DS-UA 301 Advanced Topics in Data Science

Machine Learning for Climate Change

Center for Data Science, New York University
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Instructor

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Grader/TA

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Meeting schedule

Class times: 11 AM to 12:15 PM on Tuesdays and Thursdays
Class Location: 60 5th Ave, Room 110
Lab: 10:15 AM -11:05 PM Fridays
Office hours:
With Max: room 763 at CDS (60 Fifth Avenue) every Wednesday from 10 AM to 11 AM
With Grace: By appointment. Office hours will have both in-person and remote options.

Overview

Climate change is drastically altering the world around us and, left uncheck, 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 first half of the course will focus on applications for mitigation and the second half on applications for adaptation. Each week will have a specific theme and include an overview of the ways in which machine learning can be applied in that specific area, as well as two deep dives into academic papers that describe a machine learning system relevant to the area.

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, how robotics can make difficult work safer and faster, 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 Schedule

1. Overview of Course/Intro to Climate Science
2. Overview of the problem of Climate Change
   First assignment given
3. Energy Efficiency - Optimal building design
4. Energy Efficiency - Managing power supply and demand
5. Monitoring GHGs - Methane detection
6. Monitoring GHGs - Transportation
   Second assignment given
7. Food Production - Sustainable farming
8. Food Production - Reducing food waste
9. Alternative Energy Sources - Designing better solar panels
10. Alternative Energy Sources - Accelerating nuclear fission
    Third assignment given
11. Carbon Dioxide Removal - Accelerating materials science
12. Carbon Dioxide Removal - Optimizing biology
13. Midterm Review/ Project Description
    Project proposal assignment given
14. Midterm
    SPRING BREAK
15. Catalyzing Change - Financing in a net-zero economy
16. Catalyzing Change - Influencing people/policy
17. Project Plan Presentations
18. Career Day
19. Better Predictions - Augmenting earth system models
20. Better Predictions - Predicting extreme weather events
    Fourth assignment given
21. Disaster Response - Surveying wildfires
22. Disaster Response - Search and rescue with robots
23. Food Security - Predicting food shortages
24. Food Security - Automated Farming
25. Climate Migration - Tracking human movements
26. Project work day
27. Project Presentations
28. Project Presentations

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 therefore draw from resources such as:

https://www.climatechange.ai, specifically its landmark white paper outlining the many ways in which machine learning can be applied to climate change: https://dl.acm.org/doi/10.1145/3485128

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

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

Every other week there will be a programming assignment that involves visualization of data relevant to one of the themes and the application of standard scikit-learn tools. For example, students may be asked to use a list of building features to train a supervised regression-based model to predict the energy use of a building.

In addition to the bi-weekly programming assignments (40%), students will be judged based on an in-class midterm (20%), a group project involving the application of a more advanced machine learning technique (30%), and class participation via Brightspace discussion forums (10%).

Students will have 3 “grace days” they can use through the semester 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. Grace days cannot be applied to the final project.

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).

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.