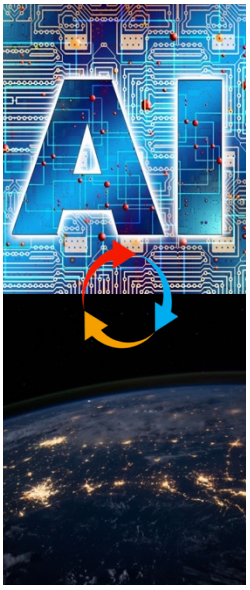
GEOG 4920/6920: Introduction to Geospatial Artificial Intelligence

Course Description

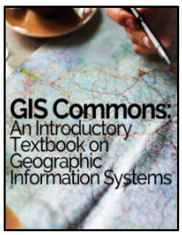


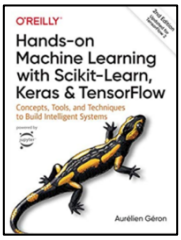
The rapid increase in high-quality data, advanced machine learning algorithms, and the availability of fast hardware have largely contributed to a renewed interest in Artificial Intelligence (AI) from academia, industry, and the general public in recent years. From a geospatial point-of-view, GeoAI, as an interdisciplinary field of Geography/GIScience and AI, advocates the idea of developing and utilizing AI techniques to address a variety of problems related to both the natural environment and our human society. In this course, we will AI and machine learning methods and will focus on their applications on geospatial problems. We will start from the fundamental techniques related to preparing GIS data for machine learning models, and then move to discussing machine learning concepts and how to use machine learning to address spatial problems. This course has an emphasis on both theoretical concepts and hands-on skills, and we will use a high-level programming language (e.g., Python) to implement machine learning models.

Course Information

- **Course number**: GEOG 4920/6920
- **Credits**: 3
- **Lectures:** TR, 15:55-17:10, Geography-Geology Building, Room 321
- **Instructor**: Dr. Gengchen Mai
    - **Email**: gengchen.mai25@uga.edu
    - **Office hours**: Tuesday 14:30-15:30
    - **Office**: Geography-Geology Building, Room 312
- **Teaching Assistant**: Chintan Maniyar
    - **Email**: chintanmaniyar@uga.edu
    - **Office hours**: Thursday 12:00-13:00
    - **Office**: Geography-Geology Building, Room 313

Textbook





- Michael Schmandt (2009): GIS Commons: An Introductory Textbook on Geographic Information Systems **(**free textbook at https://giscommons.org/; **referred as "GIS" in the syllabus**)

- Aurélien Géron (2019): Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems
  (ebook available from UB library; **referred as "ML" in the syllabus**)

Course Website

The website of this course is available on UGA Geography Website.

Prerequisites

This course does not have a formal prerequisite yet. However, before taking this upper level course, you may consider taking the following courses first:

- GIS background: Geog4470/6470, Geog4300/6300 or equivalent
- Basic programming background: CSCI 1301, C1360, Geog4590/6590, or equivalent

Software Environment

- Anaconda (a python-based software suite)
- Jupyter Notebook.

They have been installed on lab computers for you to use. However, students are also expected to download and install them on their personal computers. Both are free packages.

Tentative Course Schedule*

Week	Date	Topics	Reading
Week 1	08/18	- Course introduction	Python 1, 2, 3
Week 2	08/23 08/25	- Python, Jupyter Notebook, and Google Colab - Python fundamentals	Python 5, 6, 7
Week 3	08/30 09/01	- Python fundamentals II - Lab 1: Use geopy to calculate geodesic distances between locations	Python 8, 9, 10
Week 4	09/06 09/08	- Spatial data models & formats - Lab 1: Continue	GIS *Concepts (Ch. 1)*
Week 5	09/13 09/15	- Vector data analysis - Raster data analysis	GIS *Data Model: Vector (Ch. 1)*
Week 6	09/20 09/22	- Lab 2: vector data analysis (**Paper #1 Presentation**) - Lab 2: Continue (**Paper #2 Presentation**)	GIS *Data Model: Raster (Ch. 1)*
Week 7	09/27 09/29	- Machine learning fundamentals - Lab 3: raster data analysis (**Paper #3 Presentation**)	ML Preface, 1
Week 8	10/04 10/06	- Integrating GIS and ML in geospatial projects - Lab 3: Continue (**Paper #4 Presentation**)	ML 4
Week 9	10/11 10/13	- Regression - Project Consultant (**Paper #5 Presentation**) - **Project Proposal Due**	ML 2
Week 10	10/18 10/20	- Lab 4: Making predictions using GIS, regression, and machine learning (**Paper #6 Presentation**) - Lab 4 Continue & Project Consultant (**Paper #7 Presentation**)	ML 6
Week 11	10/25 10/27	- Decision tree and random forest - Geospatial clustering I	ML 7
Week 12	11/01 11/03	**ACM SIGSPATIAL Week** - Lab 5: Integrating GIS and random forest for land use classification on remote sensing imagery - Lab 5 Continue & Project Consultant	ML 9

Week 13	11/08 11/10	- Geospatial clustering II - Lab 6: Geospatial clustering with geotagged photo location data (**Paper #7 Presentation**)	ML 9
Week 14	11/15 11/17	- Neural Network - Lab 6: Continue & Project Consultant (**Paper #8 Presentation**)	
Week 15	11/22 11/24	**Thanksgiving – No classes**	
Week 16	11/29 12/01	- Embedding and Location Representation Learning - Course Summary (**Paper #9 Presentation**)	
Week 17	12/06	- **Final Project Presentation**	

***Course project paper is due on Dec 12, 2022, 12:00 pm (at noon).**

Course Requirements

1. Lab assignments (40%)

There will be 6 lab assignments in total led by TA. Your will learn how to use different machine learning models in different geospatial projects.

2. Student research paper presentation (10%) and participation (5%)

Each student will read one scientific paper on relevant topic and present it in class (**8 min presentation + 2 min Q&A**). You will receive a paper list early in the semester to choose the paper to present and the date of presentation:

- Undergraduate: each student can pick a general GeoAI review paper
- Graduate: each student can pick a GeoAI technical paper

Please submit the **PDF file of your presentation**. To share with the class, please also **post the original article on a designated discussion board**. The due date is your presentation day. For technical papers, your presentation should introduce the research problem, research objective, methodology, and findings/results addressed in the article, as well as your critique if any. The presentation will be graded by the instructor.

3. Course project (45%)

The course project can be about using any GeoAI models on a specific geospatial research problem.

The project needs to be conducted by:

- A team of no more than 3 undergraduate students;
- Or one graduate student.

Submission:

1) Write a project proposal (**1-2 pages, dual in Week 9**). The instructor will provide feedback on the proposed project idea. **(10%)**
2) Finish the proposed project and submit a scientific paper of it (**4-12 pages including references**). Submit the paper in ELC. **(25%)**
3) Make a final presentation of the project. **(10%)**

Both project proposal and final paper should use IJGIS word template or LaTeX template. Please **submit a single PDF for each submission**.

The presentation will be graded by all other students, teaching assistant, and the instructor. The weight for each group is - **all other students (40%), teaching assistant (30%), and the instructor (30%)**. The **maximum and minimum score from students will not be considered**.

Grade weighting scheme

Component	Weight
Lab assignment (6)	40%
Research Paper Presentation (1)	10%
Participation	5%
Course project proposal	10%
Course project paper	25%
Course project presentation	10%

Final Letter Grades: The final letter grade will be determined according to the scale below.

A : [90,100]	**C :** [74, 77)
A-: [88,90)	**C-:** [70, 74)
B+: [86, 88)	**D+:** [67, 70)
B : [83, 86)	**D :** [64, 67)
B-: [80, 83)	**D-:** [60, 64)
C+: [77, 80)	**F:** <60

Due Dates: All Assignments must be completed on time. Submittal of assignments after due dates is accepted but with a penalty as 10% of the percentage grade for each day they are late (note: anytime passing the due time will be counted as late for one day, and anytime passing the first late day will be counted as late for two days, and so forth). Submissions that are late for more than 5 days will not be accepted. Late in-class assignments will not be accepted. In each case, exceptions are possible only with documentation of a medical or family emergency.

Academic Honesty: Cheating and plagiarism will automatically earn zero (0) points for the assignment or exam. All academic work must meet the standards contained in "A Culture of Honesty." Each student is responsible to inform themselves about those standards before performing any academic work.