contact Accessibility Services as soon as possible. Their website is http://www.studentlife.utoronto.ca/as.

Other important notice

The students are expected to comply with all University policies even if not expressly mentioned above.

Absence

Please refer to the University guidelines: https://www.artsci.utoronto.ca/faculty-staff/teaching/academic-handbook#MissedTermWork

Generative AI

The University has created sample statements for instructors to include in course syllabi and course assignments to help shape the message to students about what AI technology is, or is not, allowed. Please read the following material: https://www.viceprovostundergrad.utoronto.ca/wp-content/uploads/sites/275/2023/04/Syllabus-Language-for-Gen-AI-April-2023.pdf