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**PADM-GP 2505**

Advanced Data Analytics and Evidence Building

Spring 2023

## Instructor Information

* Julia Lane
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* Office Hours: Fridays 11:40 – 12:40 pm; Wednesdays (remote) 4-5pm

## Course Time and Location

* Lecture: Fridays  10:00 AM - 11:40 AM
* GCASL, Room 269

## Course Description and Learning Objectives

## The goal of this course is to develop the key data analytics skill sets necessary to inform evidence-based policy. Its design offers hands-on training in how to make sense of and use large scale real world heterogeneous datasets in the context of addressing real world problems. The main learning objectives are to develop a better understanding of how to develop and apply new techniques to analyze social issues using data from a variety of different sources. It is designed for graduate students who are seeking a stronger foundation in data analytics and scoping questions that can be answered with available data. The online textbook provides more information.

## Learning Assessment Table

|  |  |  |
| --- | --- | --- |
| **Program Competencies**  | **Corresponding Course Learning Objective** | **Corresponding Assignment Title** |
| Foundations of Data Science | Developing and scoping a research question Developing a Theory of Change and Evaluation | Group project and team paperProject scoping memo |
| Data Exploration, Management, and Curation | Making use of different types of dataManaging and structuring heterogeneous dataSharing and documenting data decisions Schema – whatever works | Data exploration notebook |
| Measurement  | Combining and linking data from different sourcesCreating longitudinal cohorts from cross sectionsConstructing thoughtful and robust measures | Measurement memoRecord Linkage and Measurement notebookVisualization notebook |
| Analysis and Inference | Text Analysis* Bag of words

Supervised and unsupervised machine learningBasics of Evaluation and different metricsTesting for bias | Text Analysis NotebookMachine Learning memoExtra credit ML |
| Privacy, Confidentiality and Ethics | Principles of confidentialityApplication to federal, state and local dataCurrent approaches and challenges | Final project |

## Housekeeping

* The NYU Brightspace site for this course will contain the lecture slides, additional reading materials, and assignments. In addition, all lectures are recorded and available on NYU Brightspace after each session. Notifications and updates will be sent out through NYU Brightspace on a regular basis.
* You are expected to attend classes in person and use the lab time to work on your class project. We expect you to meet 1-2 hours outside of class for your group projects.
* Taking notes via laptop or phone is not permitted. Laptops and phone may only be used for in class polls.
* Punctuality is **very important**. We realize unforeseen circumstances arise, but please try to be on time. Disruptions affect not only us, but your fellow classmates as well. Please notify Professor Lane in advance if you will be late or unable to attend.
* Active participation is a part of your overall grade. This means asking questions in chat, responding to questions when asked, participating in the class polls, posting in the forum, helping classmates by sharing code snippets and helping them to debug code, sharing information you come across that might be interesting for your classmates.
* We expect you to be prepared for class discussions and to keep up with what we have done in prior classes. The open exchange of ideas will be respected by all students. Respectful and inclusive discussion is required.
* Grades on assignments and class projects are non-negotiable.
* Late assignments are accepted. If you submit an assignment after the posted deadline, it will be counted as late and will be penalized (see evaluation section). You can always turn an assignment in early to avoid penalties. There are no make-up assignments.

## Readings

This is a graduate course, so we assume that you have the self-motivation and discipline to keep up with the readings on your own. The course is mainly based on one textbook. However, the syllabus provides reference to additional readings, and you will be pointed to more readings during lectures. For each of the sessions the required readings are different chapters outlined in the syllabus of the following book:

Big Data and Social Science: A practical guide to models and tools, 2nd edition, Taylor Francis 2020, Ian Foster, Rayid Ghani, Ron Jarmin, Frauke Kreuter and Julia Lane

Democratizing Our Data: A Manifesto. MIT Press. 2020, Julia Lane

## Course Structure

The course will be structured in weekly sessions. The sessions will consist of lectures with some time also devoted for class projects. The calendar below is not set in stone and is subject to change. Readings should be completed prior to class on the day of the assigned reading. Additional resources can be found on NYU Brightspace.

**Session 1: Introduction to class work, structure and research projects**

* + Date: 01/27/2023
	+ Lecture:
		- Organizational details for class/housekeeping
		- Developing a research question
		- Project scoping
		- Basics of Theory of Change and Evaluation
	+ Readings
		- Textbook Chapter 1
		- Lane, J. (2010). Let's make science metrics more scientific. Nature, 464(7288), 488-489.
		- Data science scoping memo <http://www.datasciencepublicpolicy.org/our-work/tools-guides/data-science-project-scoping-guide/>
		- Impact Evaluation in Practice <https://www.worldbank.org/en/programs/sief-trust-fund/publication/impact-evaluation-in-practice>
	+ Application
		- Setting up Jupyter + starter notebook (connect to the class folder and read in the data)
	+ Assignment 1 release: Project scoping memo

**Session 2: Developing an empirical research question**

* + Date: 02/03/2023
	+ Lecture:
		- The Challenge of Evidence-based Policymaking
		- Scoping a question
		- Finding data sources
		- Rescoping
	+ Readings:
		- Textbook Chapter 2 and Chapter 4
		- Lane, Julia. “A Vision for Democratizing Government Data.” Issues in Science and Technology 39, no. 1 (Fall 2022): 84–88. <https://issues.org/democratizing-government-data-lane/>
	+ Assignment 2 release: Data Exploration Notebook – NIH Reporter

**Session 3: Data exploration and management**

* + Date: 02/10/2023
	+ Lecture:
		- Understanding the data generating process
		- Different data collection methods (traditional surveys, APIs and webscraping)
		- Data types and structures
		- Relational databases and schemas
	+ Readings
		- Textbook Chapter 4
		- Databases 101 <https://dssg.github.io/hitchhikers-guide/curriculum/1_getting_and_keeping_data/databases/databases.pdf>
	+ Assignment 1 due

**Session 4 : Record Linkage**

* + Date: 02/17/2023
	+ Lecture: Understanding the Problem
		- The conceptual framework
		- Deterministic approaches
		- Probabilistic approaches
		- Bias and ethics issues
	+ Readings:
		- Textbook Chapter 3
		- Chang, Garner, Owen-Smith, Weinberg A. Linked Data Mosaic or Policy-Relevant Research on Science and Innovation: Value, Transparency, Rigor, and Community <https://coleridgeinitiative.org/wp-content/uploads/2021/10/HDSR_datamosaic_for_submission_15Sept21BW-1.pdf>
	+ Assignment 3 release: Record Linkage and Measurement Notebook

**Session 5: Measurement**

* + Date: 02/24/2023
	+ Lecture:
		- Defining analytical datasets
		- Defining input measures
		- Defining output measures
	+ Readings:
		- Chapters 2 and 3 of Democratizing our Data
		- <https://www.callingbullshit.org/>
			* <https://www.callingbullshit.org/case_studies/case_study_rule_of_21_part_1.html>
			* <https://www.callingbullshit.org/case_studies/case_study_rule_of_21_part_2.html>
	+ Assignment 4 release: Measurement Memo
	+ Assignment 2 due

**Session 6: Visualization**

* + Date: 03/03/2023
	+ Lecture:
		- Basics of visualization
		- Examples of successful visualizations
		- Applications (two notable uses for visualization: data exploration, presentation)
	+ Readings:
		- Chapter 6 of textbook
		- Tufte and the Challenger Disaster <http://williamwolff.org/wp-content/uploads/2013/01/tufte-challenger-1997.pdf>
		- The Healing power of data <https://theconversation.com/the-healing-power-of-data-florence-nightingales-true-legacy-134649>
	+ Assignment 5 release : Visualization Notebook

**Session 7: Data in public policy**

o Date: 03/10/2023

o No class. Review the theory of change in the final report of the National AI Research Resources Task force (https://www.ai.gov/nairrtf/)

o Assignment 6 release: Provide a summary of the theory of change and discuss how the input, activities, outputs and outcomes might be measured if you were only looking at NIH AI investments.

o Assignment 3 due

**03/17/2022 Spring Break: No classes**

**Session 8: Midterm project presentations**

* + Date: 03/24/2023
		- Students present current stage of their project
		- Students provide feedback on projects
	+ Readings: no readings

**Session 9: Text Analysis**

* + Date: 03/31/2023
	+ Lecture:

▪ Conceptual framework

▪ Introduction to text analysis: Information retrieval, clustering and text categorization, text summarization

▪ Learn how to implement topic modeling

▪ Application to scientific fields

▪ Evaluation

* + Readings:
* Chapter 8 of textbook
	+ Assignment 7 release: Text Analysis Notebook
	+ Assignment 4 due

**Session 10: Machine Learning Models I**

* + Date: 04/07/2023
	+ Lecture:
		- Formulate research questions in a machine learning framework: from transformation of raw data to feeding them into a model
		- How to build, evaluate, compare, and select models
		- How to reasonably and accurately interpret models
	+ Readings:
		- Chapter 7 of textbook
		- Hao, J., & Ho, T. K. (2019). Machine Learning Made Easy: A Review of Scikit-learn Package in Python Programming Language. Journal of Educational and Behavioral Statistics, 44(3), 348–361. <https://doi.org/10.3102/1076998619832248>
	+ Assignment 5 due

**Session 11: Machine Learning Models II**

* + Date: 04/14/2023
	+ Lecture:
		- Supervised Machine Learning
		- Assessing model fit
	+ Readings:
		- Chapter 7 of textbook
		- Athey, Susan. "Machine learning and causal inference for policy evaluation." Proceedings of the 21th ACM SIGKDD international conference on knowledge discovery and data mining. 2015.
		- <https://www.nber.org/system/files/chapters/c14009/c14009.pdf>
		- <https://www.brookings.edu/techstream/the-tensions-between-explainable-ai-and-good-public-policy/>
		- Can an algorithm tell when kids are in danger? https://www.nytimes.com/2018/01/02/magazine/can-an-algorithm-tell-when-kids-are-in-danger.html
	+ Assignment 6 due
	+ Assignment 8 release: Machine Learning memo
	+ For review: Machine Learning Notebook – do on own for extra credit

**Session 12: Biases, Fairness, and Inference**

* + Date: 04/21/2023
	+ Lecture:
		- Address biases in machine learning techniques and their consequences for public policy
		- How to deal with inference and the errors associated with big data
		- Problems of Big data and the errors resulting from it
	+ Readings:
		- [Implicit bias test](https://implicit.harvard.edu/implicit/blog.html)
		- Chapter 10 and 11 of textbook
		- Ross, M.B., Glennon, B.M., Murciano-Goroff, R. *et al.* Women are credited less in science than men. *Nature* **608**, 135–145 (2022). <https://doi.org/10.1038/s41586-022-04966-w>
		- [Dealing with Bias and Fairness in Data Science Systems: A Practical Hands-on Tutorial](https://dssg.github.io/fairness_tutorial/)

Assignment 7 due

**Session 13: Privacy, Confidentiality, and Ethics in Research**

* + Date: 04/28/2023
	+ Lecture:
		- Recognize where and understand why ethical and confidentiality issues can arise when applying analytics to policy problems
		- Plan, execute, and evaluate a research project along privacy concerns and ethical obligations
	+ Readings:
		- Chapter 12 of textbook
		- Lane, J., Stodden, V., Bender, S., & Nissenbaum, H. (2014). Privacy, big data and the public good: Frameworks for engagement. Cambridge University Press.
	+ Assignment 8 due

**Session 14: Final Project Presentations**

* + Date: 05/05/2023
		- Students present their final project

## Evaluation

Project work

During the class students will work on their own small class research project during the entire semester. The goal of the research project is for students to develop and apply the techniques taught in the class. Groups are expected to summarize the results of their meetings each week, together with any questions about the project or the class using a [Google Form](https://docs.google.com/forms/d/1-fyZEsGRybHgmjdU2BfwW5KeKa4e21ckNLE4yxBswSU/edit). This helps identify any problems early and help ensure your success!

There will be a midterm presentation and final presentation of the project results. At the end of the semester each team will be required to submit a short research paper documenting their project work.

At the end of the semester, each group member will be asked to rate the contribution of the other group members on a scale of 1 to 10. The group grade will be allocated to each individual based on the rating of the other team members.

Assignments

You are required to complete 5 assignments throughout the class. The assignments constitute 25% of the grade: Please submit your assignments on time. Assignments up to 24 hours late will have their grade reduced by 25%; assignments up to one week late will have their grade reduced by 50%. After one week, late assignments will receive no credit. Please turn in your assignment early if there is any uncertainty about your ability to turn it in on time. You are expected to use Python throughout the entire class.

Class preparation and participation

Active participation in class will constitute 15% of the final grade (examples: participation in class and group discussions, responses in class polls, posting on NYU Classes forum, responding to questions when asked, helping classmates by sharing code snippets and helping them to debug code, sharing information you come across that might be interesting for your classmates).

The breakdown of the evaluation activities:

|  |  |
| --- | --- |
| **Activity** | **Proportion of Grade** |
| **Project work**  | **30%** |
| Midterm presentation | 10% |
| Final presentation | 10% |
| Research memo (10 pages) | 10% |
| **Assignments** | **40%** |
| Assignment 1: Project scoping memo | 5% |
| Assignment 2: Data Exploration Notebook  | 5% |
| Assignment 3: Record Linkage and Measurement Notebook | 5% |
| Assignment 4: Measurement memo | 5% |
| Assignment 5: Visualization Notebook | 5% |
| Assignment 6: Data in Public Policy Meeting memo | 5% |
| Assignment 7: Text Analysis Notebook | 5% |
| Assignment 8: Machine Learning memo | 5% |
| **Class preparation and participation** | **30%** |
| Polling | 15% |
| Active class participation | 15% |

## General guidance

The statistical package used to work on the assignments and project work is Python. All project and individual assignments should be posted on NYU Classes before the deadline. Answers to the assignments should be well thought out and communicated precisely, as if reporting to your boss, client, or potential funding source. Avoid sloppy language, poor diagrams, irrelevant discussion, and irrelevant program output.

If you prepare and participate in the course you should be able to work on the assignments without major problems. But we all experience problems that we can’t figure out right away. If you get stuck on something while preparing for class or working on the assignments, spend some time Googling to try to find the answer. If you seem to be moving forward, keep going. That search and discovery method will pay off, both in terms of the direct learning about how to do what you need to do, and also in terms of your learning how to find such things out. (if you don’t know what Stackoverflow is, you will learn!).

However, in order to limit frustrations with class work we advise you to start your assignments early enough that if you experience problems without finding an answer, you still have enough time to ask about it.

If you are stuck after 30 minutes, just stop and ask your classmates or post on the forum on NYU classes. All class participants have access to this and can help you with your questions. You will most likely encounter the same problems as your peers. The forum is there for you to ask your peers for advice. If you don’t find a solution, escalate it to the instructors.

## Plagiarism

All students must produce original work. Outside sources are to be properly referenced and/or quoted. Lifting copy from websites or other sources and trying to pass it off as your original words constitutes plagiarism. Such cases can lead to academic dismissal from the university.

## Academic Integrity

Academic integrity is a vital component of Wagner and NYU. All students enrolled in this class are required to read and abide by [Wagner’s Academic Code](https://wagner.nyu.edu/portal/students/policies/code). All Wagner students have already read and signed the [Wagner Academic Oath](https://wagner.nyu.edu/portal/students/policies/academic-oath). Plagiarism of any form will not be tolerated and students in this class are expected to report violations to me. If any student in this class is unsure about what is expected of you and how to abide by the academic code, you should consult with me.

## Henry and Lucy Moses Center for Students with Disabilities at NYU

Academic accommodations are available for students with disabilities. Please visit the [Moses Center for Students with Disabilities (CSD) website](https://www.nyu.edu/students/communities-and-groups/students-with-disabilities.html) and click on the Reasonable Accommodations and How to Register tab or call or email CSD at (212-998-4980 or mosescsd@nyu.edu) for information. Students who are requesting academic accommodations are strongly advised to reach out to the Moses Center as early as possible in the semester for assistance.

## NYU’s Calendar Policy on Religious Holidays

[NYU’s Calendar Policy on Religious Holidays](https://www.nyu.edu/about/policies-guidelines-compliance/policies-and-guidelines/university-calendar-policy-on-religious-holidays.html) states that members of any religious group may, without penalty, absent themselves from classes when required in compliance with their religious obligations. Please notify me in advance of religious holidays that might coincide with exams to schedule mutually acceptable alternatives.