MATH 494: Data-Driven Methods for Dynamic Systems (Winter 2023)

Instructor:	Jason Bramburger
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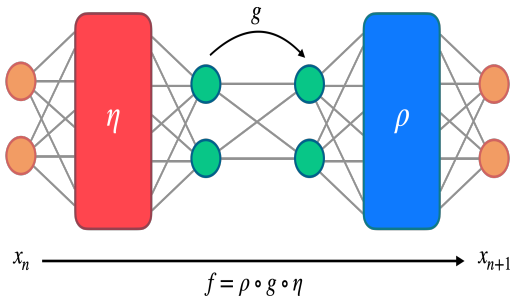
Instructor Office:	LB 901-21
Lectures:	Wednesday/Friday 4:15 - 5:30 pm
Office Hours:	Tuesday 1:00 - 4:00 pm in LB 759-06 Virtual: by appointment only
Course Website:	Moodle
GitHub Code Repo:	jbramburger/DataDrivenDynSyst



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.

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

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

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 picking 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.

Accommodations for Students with Disabilities
If you need accommodations for classes or assignments, 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 registered Concordia students who are in Quebec. Appointments can be either virtual and in-person. Website: https://www.concordia.ca/health/mental-health/counselling.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. Concordias website on academic integrity can be found at the following address, which also includes links to each Faculty and the School of Graduate Studies: concordia.ca/students/academic-integrity." [Undergraduate Calendar, Sec 17.10.2]

Diversity and Inclusion Statement
Concordia University is an intentionally inclusive community that promotes and maintains 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 with 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.