DS-UA 205 Machine Learning for Climate Change

Center for Data Science, New York University
Spring 2026
Note: This syllabus is subject to change as announced in class.

Instructor

Prof. Grace Lindsay
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TA

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Graders

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Meeting schedule

Class time: 8 AM to 10:30 AM on Tuesdays
Class Location: 238 Thompson St (GCASL) Room 383
Labs:
DS-UA 205.002 Fridays from 2:00pm-3:15pm
DS-UA 205.003 Fridays from 3:30pm-4:45pm

Office hours

With Surbhi:
Wednesdays, 1 PM to 2 PM. Location TBA. Or by appointment.
With Grace:
By appointment (email me), either in-person or on Zoom.

Course materials

Materials will be posted on Brightspace.
You can join the course slack here:
https://join.slack.com/t/coursediscuss-tcx6125/shared_invite/zt-3m969uph2-xV~wtMpFVMhLIRzJyLOrSA (join the ml4cc channel)

Overview

Climate change is drastically altering the world around us and, if left unchecked, will push natural and man-made systems past their operational points. While this is a grave threat to humanity's prosperity, it is also a great opportunity for innovation. In the coming years, the world will need to change with a speed and scale unseen before and machine learning will play an important role in making this transformation possible. In this course, students will learn the many ways in which machine learning can be applied to both the mitigation of and adaptation to climate change.

Because climate change touches nearly every aspect of daily life, no particular content expertise is required. The course will cover the basics of climate science and climate change before diving into the ways in which machine learning can be useful. The course will include examples that focus on applications for mitigation as well as applications for adaptation. Each week will provide domain area background as well as information on machine learning techniques. These will connect to a specific research paper on the topic.

Students should walk away from this course with an understanding of the complexities involved in tackling climate change and the landscape of applications for machine learning in this domain. Specifically, they will learn about how remote sensing can be used to monitor and interact with the natural and manmade world, how optimization methods can aid in the design of new materials, and how predictive models can help avoid worst-case outcomes. They should also gain the confidence to explore different datasets relevant to climate, energy, agriculture, etc. and brainstorm ways in which machine learning can be applied in new ways to these problems.

Course Structure

This course will introduce you to both modern machine learning techniques as well as their domain-specific application toward climate change problems. Lectures will be organized around published research papers. Unless otherwise noted, in the second half of each class, there will be a lecture that provides the necessary background needed to read the assigned paper. In the first half of the next class, we will have a group discussion on the assigned paper.

Course Schedule

Jan 20 - Intro and Background on Climate Change. Lecture on energy efficiency and regression techniques.
Paper 1 assigned.
Jan 27 - Discuss paper 1. Lecture on extreme weather/disaster response and computer vision/convolutional neural networks.
Paper 2 assigned. HW 1 assigned.
Feb 3 - Discuss paper 2. Lecture on ocean impacts and remote sensing/segmentation.
Paper 3 assigned.
Feb 10 - Discuss paper 3. Lecture on climate science models and unsupervised and generative models.
Paper 4 assigned. HW 1 due. HW 2 assigned.
Feb 17 - Legislative Monday
Feb 24 - Discuss paper 4. Lecture on food/agriculture and time series models.
Paper 5 assigned.
Mar 3 - Discuss paper 5. Career Day, Project Info and Exam Prep.
HW 2 due.
Mar 10 - Exam I. Lecture on transportation and reinforcement learning. Paper 6 assigned.
HW 3 assigned. Project HW assigned.
Mar 17 - Spring Break
Mar 24 - Discuss paper 6. Lecture on human psychology and climate communication.
Paper 7 assigned.
Mar 31 - Discuss paper 7. Lecture on climate finance and recommender systems and

genetic algorithms.Paper 8 assigned. HW 3 due (before class). Project HW due (end of day).
Apr 7 - Discuss paper 8. Lecture on power grid/renewables and graph neural networks. Paper 9 assigned.
Apr 14 - Discuss paper 9. Lecture on carbon dioxide removal and review of graph neural networks, RL, transformers etc.
Paper 10 assigned.
Apr 21 - Discuss paper 10. Project check-ins and exam prep.
Apr 28 - Exam II. Project work time.
May 5 - Project Presentations
Project reports due May 12th.

Papers [SUBJECT TO CHANGE]:

1. Robinson, C., Dilkina, B., Hubbs, J., Zhang, W., Guhathakurta, S., Brown, M. A., & Pendyala, R. M. (2017). Machine learning approaches for estimating commercial building energy consumption. *Applied energy*, *208*, 889-904.
2. Chen, T. Y. (2022). Interpretability in convolutional neural networks for building damage classification in satellite imagery. *arXiv preprint arXiv:2201.10523*.
3. Diaconu, C. A., & Bamber, J. L. (2023). Detailed Glacier Area Change Analysis in the European Alps with Deep Learning. In NeurIPS 2023 Workshop on Tackling Climate Change with Machine Learning (pp. 1-5).
4. Hoffmann, S., & Lessig, C. (2022). AtmoDist: Self-supervised Representation Learning for Atmospheric Dynamics. arXiv preprint arXiv:2202.01897.
   or
   "ClimaX: A foundation model for weather and climate", Nguyen et al., 2023.
5. Yang, Lingbo, et al. "Semantic segmentation based on temporal features: Learning of temporal–spatial information from time-series SAR images for paddy rice mapping." IEEE Transactions on Geoscience and Remote Sensing 60 (2021): 1-16.
6. Suresh, A., Milikic, L., Murray, F., Zhu, Y., & Grossglauser, M. (2023, May). Mining Effective Strategies for Climate Change Communication. In *ICLR 2023 Workshop on Tackling Climate Change with Machine Learning*.
   or
   "ClimateGPT: Towards AI Synthesizing Interdisciplinary Research on Climate Change" Thulke et al, 2024.
7. Asikis, T. (2023). Multi-Objective Optimization for Value-Sensitive and Sustainable Basket Recommendations.
8. Pham, T, Li, X. (2022). Reduced Optimal Power Flow Using Graph Neural Network. arXiv preprint arxiv: 2206.13591
9. Shivashankar, S. (2023). AI assisted Search for Atmospheric CO2 Capture

Course Materials

The application of machine learning to climate change is a relatively new and quickly-evolving field. As such there are no established textbooks for the field as a whole, however there are many online resources, as well as textbooks for the more established sub-components of the field. The course will primarily focus on research papers but also draw from resources such as:

https://www.climatechange.ai - This organization hosts datasets, papers, tools, and message boards regarding working that applies machine learning to climate change problems.

https://regeneration.org/nexus

Introduction to Remote Sensing by Cambell, Wynne, & Thomas

Artificial Intelligence for Humanitarian Assistance and Disaster Response Workshop and Applications of artificial intelligence for disaster management

Machine Learning and Artificial Intelligence to Advance Earth System Science

Machine learning for a sustainable energy future

Green and intelligent: the role of AI in the climate transition

Prerequisites

Students should be comfortable programming in Python and have familiarity with basic data science and visualization toolboxes (scikit-learn, matplotlib). No domain expertise in climate change topics is required.

Evaluation

Your grade will be calculated according to following proportions:

Exams - 30% (15% each exam)
Project - 35%
Homeworks - 15% (5% each assignment)
Participation - 20%

Exams: Two in-class exams will be administered that evaluate understanding of climate change concepts and the papers read in class. Make-up exams will only be offered in the case of medical emergencies; they must be arranged before the start of the exam and must be completed before the next class.
Project: Students will work in groups on an advanced research project of their design. Grades will be the same for all members of the group and will be based on both the project and its presentation.
Homework: Homework assignments will be coding assignments related to the themes of the class. Assignments must be turned in before the start of class on the due date. Students will have 3 "grace days" they can use toward the assignments that will allow them to turn in assignments late. They can be used altogether (allowing a single assignment to be 3 days late) or separately. *Once the grace days are used, late assignments will not be accepted and will be treated as a 0.*
Participation: Students will be required to submit a PMIRO+Q (*this will be explained*) before and after in-class discussions of assigned papers. Participation grades will also be based on attendance, which will be taken by discussion groups. Students are expected to attend each class in-person. If for rare circumstances you need to attend virtually, you must contact

Grace in advance for permission and you must organize a plan for communicating with your discussion group virtually. You can miss one discussion without penalty.
Extra Credit - Students who demonstrate a sincere desire to correct poor performance before the end of the course can request an additional assignment. Requests for extra credit ***cannot*** be made after May 1.

Academic integrity

Academic Integrity, Plagiarism, and Cheating (adapted from the website of the College of Arts & Science): Academic integrity means that the work you submit is original. Obviously, bringing answers into an examination or copying all or part of a paper/code straight from a book, the Internet, or a fellow student is a violation of this principle. But there are other forms of cheating or plagiarizing which are just as serious — for example, presenting an oral report drawn without attribution from other sources (oral or written); writing a sentence or paragraph which, despite being in different words, expresses someone else's idea(s) without a reference to the source of the idea(s); or submitting essentially the same paper in two different courses (unless both instructors have given their permission in advance). Receiving or giving help on a take-home paper, examination, or quiz is also cheating, unless expressly permitted by the instructor (as in collaborative projects). Copying AI-generated text or code and presenting it as your own is another form of academic misconduct unless explicitly allowed in the course. *In this course, AI tools are allowed only for the purposes of tutoring (i.e. assisting students in understanding topics important for the course). They cannot be used to directly generate outputs used to fulfill course assignments.*

Disability Disclosure Statement

Academic accommodations are available for students with disabilities. The Moses Center website is www.nyu.edu/csd. Please contact the Moses Center for Student Accessibility (212-998-4980 or mosescsd@nyu.edu) for further information. Students who are requesting academic accommodations are advised to reach out to the Moses Center as early as possible in the semester for assistance.