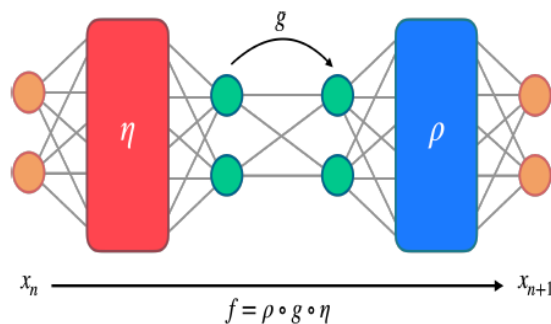


MATH 494 (MAST 680/MAST 865), Sec. A
Topics in Pure & Applied Mathematics
Data Driven Methods for Dynamic Systems
Winter 2023



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Course Website: Moodle
GitHub Code Repo: [jbramburger/DataDrivenDynSyst](https://github.com/jbramburger/DataDrivenDynSyst)

Lectures: Wednesday & Friday, 4:15-5:30 PM.

Office Hours: TBD, LB 759-06.
Virtual: by appointment only.

Course Topics and Goals: The goal of this course is to explore modern data science techniques for interpreting, analyzing, forecasting, and controlling dynamic data. In doing so we will be presented with many classical problems stemming from the theory of dynamical systems and then proceed to describe how state-of-the-art computational methods can help to resolve the gap between theory and practice. Course topics will include dynamic mode decomposition, the Koopman operator, kernel methods, system identification, and neural networks. This course will have a strong computational bend with each lecture being supplemented with full user-friendly scripts and notebooks that can reproduce the results presented in lecture.

Prerequisites: You will need to have a basic understanding of differential and difference equations. The ability to program in a language of your choice is necessary for all assessment.

Textbook: This course does not have a textbook. The instructor will provide complete notes that describe all course material in detail.

Assessments: Your grade in this course will be assigned according to the following rubric:

- 20% Assignment 1
- 20% Assignment 2
- 20% Assignment 3
- 25% Final Project
- 10% Final Presentation
- 5% Github Repo

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.

Assignments: The majority of assessment in this course will consist 3 assignments. As opposed to a traditional mathematics course, these assignments will not necessarily have “right answer”. The reason for this is that real-world data is messy and therefore assignments are more about exploring different methods and techniques, while reporting your findings in a long-form typed submission. You will be given approximately 1 month to complete each assignment. **You are strongly encouraged to start your assignments early** as they will be demanding of your time and will take serious care in completing them. Late assignments will **not** be accepted without a legitimate excuse and prior approval. A separate document with detailed instructions about assignment submissions and grading will be posted on the course website.

Final Project and Presentation: Your final project in this class will take a similar structure to that of the assignments. However, while the assignment submissions will be limited to 6 pages, your final project can have a maximum of **10 pages**. Final projects differ by the academic level of the student, as follows:

Undergraduate: If you are an undergraduate student in this course your final project will consist of you pick- ing a section from the notes and reproducing all code from that section in a different programming language than the one provided by the instructor. You are expected to reproduce all results and **you must further apply the method to a new system or data** than that provided in the notes.

Graduate: Graduate students are expected to investigate an aspect of data-driven methods for dynamic systems that was not covered in this course. One should consult the instructor for guidance in picking a method from the literature, while prospective projects could be gathered from the references in the discussion from the end of each chapter in the notes. **Students will be expected to write about their method and apply it to a system or data of their choice.**

As is shown in the grade breakdown above, your final project will consist of 25% of your final grade in this course. Furthermore, at the end of the course each student will present their findings to the rest of the class. Your presentation will consist of 10% of your final grade. Presentations will be 10-15 minutes in length and will be graded based on one's ability to convey the relevant details in a way that their classmates can understand. As public speaking can be uncomfortable for many, **you will not be graded explicitly on your speaking ability**, just the content of the presentation.

GitHub Repo: You will be required to create a GitHub repository and upload all of your reports and code for the assignments and final project to GitHub. This will account for 5% of your final grade. The assignments should NOT be made publicly available on GitHub until AFTER the due date. A date will be set by the instructor by which all assignments and the final project must be uploaded to the GitHub. A GitHub tutorial [can be found at this link](#).

Web Resources: Each lecture and section of the notes contains detailed computational scripts and notebooks that reproduce all results. These scripts can be downloaded from my GitHub repo: [jbramburger/DataDrivenDynSyst](https://github.com/jbramburger/DataDrivenDynSyst).

Accommodations for Students with Disabilities

If you need accommodations for classes, assignments, or exams, please contact me and the Access Center for Students with Disabilities. Website: <https://www.concordia.ca/students/accessibility.html>

Counselling and Psychological Services

Counselling and Psychological Services offers short-term counselling to register Concordia students who are in Quebec. Appointments can be either virtual and in-person. Website: <https://www.concordia.ca/health/mental-health/counselling.html>

Diversity and Inclusion Statement

Concordia University is an intentionally inclusive community that promotes and maintain an equitable and just work and learning environment. We welcome and value individuals and their differences including race, economic status, gender expression and identity, sex, sexual orientation, ethnicity, national origin, first language, religion, age and disability. I invite and respect any concerns about inequitable access or treatment in this course.

I strive to create a learning environment for you that supports a diversity of thoughts, perspectives, and experiences, and honours your identities. To help accomplish this:

- If you have a name and/or set of pronouns that differ from those that appear in your official Concordia records, you are encouraged to let me know.
- If you feel your performance in the course is being impacted by your experiences outside of class, please come talk to me.
- I am still in the process of learning about inclusion, diverse perspectives and identities. If something was said in class (by anyone, including me) that made you feel uncomfortable, please talk to me about it.
- As a participant in course discussion and problem-based sessions, you should strive to honour the diversity of your classmates.

Additional Course Policies

- The best way to engage with this course is to attempt to program each of the topics from class on your own. This is tedious, but it will guarantee that you fully understand the course content.
- All announcements will be posted on Moodle. Be sure your Moodle notifications are turned on, and you check it regularly.
- I am here to facilitate your learning; let me know if you have questions! I can always be reached by e-mail, and can schedule additional office hours should you need them.

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.

Use of Zoom

Note: Zoom is included as an institutionally-approved technology. This means we have been assured of the privacy protections needed to use freely within the classroom.

Zoom might be used in this course to facilitate learning at a distance. It may be used to record some or all of the lectures and/or other activities in this course. If you wish to ensure that your image is not recorded, speak to your instructor as soon as possible.

Also, please note that you may not share recordings of your classes and that the instructor will only share class recordings for the purpose of course delivery and development. Any other sharing may be in violation of the law and applicable University policies, and may be subject to penalties.

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.