

# Current Topics in Computer Science: Geospatial and Statistical Machine Learning

Fall 2024 at CU Boulder

Last update: August 26, 2024

## CSCI 7000 - Section 007

Tue/Thur 12:30-1:45 pm

Room: [Lucile Berkeley Buchanan Bldg 330](#)

Instructor: Esther Rolf

Office hours: Thursdays 2-3pm, ECES 122 (Engineering Center)

## Course description

Statistical machine learning has been used to extract patterns and fill in gaps in geospatial data in consequential *applications* ranging from monitoring ecological phenomena (e.g., forest cover, land use) to estimating socio-economic conditions (e.g., population density, well-being). Behind the success of these applications of geospatial machine learning (GeoML) are the *methods* that fuse knowledge and recent research in machine learning, geostatistics, and remote sensing, among other fields. In this course, students will learn fundamentals of GeoML and orient novel research within recent advances in geospatial and statistical ML. Topics include: machine learning with satellite data, geospatial deep learning architectures and libraries, spatial statistics and model evaluation, application areas and the “duality” of potential impacts of GeoML technologies.

## Course objectives

This course will prepare students to:

- Understand the established practices and recent research in geospatial ML, with emphasis on geospatial statistics and ML with satellite data.
- Contribute new research ideas in geospatial and statistical ML, and be able to efficiently and iteratively improve on these ideas. This will include:
  - Working with geospatial deep learning libraries to prototype and implement algorithmic ideas.
  - Working with formal statistical characterisations of geospatial data to describe key aspects of geospatial ML (including spatial autocorrelations and spatial domain adaptation).
- Communicate scientific results through research presentations and written reports.
- Deliver critical and constructive feedback on research papers, relevant to the research skills of paper reviewing, peer-editing, and self editing.

## Prerequisites

- Machine learning (e.g. CSCI 5622)

- Experience with python is highly encouraged

## Deliverables\*

- **Research Project.** In teams of 1-3, students will plan and execute a research project in a topic of their choosing relevant to the themes of this course. This will consist of several deliverables:
  - Project proposal, detailing the ideas and goals of the project, so that I can provide feedback on the proposed project and expectations. Due a few weeks into the semester.
  - An intermediate report with preliminary findings, between 2-4 pages. Due mid-semester.
  - A final research report, 4 pages (excluding references), in a “workshop” style template, due at the end of the semester.
- **Peer feedback on mid-semester report.** Students will provide peer-feedback on other teams’ mid-semester reports, and suggest avenues to improve the research in the second half of the semester.
- **Homeworks.** In the first half of the semester, there will be two homeworks – one coding based, and one math based. These homeworks are designed to be relatively “lightweight” assignments to refresh the ML skills that will be helpful for the research projects. That said, start early! These may take a while if students need to brush up on coding/mathematical background along the way.
- **Paper presentations.** Throughout the semester, students will deliver 20-25 minute presentations on recent research in geospatial and statistical ML. Papers will be assigned based on student preference, and each student will be expected to present 2\* times per semester.
- **Readings/ class participation.** All students are expected to contribute to the discussion of the paper lectures. At a minimum, this means reading the required papers for each week, and it is recommended to come to class with at least one question about each paper.

\*Note that the exact parameters of these deliverables are subject to change, depending on class enrollment.

## Grading

Your grade will be determined as followed:

- Project (45%) broken down into: Proposal (5%), Mid-point report (10%), Final report (30%: 15% writeup, 15% presentation)
- Homeworks (20%): 10% each
- In-class paper presentation(s) (25%: 10% each presentation, 5% in class participation)
- Peer feedback on midterm report (10%)

Rubrics and grading breakdowns will be provided for each deliverable.

## Classroom Behavior

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important

with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, marital status, political affiliation, or political philosophy.

For more information, see the [classroom behavior policy](#), the [Student Code of Conduct](#), and the [Office of Institutional Equity and Compliance](#).

## Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or [DSinfo@colorado.edu](mailto:DSinfo@colorado.edu) for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

Missed class policy: Every student is allowed to miss two classes, to account for illness or other events that may come up during the course of the semester. If you have a temporary illness, injury or required medical isolation for which you require adjustments beyond missing two classes, please alert me to the adjustment you need via email. Please do not disclose the nature of your illness.

## Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

## Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the [Honor Code](#). Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. Understanding the course's syllabus is a vital part in adhering to the Honor Code.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: [StudentConduct@colorado.edu](mailto:StudentConduct@colorado.edu). Students found responsible for violating the [Honor Code](#) will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit [Honor Code](#) for more information on the academic integrity policy.

## Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits [protected-class](#) discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner abuse (dating or domestic violence),

stalking, and related retaliation by or against members of our community on- and off-campus. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email [CUreport@colorado.edu](mailto:CUreport@colorado.edu).

Information about university policies, [reporting options](#), and [support resources](#) including confidential services can be found on the [OIEC website](#).

Please know that faculty and graduate instructors must inform OIEC when they are made aware of incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive outreach from OIEC about resolution options and support resources. To learn more about reporting and support for a variety of concerns, visit the [Don't Ignore It page](#).

## Religious Accommodations

Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please communicate the need for a religious accommodation in a timely manner. In this class, please (i) use the two missed class allowances for conflicts during class, (ii) make sure to note any days you will not be able to present in class in the paper sign-up form in the beginning of the semester, and (iii) the alert me via email of conflicts beyond that.

See the [campus policy regarding religious observances](#) for full details.

## Mental Health and Wellness

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact [Counseling and Psychiatric Services \(CAPS\)](#) located in C4C or call (303) 492-2277, 24/7.

Free and unlimited telehealth is also available through [Academic Live Care](#). The [Academic Live Care](#) site also provides information about additional wellness services on campus that are available to students.