Term Information

Effective Term	Autumn 2026

General Information

Course Bulletin Listing/Subject Area	Geography
Fiscal Unit/Academic Org	Geography - D0733
College/Academic Group	Arts and Sciences
Level/Career	Graduate
Course Number/Catalog	6229
Course Title	Artificial Intelligence and Machine Learning for Geospatial Data Science
Transcript Abbreviation	Geospatial AI/ML
Course Description	AI/ML methods and applications using geospatial data through hands-on programming exercises.
Semester Credit Hours/Units	Fixed: 3

Offering Information

Length Of Course	14 Week, 12 Week
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	Yes
Is any section of the course offered	100% at a distance
Grading Basis	Letter Grade
Repeatable	No
Course Components	Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites	Prerequisite: GEOG 5222 or instructor permission.
Exclusions	none
Electronically Enforced	Yes

Cross-Listings

Cross-Listings	none

Subject/CIP Code

Subject/CIP Code	30.4401
Subsidy Level	Doctoral Course
Intended Rank	Masters, Doctoral

Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Understand the history of AI/ML in geography and related fields.
- Understand how AI/ML models work for geospatial data.
- Identify appropriate deep learning and machine learning methods for different data and applications.
- Design and train deep learning neural network models.
- Explain the results from AI/ML models in the context of computational and geospatial applications.

Content Topic List

- Classification
- Artificial neural networks
- Deep feedforward networks
- Convolutional neural networks and computer vision
- Evolutionary algorithms
- Ensemble learning and random forests
- Support vector machines
- Decision trees
- Unsupervised learning techniques

Sought Concurrence

Yes

Attachments

- GEOG6229-concurrency-1.pdf: Concurrence_Sociology

  (Concurrence. Owner: Branham,Joslyn Cassandra)
- GEOG6229-concurrency-2.pdf: Concurrence_Speech_Hearing

  (Concurrence. Owner: Branham,Joslyn Cassandra)
- GEOG 6229 reviewed.pdf: DL_Cover_Letter_Approved

  (Cover Letter. Owner: Branham,Joslyn Cassandra)
- GEOG6229-online_11.3.25.pdf: Syllabus_11.3.25

  (Syllabus. Owner: Branham,Joslyn Cassandra)
- cse-concurrence.pdf: CSE_Concurrence_11.24.25

  (List of Depts Concurrence Requested From. Owner: Branham,Joslyn Cassandra)
- stats-concurrence.pdf: Statistics_Concurrence_11.24.25

  (List of Depts Concurrence Requested From. Owner: Branham,Joslyn Cassandra)
- GEOG6229-onlin-v2.pdf: Updated_Syllabus_11.24.25

  (Syllabus. Owner: Branham,Joslyn Cassandra)

Comments

- Please request concurrences from Stats & CSE. *(by Vankeerbergen,Bernadette Chantal on 11/03/2025 11:03 AM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Branham,Joslyn Cassandra	11/03/2025 09:19 AM	Submitted for Approval
Approved	Coleman,Mathew Charles	11/03/2025 09:19 AM	Unit Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	11/03/2025 11:03 AM	College Approval
Submitted	Branham,Joslyn Cassandra	11/24/2025 08:39 AM	Submitted for Approval
Approved	Coleman,Mathew Charles	11/24/2025 09:40 AM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	11/24/2025 09:30 PM	College Approval
Pending Approval	Jenkins,Mary Ellen Bigler Neff,Jennifer Vankeerbergen,Bernadette Chantal Steele,Rachel Lea	11/24/2025 09:30 PM	ASCCAO Approval

Syllabus: GEOG 6229

Artificial Intelligence and Machine Learning for Geospatial Data Science

Term: Autumn 2026

Credit Hours: 3

Asynchronous Online

Course overview

Instructor

- Name: Ningchuan Xiao
- Email Address: xiao.37@osu.edu
- Phone Number: 614-292-2514

- Course Zoom Link: TBD
- Office Hours: TBD
  - Zoom Link: TBD

Course description

The application of artificial intelligence (AI) and machine learning (ML) on geospatial data has seen a rapid growth in the past few years. The purpose of this course is to help students understand the history of AI/ML in geospatial data science and provide them with experiences and skills to build their own applications. Students will learn various AI/ML methods and applications using geospatial data through hands-on programming exercises using Jupyter notebooks. A wide range of geospatial applications in geographic information systems, cartography, urban studies, transportation, environmental science, spatial decision making, and geographic knowledge discovery will be explored. The final project will help students consolidate what they learn from this class and showcase in a specific geospatial application.

Course expected learning outcomes

By the end of this course, successful students should be able to:

1. Understand the history of AI/ML in geography and related fields.
2. Understand how AI/ML models work for geospatial data.
3. Identify appropriate deep learning and machine learning methods for different data and applications.
4. Design and train deep learning neural network models.
5. Explain the results from AI/ML models in the context of computational and geospatial applications.

Prerequisites

GEOG 5222 or consent of instructor.

How this online course works

Mode of delivery

This course is 100% online. There are no required sessions when you must be logged in to Carmen at a scheduled time.

Pace of online activities

All course materials will be available on Carmen. The course is organized in modules and each module is typically a week long. During each week, students will be working on the following types of materials (assessment items are underlined):

Videos and quizzes. There may be two types of videos posted each week.

- The first is a **lecture video** of approximately one hour that goes through the topics of the week. Each week will have a lecture video. Students are required to watch the lecture video each week. At the end of the video, there will be some questions used for that week's quiz. Slides used in the lecture video will also be available on Carmen for note taking.

- The second type of video refers to the short videos (about 15 minutes) that are embedded in the tutorials (notebooks).

Each video will have close captioning and chapters. Students will be able to stop at anytime in the video and come back to the same spot next time when they resume the video.

Readings. Students should expect to spend at least one hour on the reading materials each week. Reading materials will also be reflected in the lecture video, quizzes and/or exercises.

Jupyter notebooks and exercises. Each week there will be at least one working Jupyter notebook that contains tutorials and coding exercises to help students understand the theory, methods, and application covered in that module. A number of blank cells in the notebook(s) will be marked as TODO, which are the questions for students to finish for that week's exercises.

Other activities. There will be weeks when student work on their final projects (e.g., proposal, presentation, and report), and peer review of other peoples' videos. For some weeks (see schedule for the detailed time) students will also make a short explanation video for their work and code.

Credit hours and work expectations

This is a **3-credit-hour course**. According to Ohio State policy (go.osu.edu/credithours), students should expect around 9 hours of engagement with the class each week to receive a grade of (C) average. Actual hours spent will vary by student learning habits and the assignments each week.

Participation requirements

Because this is an online course, your attendance is based on your online activity and participation. The following is a summary of students' expected participation:

Participating in online peer-review

You will be required to peer review some explanation videos or final presentation videos.

Office hours and live sessions

All live, scheduled events for the course, including my office hours, are optional.

Office hours are listed on the Carmen page. These are optional and I will be able to meet with you outside these hours if necessary. Please give at least 24 hours notification and it will only be available during school days.

Course communication guidelines

Students are expected to follow the guidelines listed below when they communicate with the instructor or other students in the class through email or discussion board.

Writing style

While there is no need to participate in class discussions as if you were writing a research paper, you should remember to write using good grammar, spelling, and punctuation. Informality (including an occasional emoticon) is fine for non-academic topics.

Tone and civility

Let's maintain a supportive learning community where everyone feels safe and where people can disagree amicably. Remember that sarcasm doesn't always come across online.

Citing your sources

When we have academic discussions, please cite your sources to back up what you say. (For the textbook or other course materials, list at least the title and page numbers. For online sources, include a link.)

Protecting and saving your work

Consider composing your academic posts in a word processor or text editor, where you can save your work, and then copying into the Carmen discussion.

Course materials and technologies

Textbooks

Required

1. Géron, Aurélien, 2019. *Hands-On Machine Learning with Scikit-Learn, Keras and Tensorflow: Concepts, Tools, and Techniques to Build Intelligent Systems*. Oreilly.
2. Zhang, Aston, Zachary C. Lipton, Mu Li and Alexander J. Smola. 2021. *Dive into Deep Learning*. Cambridge University Press. ArXiv:2106.11342 (preprint), https://d2l.ai/ (free online)
3. Additional materials will be distributed on Carmen. A complete list of the readings is included at the end of the course schedule.

Course technology

Technology support

For help with your password, university email, Carmen, or any other technology issues, questions, or requests, contact the Ohio State IT Service Desk. Standard support hours are available at it.osu.edu/help, and support for urgent issues is available 24/7.

- Self-Service and Chat support: it.osu.edu/help
- Phone: 614-688-4357(HELP)
- Email: 8help@osu.edu
- TDD: 614-688-8743

Technology skills needed for this course

- Basic computer and web-browsing skills
- Navigating Carmen (go.osu.edu/canvasstudent)
- CarmenZoom virtual meetings (go.osu.edu/zoom-meetings)

Required Equipment

- Computer: current Mac (MacOs) or PC (Windows 10) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed and tested
- Microphone: built-in laptop or tablet mic or external microphone
- Other: a mobile device (smartphone or tablet) to use for BuckeyePass authentication

Required software

- OpenOffice is a free and complete suite of software tools for world processing, spreadsheet, and presentations. View their privacy statement at https://www.openoffice.org/privacy.html.
- Microsoft Office 365: All Ohio State students are now eligible for free Microsoft Office 365. Full instructions for downloading and installation can be found at go.osu.edu/office365help.
- Python: This is essential for this class. Students will install Python 3 and necessary libraries (including PyTorch, TensorFlow, SciKit-Learn, keras, pandas, geopandas) on their own computers for some of the assignments and projects. We will use Python in Jupyter Notebooks online using the service provided by Google Colab (see below). The privacy policy for Python can be found at https://www.python.org/privacy/.
- Jupyter Notebook and Google Colaboratory (a.k.a. Colab): we will use the free version of Google Colab for this class. This will help us focus on the use of the models instead of concerning about the hardware (GPU, CPU, etc.) settings. All the libraries mentioned above are also supported in Colab. The terms of service of Google Colab can be found at https://colab.research.google.com/pro/terms/v1 and the privacy policy can be found at https://policies.google.com/privacy?hl=en. The accessibility statement of Jupyter Notebook can be found at https://jupyterlab.readthedocs.io/en/latest/getting_started/accessibility.html.

Carmen Access

You will need to use BuckeyePass (buckeyepass.osu.edu) multi-factor authentication to access your courses in Carmen. To ensure that you are able to connect to Carmen at all times, it is recommended that you take the following steps:

- Register multiple devices in case something happens to your primary device. Visit the BuckeyePass website for more information: https://buckeyepass.osu.edu/
- Request passcodes to keep as a backup authentication option. When you see the Duo login screen on your computer, click **Enter a Passcode** and then click the **Text me new codes** button that appears. This will text you ten passcodes good for 365 days that can each be used once.

- Download the Duo Mobile application to all of your registered devices for the ability to generate one-time codes in the event that you lose cell, data, or Wi-Fi service

If none of these options will meet the needs of your situation, you can contact the IT Service Desk at 614-688-4357(HELP) and IT support staff will work out a solution with you.

Grading and instructor response

How your grade is calculated

Assignment Category	Percentage
Weekly exercises	30
Quizzes	15
Explanation videos	15
Final projects	30
Participation	10
Total	**100**

Description of major course assignments

All assignments are open on Monday and due by the end of Sunday.

Weekly exercises

- **Description**

Each week, students will turn in a completed Jupyter notebook or notebooks (when multiple are used). These notebooks contain

tutorials and places (code or text cells) that are marked as TODO. Students will fill in the TODO cells with their code to complete the work and/or text to answer certain questions.

- **Academic integrity and collaboration guidelines**

Student must do their own work. The use of generative AI is welcome, but students must be able to legibly explain their code and work using their own words in explanation videos.

Explanation videos

- **Description**

Students will make a short video (about 5 minutes) to explain selected topics from their code and work for a module, for about 8 weeks when we have intensive coding exercises. The specific weeks are indicated in the course schedule. Feedback will be given by the instructor as well as by other students as these videos will be peer reviewed.

- **Academic integrity and collaboration guidelines**

Students must make the videos by themselves using their own words, slides, and other materials.

Quizzes

- **Description**

Each lecture video will be associated with a quiz that covers the concepts, theories, methods, and coding topics discussed in the lecture (and in the reading materials). These quizzes will be graded automatically. Students have a week to complete each quiz and can start anytime during the week. Students must submit the quiz when they are done to make sure the quiz is graded properly. While these quizzes are automatically graded, I will regularly check the status and communicate with individual students or the entire class when I spot any issues.

- **Academic integrity and collaboration guidelines**

Students shall not consult with any other people when taking the quiz.

Final projects

- ### Description

Each student will conduct a final project for this class. This is a semester long process where students propose the project ideas in week 6, identify data and methods in week 8, report preliminary results in week 13, and present a final presentation and write-up in week 15.

- ### Academic integrity and collaboration guidelines

Students must design and implement the final project by themselves. It is OK to consult with the instructor and other people, but the work must be done by the students. The use of AI is welcome but students must be able to fully explain the work and results.

Reusing past work: In general, you are prohibited in university courses from turning in work from a past class to your current class, even if you modify it. If you want to build on past research or revisit a topic you've explored in previous courses, you must first discuss the situation with me ahead of time.

Falsifying research or results: All research you will conduct in this course is intended to be a learning experience; you should never feel tempted to make your results or your library research look more successful than it was.

Deliverables: After completion of the final project, students will (1) make a video and (2) write a report to describe the problem, data, methods, and findings of the project. There will be a scaffolding process to write the report as there will be multiple milestones for students to identify the problem, data and methods, and present the preliminary results throughout the semester. See the course schedule for details.

Participation

- ### Description

Throughout the semester, students will be required to peer review explanation videos, as well as the final project presentations.

There will also be a discussion board for students to ask questions and share their experiences. Each student must participate at least once each week in the discussion, by either responding other people's questions or asking questions or start a discussion topic.

Late assignments

Late submissions may be accepted up to a week past the due date. Each day after the due date will incur a 10% penalty. The total penalty will be up to 50%. Five to seven days late will only receive 50% credit of the grade you would have received if it was submitted on time. If you contact me ahead of time for deadline adjustments you will not incur any penalty. Please note this may not apply to every assignment. The final project, for example, has a firm deadline that cannot be changed. Please refer to Carmen for due dates.

Grading Scale

The following grading scale will be used to decide the final grade of this class.

- 93-100: A
- 90-92: A−
- 87-89: B+
- 83-86: B
- 80-82: B−
- 77-79: C+
- 73-76: C
- 70-72: C−
- 67-69: D+
- 60-66: D
- Under 60: E

Instructor feedback and response time

The following list outlines my intended availability throughout the course. (Remember that you can call 614-688-HELP at any time if you have a technical problem.)

Grading and feedback

For the exercises, students should be able to see the grade and feedback in a week after the due dates. For large tasks such as a homework assignment, the time frame to expect feedback is generally up to 2 weeks.

Preferred contact method

Please contact me using my OSU email address. E-mails will be replied within 48 hours, and we aim for 24 hours during school days.

Academic policies

Academic Misconduct

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the University's Code of Student Conduct, and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the University's Code of Student Conduct and this syllabus may constitute Academic Misconduct.

The Ohio State University's Code of Student Conduct (Section 3335-23-04) defines academic misconduct as: Any activity that tends to compromise the academic integrity of the University or subvert the educational process. Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the University's Code of Student Conduct is never considered an excuse for academic misconduct, so please review the Code of Student Conduct and, specifically, the sections dealing with academic misconduct.

If an instructor suspects that a student has committed academic misconduct in this course, the instructor is obligated by University Rules to report those suspicions to the Committee on Academic Misconduct. If COAM determines that a student violated the University's Code of Student Conduct (i.e., committed academic misconduct), the sanctions for the

misconduct could include a failing grade in the course and suspension or dismissal from the University.

If students have questions about the above policy or what constitutes academic misconduct in this course, they should contact the instructor.

Religious Accommodations

Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not question the sincerity of a student's religious or spiritual belief system in reviewing such requests and shall keep requests for accommodations confidential.

With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concerns arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days after a course begins, instructors are strongly encouraged to work with the student to provide a reasonable accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.

If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the Civil Rights Compliance Office.

Policy: Religious Holidays, Holy Days and Observances

Disability Statement (with Accommodations for Illness)

The university strives to maintain a healthy and accessible environment to support student learning in and out of the classroom. If students anticipate or experience academic barriers based on a disability (including mental health and medical conditions, whether chronic or temporary), they should let their instructor know immediately so that they can privately discuss options. Students do not need to disclose specific information about a disability to faculty. To establish reasonable accommodations, students may be asked to register with Student Life Disability Services (see below for campus-specific contact information). After registration, students should make arrangements with their instructors as soon as possible to discuss your accommodations so that accommodations may be implemented in a timely fashion.

If students are ill and need to miss class, including if they are staying home and away from others while experiencing symptoms of viral infection or fever, they should let their instructor know immediately. In cases where illness interacts with an underlying medical condition, please consult with Student Life Disability Services to request reasonable accommodations.

Intellectual Diversity

Ohio State is committed to fostering a culture of open inquiry and intellectual diversity within the classroom. This course will cover a range of information and may include discussions or debates about controversial issues, beliefs, or policies. Any such discussions and debates are intended to support understanding of the approved curriculum and relevant course objectives rather than promote any specific point of view. Students will be assessed on principles applicable to the field of study and the content covered in the course. Preparing students for citizenship includes helping

them develop critical thinking skills that will allow them to reach their own conclusions regarding complex or controversial matters.

Course Schedule

This is a tentative schedule and the content may change. Underlined parts highlight geospatial contents. Note this schedule is for 14 weeks of instructions and 1 finals week. It does not include the spring break or Thanksgiving week in Spring or Autumn, respectively. Refer to our Carmen course page for the up-to-date schedule and content. There will be a quiz associated with each week's lecture video. A module starts on Monday and ends by the end of Sunday.

Week	Topics/Readings/Assignments
1	**Introduction and overview** • Topics: Basic concepts of AI and machine learning, and their history in spatial data analysis and modeling • Coding and exercises: Python and Jupyter notebooks refresher • Readings (70 pages): Zhang et al. 2021, ch 1; Openshaw and Openshaw 1997, ch 1, 2
2	**Geospatial data** • Topics: data processing (indexing, slicing, mapping), linear algebra, calculus, automatic differentiation, probabilities • Coding and exercises: getting started with pandas, geopandas • Readings (50 pages): Zhang et al. 2021, ch 2
3	**Classification** • Topics: binary classifier, accuracy and cross validation, confusion matrix, precision, recall • Coding and exercises: getting started with tensorflow, scikit-learn, keras, PyTorch • Explanation video (#1) to discuss your code and work • Reading (26 pages): Géron 2019, ch 3

Week	Topics/Readings/Assignments
4	**Introduction to artificial neural networks** • Topics: perceptrons, activation functions, ReLU (Rectified Linear Unit), loss function, image classification, softmax regression, spatial interaction modeling using ANN • Coding and exercises: object-oriented design and implementation from scratch and using Kera or PyTorch • Readings (35 pages): Zhang et al. 2021, ch 3 (optional), 4 (optional); Openshaw and Openshaw 1997 ch 6
5	**Deep feedforward networks** • Topics: multilayer perceptrons, forward and backward propagation, overfitting, regularization, dropout • Coding and exercises: implementation from scratch and using PyTorch • Explanation video (#2) to discuss your code and work • Readings (40 pages): Zhang et al. 2021, ch 5
6	**Builder's guide** • Topics: Layers, parameters and hyperparameters, custom layers, GPU, AI for geospatial data review • Coding and exercises: experiments using PyTorch • Readings (46 pages): Zhang etal. ch 6; Mai et al. 2023; Li and Zhang 2023 • Final project: Proposal with main topics, milestones, and deliverables due this week
7	**Convolutional neural networks and computer vision** • Topics: convolutional operations, padding, stride, pooling, backbone networks (VGG, etc.), map identification • Coding and exercises: implementation using PyTorch • Explanation video (#3) to discuss your code and work • Readings (60 pages): Zhang et al. 2021, ch 7, 8.2, 8.8; Li & Xiao 2023

Week	Topics/Readings/Assignments
8	**Computer vision** • Topics: Image augmentation, object detection and bounding boxes, region-based CNNs, LiDAR data • Coding and exercises: implementation using PyTorch • Explanation video (#4) to discuss your code and work • Readings (41 pages): Zhang et al. 2021, ch 14.1, 14.2, 14.8, 14.11; Hoeser and Kuenzer 2020 (pp. 1-3); Hoeser et al. 2020 (pp. 1-8) • Final project: report for data collection/preparation and method description
9	**Evolutionary algorithms** • Topics: data representation, crossover, mutation, genetic algorithms, spatial optimization • Coding and exercises: implementation using Python • Explanation video (#5) to discuss your code and work • Readings (50 pages): Openshaw and Opewnshaw 1997, ch 3; Xiao et al. 2008; Xiao and Armstrong 2020 (optional)
10	**Ensemble learning and random forests** • Topics: voting classifiers, bagging and pasting, random patches, random subspaces, boosting, stacking, applications in transportation • Coding and exercises: implementation using SciKit-Learn • Explanation video (#6) to discuss your code and work • Reading (40 pages): Géron 2019, ch 7; Kar et al. 2024 • Final project: preliminary results due this week

Week	Topics/Readings/Assignments
11	**Support vector machines (SVMs)** • Topics: linear and nonlinear SVM classification, decision function and predictions, quadratic programming, feature detection on historical maps • Coding and exercises: implementation using SciKit-Learn • Explanation video (#7) to discuss your code and work • Reading (40 pages): Géron 2019, ch 5; Lin et al. 2023
12	**Decision trees** • Topics: Classification and Regression Tree (CART) algorithm, C4.5, Gini impurity, entropy, **geographical classification** • Coding and exercises: implementation using SciKit-Learn • Explanation video (#8) to discuss your code and work • Final project: preliminary results • Reading (26 pages): Géron 2019, ch 6; Jiang et al. 2012; Im and Jensen 2005
13	**Unsupervised learning techniques** • Topics: k-means, Gaussian mixtures, spatial clustering • Coding and exercises: implementation using SciKit-Learn • Reading (44 pages): Géron 2019, ch 9; Xiao 2016, ch 9.3
14	**Project** • Topics: this week is designated to final projects

Week	Topics/Readings/Assignments
15	**Presentations and final report** • Students will prepare a video of 10 to 15 minutes and present it to the class. The presentations will be peer-reviewed using a rubric that evaluates the format and content of the video. • Students will also submit a report that details the motivation, methods, data, results, and findings of the project.

List of readings

Géron, Aurélien, 2019. *Hands-On Machine Learning with Scikit-Learn, Keras and Tensorflow: Concepts, Tools, and Techniques to Build Intelligent Systems*. OReilly.

Hoeser, T. and Kuenzer, C., 2020. Object detection and image segmentation with deep learning on earth observation data: A review-part I: Evolution and recent trends. *Remote Sensing*, 12(10), p.1667.

Hoeser, T., Bachofer, F. and Kuenzer, C., 2020. Object detection and image segmentation with deep learning on Earth observation data: A review—Part II: Applications. *Remote Sensing*, 12(18), p.3053.

Im, J. and Jensen, J.R., 2005. A change detection model based on neighborhood correlation image analysis and decision tree classification. *Remote Sensing of Environment*, 99(3), pp.326-340.

Jiang, Z., Shekhar, S., Mohan, P., Knight, J. and Corcoran, J., 2012, November. Learning spatial decision tree for geographical classification: a summary of results. In *Proceedings of the 20th International Conference on Advances in Geographic Information Systems* (pp. 390-393).

Kar, A., Xiao, N., Miller, H.J. and Le, H.T., 2024. Inclusive accessibility: Analyzing socio-economic disparities in perceived accessibility. *Computers, Environment and Urban Systems*, 114, p.102202.

Li, J. & Xiao, N. 2023. Computational Cartographic Recognition: Identifying Maps, Geographic Regions, and Projections from Images Using Machine Learning, *Annals of the American Association of Geographers*, 113(5): 1243-1267.

Li, D. and Zhang, Z., 2023. MetaQA: Enhancing human-centered data search using Generative Pre-trained Transformer (GPT) language model and artificial intelligence. *Plos One*, 18(11), p.e0293034.

Lin Y, Li J, Porr A, Logan G, Xiao N, Miller, HJ. 2023. Creating building-level, three-dimensional digital models of historic urban neighborhoods from Sanborn Fire Insurance maps using machine learning. *PLoS ONE* 18(6): e0286340

Mai, G., Huang, W., Sun, J., Song, S., Mishra, D., Liu, N., ... & Lao, N. (2023). On the opportunities and challenges of foundation models for geospatial artificial intelligence. *arXiv preprint* arXiv:2304.06798.

Ning, H., Li, Z., Akinboyewa, T. and Lessani, M.N., 2025. An autonomous GIS agent framework for geospatial data retrieval. *International Journal of Digital Earth*, 18(1), p.2458688.

Openshaw, S. and C. Openshaw. 1997. *Artificial Intelligence in Geography*. Wiley.

Xiao, N. 2008. A unified conceptual framework for geographical optimization using evolutionary algorithms. *Annals of the Association of American Geographers*, 98(4), pp.795-817.

Xiao, N. 2016. *GIS Algorithms*. London: Sage Publications.

Xiao, N. and Armstrong, M. P. (2020). Genetic Algorithms and Evolutionary Computing. *The Geographic Information Science & Technology Body of Knowledge* (1st Quarter 2020 Edition), John P. Wilson (ed.). DOI:10.22224/gistbok/2020.1.1. https://gistbok-topics.ucgis.org/AM-07-078

Zhang, Aston, Zachary C. Lipton, Mu Li and Alexander J. Smola. 2021. *Dive into Deep Learning*. Cambridge University Press. ArXiv:2106.11342

Distance Approval Cover Sheet

For Permanent DL/DH Approval | College of Arts and Sciences
(Updated 2-1-24)

Course Number and Title: GEOG 6229
Artificial Intelligence and Machine Learning for Geospatial Data Science

Carmen Use

When building your course, we recommend using the ASC Distance Learning Course Template for CarmenCanvas. For more on use of Carmen: Common Sense Best Practices.

[X] A Carmen site will be created for the course, including a syllabus and gradebook at minimum.

If no, why not?

Syllabus

[X] Proposed syllabus uses the ASC distance learning syllabus template, includes boilerplate language where required, as well as a clear description of the technical and academic support services offered, and how learners can obtain them.

[X] Syllabus is consistent and is easy to understand from the student perspective.

[X] Syllabus includes a schedule with dates and/or a description of what constitutes the beginning and end of a week or module.

[ ] If there are required synchronous sessions, the syllabus clearly states when they will happen and how to access them.

Additional comments (optional).

There will be no required synchronous sessions.

Instructor Presence

For more on instructor presence: About Online Instructor Presence.
For more on Regular and Substantive Interaction: Regular Substantive Interaction (RSI) Guidance

Students should have opportunities for regular and substantive academic interactions with the course instructor. Some ways to achieve this objective:

[X] Instructor monitors and engages with student learning experiences on a regular and substantive cadence.

Explain your plan for understanding student experiences of the course and how the instructor will be responsive to those experiences (required).

Every assignment will be graded and feedback will be shared with students on a weekly basis. This includes the quizzes that are automatically graded. The final project includes three stages before the final presentation and report, including proposal, identification of data and methods, and report of preliminary results. Students will receive detailed comments from me about these products. I will also create Jupyter notebooks each week for students to work on the coding and conceptual topics of the week. These are posted online and students will download to complete the work.

[X] Regular instructor communications with the class via announcements or weekly check-ins.

[X] Instructional content, such as video, audio, or interactive lessons, that is visibly created or mediated by the instructor.

[X] Regular participation in class discussion, such as in Carmen discussions or synchronous sessions.

[X] Regular opportunities for students to receive personal instructor feedback on assignments.

Please comment on this dimension of the proposed course (or select/explain methods above).

While not specifically stated in the syllabus, I will send out weekly check-ins to students before the week starts. I will also create and post lecture videos and (optionally) short embedded videos in the tutorials each week. There is also a discussion board each week and each student is required to participate.

For each week, I will record an hour-long lecture video, prepare the detailed Jupyter notebook that serves as the tutorial of the topic and exercises. Students will receive feedback on every assignment (see above).

Delivery Well-Suited to DL/DH Environment

Technology questions adapted from the Quality Matters rubric. For information about Ohio State learning technologies: Toolsets.

- [X] The tools used in the course support the learning outcomes and competencies.
- [X] Course tools promote learner engagement and active learning.
- [ ] Technologies required in the course have been vetted for accessibility, security, privacy and legality by the appropriate offices and are readily and reasonably obtainable.
- [X] Links are provided to privacy policies for all external tools required in the course.

Additional technology comments:

The use of Jupyter Notebooks in Google Colab is a very common practice throughout AI and machine learning communities, and is approved by OSU's Office of Technology and Digital Innovation.

Which components of this course are planned for synchronous delivery and which for asynchronous delivery? (For DH, address what is planned for in-person meetings as well)

All the components are planned for asynchronous delivery.

If you believe further explanation would be helpful, please comment on how course activities have been adjusted for distance learning:

Workload Estimation

For more information about calculating online instruction time: ODEE Credit Hour Estimation.

[X] Course credit hours align with estimated average weekly time to complete the course successfully.

[X] Course includes regular substantive interaction well-suited to the learning environment at a frequency and engagement level appropriate to the course.

Provide a brief outline of a typical course week, categorizing course activities and estimating the approximate time to complete them or participate (required):

Students start each week with reading (1.5 hour). Then they should watch the lecture video. The video contains quiz questions and students must finish and submit by the end of Sunday. They can continue to watch the video without having to finish the quiz (1.5 hour video and quiz). Students should then work on the code and exercises in the notebooks. They will use Google Colab for this purpose. After the notebook is completed, they will submit it on Carmen (4 hours).

I will post at least one question to start the week's discussion. Students are encouraged to start their own questions. In some weeks, students will make a short video (about 5 minutes) to explain a topic from their work. Students have options to choose which part of the work they want to explain. In the next week, students will be asked to peer review one or two explanation videos made by other students in the previous week. Also in some weeks, students will be asked to work on the proposal (proposal, data/methods, or preliminary

[ ] In the case of course delivery change requests, the course demonstrates comparable rigor in meeting course learning outcomes.

Accessibility

For more information or a further conversation, contact the accessibility coordinator for the College of Arts and Sciences. For tools and training on accessibility: Digital Accessibility Services.

[X] Instructor(s) teaching the course will have taken Digital Accessibility training (starting in 2022) and will ensure all course materials and activities meet requirements for diverse learners, including alternate means of accessing course materials when appropriate.

[X] Information is provided about the accessibility of all technologies required in the course. All third-party tools (tools without campus-wide license agreements) have their accessibility statements included.

Description of any anticipated accommodation requests and how they have been/will be addressed.

Additional comments (optional):

We will use Python in Jupyter Notebooks through the service provided in Google Colab. The link to the accessibility statements of Jupyter Notebooks is provided.

Academic Integrity

For more information: Academic Integrity.

[X] The course syllabus includes online-specific policies about academic integrity, including specific parameters for each major assignment:

[X] Assignments are designed to deter cheating and plagiarism and/or course technologies such as online proctoring or plagiarism check or other strategies are in place to deter cheating.

Additional comments (optional):

Frequent, Varied Assignments/Assessments

For more information: *Designing Assessments for Students*.

Student success in online courses is maximized when there are frequent, varied learning activities. Possible approaches:

[C] Opportunities for students to receive course information through a variety of different sources, including indirect sources, such as textbooks and lectures, and direct sources, such as scholarly resources and field observation.

[X] Variety of assignment formats to provide students with multiple means of demonstrating learning.

[X] Opportunities for students to apply course knowledge and skills to authentic, real-world tasks in assignments.

Comment briefly on the frequency and variety of assignment types and assessment approaches used in this course or select methods above:

Each week students will work on at least three of the following types of assignments:

Weekly exercises (every week)
Quiz (every week)
Discussion board (every week)
Explanation videos (8 weeks)
Final project (3 weeks)
Peer review (8 weeks)

Community Building

For more information: Student Interaction Online.

Students engage more fully in courses when they have an opportunity to interact with their peers and feel they are part of a community of learners. Possible approaches:

- [X] Opportunities for students to interact academically with classmates through regular class discussion or group assignments.
- [X] Opportunities for students to interact socially with classmates, such as through video conference sessions or a course Q&A forum.
- [X] Attention is paid to other ways to minimize transactional distance (psychological and communicative gaps between students and their peers, instructor, course content, and institution).

Please comment on this dimension of the proposed course (required)

Students will interacte with each other in every week through the discussion board. In 8 weeks they will also get to know other students through peer reviews. The discussion is meant to be "social" in the sense that students will following course communication guidelines to help create a supportive environment. This is also lightly graded as a means to encourage students to participate and know each other. Lecture videos will have chapters to help students navigate through the relatively long format. Short videos will also be used to reduct the anxiety of finishing the video.

Transparency and Metacognitive Explanations

For more information: *Supporting Student Learning*.

Students have successful, meaningful experiences when they understand how the components of a course connect together, when they have guidance on how to study, and when they are encouraged to take ownership of their learning. Possible approaches:

- [X] Instructor explanations about the learning goals and overall design or organization of the course.
- [X] Context or rationale to explain the purpose and relevance of major tasks and assignments.

- [X] Guidance or resources for ancillary skills necessary to complete assignments, such as conducting library research or using technology tools.
- [X] Opportunities for students to take ownership or leadership in their learning, such as by choosing topics of interest for an assignment or leading a group discussion or meeting.
- [X] Opportunities for students to reflect on their learning process, including their goals, study strategies, and progress.
- [X] Opportunities for students to provide feedback on the course.

Please comment on this dimension of the proposed course (or select methods above):

Not included in the syllabus: weekly surveys are used to ask students their experiences.

Additional Considerations

Comment on any other aspects of the online delivery not addressed above (optional):

Syllabus and cover sheet reviewed by Bob Mick on 9/26/25

Reviewer Comments:

I have completed my review of Geography 6229 A.I. and M.L. for Geospatial Data Science. The summary of my review and comments are included in the attached document.

Additional resources and examples can be found on ASC's Office of Distance Education website.

Attachment from ODE/Bob Mick

Geography 6229 – A.I. and M.L. for Geospatial Data Science

I am returning the signed Distance Approval Cover Sheet after completing the review of the distance learning syllabus and cover sheet. Below are my comments regarding the syllabus.

1. Instructor Presence and Regular Substantiative Interaction (RSI):
Regular and substantiative interaction will exist on a regular weekly basis in the course between the instructor and students that includes:

- Direct instruction (weekly recorded lecture videos, Jupyter notebooks tutorials)
- Instructor assessing and providing regular feedback on student's course work and assignments and weekly check-ins on course progress
- Facilitating group discussion (required participation in discussion board posts, responding to classmates, peer reviews of Student Explanation Videos)
- Instructor providing opportunities to ask questions on content of course through email, discussion boards, and live office hours

2. How this Online Course Works
This section provides clear direction for the students so they are aware of what they will be expected to complete each week and how they will interact with the instructor in this online course.

3. Credit hours and work expectations
The information in the syllabus and cover sheet states the total amount of time to be spent on this course with direct and indirect instruction is an average of 9 hours minimum per week. This is correct for a 3 cr hr, 14-week course.

4. Description of Major Assignments
All major assignments are clearly explained.

Outlook

Fw: GEOG 6229 concurrences

From Mansfield, Becky <mansfield.32@osu.edu>
Date Tue 2025-10-21 10:57 AM
To Xiao, Ningchuan <xiao.37@osu.edu>

Becky Mansfield, Professor and Director of Graduate Studies
Department of Geography, The Ohio State University
1054 Derby Hall, 154 N Oval Mall, Columbus, OH 43210, USA
mansfield.32@osu.edu

From: Roup, Christina <roup.2@osu.edu>
Sent: Wednesday, October 1, 2025 11:10 AM
To: Vankeerbergen, Bernadette <vankeerbergen.1@osu.edu>
Cc: Mansfield, Becky <mansfield.32@osu.edu>
Subject: RE: GEOG 6229 concurrences

Hello Bernadette,
The Department of Speech and Hearing Science is happy to provide concurrence for the proposed Geography course.

Best,
Christina

Christina M. Roup, Ph.D.
Associate Professor
Graduate Studies Chair, PhD Coordinator
Department of Speech and Hearing Science
104b Pressey Hall, 1070 Carmack Road
Columbus, OH 43210; 614-247-8614 Office
roup.2@osu.edu

From: Vankeerbergen, Bernadette <vankeerbergen.1@osu.edu>
Sent: Tuesday, September 30, 2025 3:08 PM
To: _ASC SBS GRD Directors <ASC-SBS-GRD-Directors@osu.edu>
Cc: Mansfield, Becky <mansfield.32@osu.edu>
Subject: GEOG 6229 concurrences

Dear SBS Directors of Graduate Studies,

Please find attached a proposal for new course Geography 6229 "Artificial Intelligence and Machine Learning for Geospatial Data Science." The Department of Geography is requesting concurrence for the proposed new online course. Please email your responses/concurrences to Becky Mansfield.32 and me.

*Responses are due by **Wednesday, October 15, 2025***. Please note that if we do not hear back from you by that date, concurrence will be assumed.

Please let me know if you have any questions.

Many thanks,
Bernadette

Bernadette Vankeerbergen, Ph.D.
Assistant Dean, Curriculum
College of Arts and Sciences
114F University Hall, 230 North Oval Mall.
Columbus, OH 43210
Phone: 614-688-5679
http://asccas.osu.edu

Outlook

Fw: GEOG 6229 concurrences

From Mansfield, Becky <mansfield.32@osu.edu>
Date Tue 2025-10-21 10:57 AM
To Xiao, Ningchuan <xiao.37@osu.edu>

Becky Mansfield, Professor and Director of Graduate Studies
Department of Geography, The Ohio State University
1054 Derby Hall, 154 N Oval Mall, Columbus, OH 43210, USA
mansfield.32@osu.edu

From: Vuolo, Michael <vuolo.2@osu.edu>
Sent: Tuesday, September 30, 2025 5:25 PM
To: Vankeerbergen, Bernadette <vankeerbergen.1@osu.edu>
Cc: Mansfield, Becky <mansfield.32@osu.edu>
Subject: RE: GEOG 6229 concurrences

Hi Bernadette and Becky: This is my first time as DGS getting an email like this. Can you explain what I'm supposed to be doing? Is this to determine if there's overlap with sociology courses? If so, there is not. Thanks! Mike.

Mike Vuolo, PhD (he/him)
Professor & Director of Graduate Studies, Department of Sociology
The Ohio State University
Web: http://u.osu.edu/vuolo.2

From: Vankeerbergen, Bernadette <vankeerbergen.1@osu.edu>
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Please let me know if you have any questions.

Many thanks,
Bernadette

Bernadette Vankeerbergen, Ph.D.
Assistant Dean, Curriculum
College of Arts and Sciences
114F University Hall, 230 North Oval Mall.
Columbus, OH 43210
Phone: 614-688-5679
http://asccas.osu.edu

Outlook

Re: GEOG 6229 concurrence

From Sivakoff, David <dsivakoff@stat.osu.edu>
Date Wed 2025-11-19 7:19 AM
To Xiao, Ningchuan <xiao.37@osu.edu>
Cc Lee, Yoonkyung <yklee@stat.osu.edu>

Dear Ningchuan,

Thank you for making the suggested changes to the syllabus. We grant our concurrence with the course proposal.

Best regards,
David and Yoon

From: Xiao, Ningchuan <xiao.37@osu.edu>
Sent: Monday, November 17, 2025 5:13:16 PM
To: Sivakoff, David <dsivakoff@stat.osu.edu>
Cc: Lee, Yoonkyung <yklee@stat.osu.edu>
Subject: Re: GEOG 6229 concurrence

Dear David and Yoon,

Thank you so much for the feedback. I understand the original syllabus I sent to you is probably more implicit on geospatial topics. I would like to clarify that students will use geospatial data every week for their exercises. More specifically, I updated the course schedule in the attached revised syllabus, where geospatial topics are underlined. The bold and underlined texts are newly added, either because they should be included from the beginning because the topics are in the reading, or because new readings (underlined and bold) will cover explicitly geospatial topics. For all the readings, other than Zhang et al. 2021, all other readings are about various topics of AI/ML in geospatial data.

Noticeably weeks 3 and 5 do not have any underlined text. This is because they really focus on the methods in AI/ML. But students will use spatial data for their hands-on exercises.

Please let me know if you need more information.

Best,
Ningchuan

From: Sivakoff, David <dsivakoff@stat.osu.edu>
Sent: Monday, November 17, 2025 8:00 AM
To: Xiao, Ningchuan <xiao.37@osu.edu>
Cc: Lee, Yoonkyung <yklee@stat.osu.edu>
Subject: GEOG 6229 concurrence

Dear Ningchuan,

The Department of Statistics Curriculum Committee has reviewed the course proposal for GEOG 6229. We found that the schedule of topics and assignments in the syllabus resemble those of a general course on AI and ML, and we suggest that it should be made clear how the

weekly topics and assignments are related to geospatial data analysis, for example, by listing relevant applications in the field. Conditional on this clarification in the syllabus, we are happy to give concurrence for the proposed course.

Best regards,
David Sivakoff and Yoon Lee

Outlook

Re: GEOG 6229 concurrence

From Williamson, Donald <williamson.413@osu.edu>
Date Fri 2025-11-21 1:54 PM
To Xiao, Ningchuan <xiao.37@osu.edu>
Cc Ramnath, Rajiv <ramnath.6@osu.edu>; Arora, Anish <anish@cse.ohio-state.edu>

Dear Ningchuan,

The CSE curriculum committee has agreed to offer concurrence for this course.

Best,

Donald S. Williamson
Associate Professor
Director, The ASPIRE Group
Affiliated faculty, Translational Data Analytics Institute
Computer Science and Engineering
493 Dreese Labs, 2015 Neil Ave, Columbus, OH 43210
williamson.413@osu.edu

THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

From: Arora, Anish <anish@cse.ohio-state.edu>
Date: Monday, November 3, 2025 at 4:21 PM
To: Williamson, Donald <williamson.413@osu.edu>
Cc: Ramnath, Rajiv <ramnath.6@osu.edu>, Fosler-Lussier, Eric <fosler@cse.ohio-state.edu>, Machiraju, Raghu <machiraju.1@osu.edu>
Subject: Fw: GEOG 6229 concurrence

This time with document.

From: Xiao, Ningchuan <xiao.37@osu.edu>
Sent: Monday, November 3, 2025 3:07:19 PM
To: Arora, Anish <anish@cse.ohio-state.edu>
Subject: Re: GEOG 6229 concurrence

I am sorry. I forgot to attach the proposal (syllabus). Please see the attached!

Thanks,
Ningchuan

From: Xiao, Ningchuan
Sent: Monday, November 3, 2025 3:58 PM
To: Arora, Anish <anish@cse.ohio-state.edu>
Subject: GEOG 6229 concurrence

Dear Prof. Arora,

The Department of Geography would like to propose a new online graduate level course, Geography 6229 "Artificial Intelligence and Machine Learning for Geospatial Data Science." This course is targeted to the graduate students in our department, including those in our regular graduate programs and in the Master of Geographic Information Science and Technology program. We would like to request concurrence for this new course.

Please email your responses/concurrences to me (xiao.37) by Monday, November 24, 2025. Please note that if we do not hear back from you by that date, concurrence will be assumed.

If you need any additional information, please let me know.

Best,
Ningchuan

Ningchuan Xiao
Professor and Director of MGIST
Department of Geography
1036 Derby Hall, 154 N Oval Mall
Columbus, OH 43210
Pronouns: he/him/his
https://geography.osu.edu/mgist