

# GEOG 384: Principles of the Geospatial Web

Tuesdays and Thursdays, 11:35-12:55, Burnside 511

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## Introduction

Most often when students think of geographic information systems (GIS), it is a mapmaking tool, a complete yet expensive, desktop-bound software package requiring considerable computational power. We now work in a software “stack” of interoperable and “mashed up” web 2.0 applications, some of which are “free” and require no more processing power than being able to run a basic web browser. The learning curve has changed as well. Where once a GIS technician entered, managed and visualized data as part of a specific learning curve, these functions are being replaced by “smarter” algorithms with the skillset having shifted to coding by non-geographers, engineers and computer scientists.

With smarter software comes the advent of generative AI and geofoundation models (colloquially known as GPTs or generative pre-transformers). GPTs promise to write perfect computer code, craft explainable documentation and reason over geographic space (function multi-modally e.g., by integrating coordinates and semantics, automatically processing remotely sensed imagery). GPTs propose to basically cut humans out of the loop, although they are also prone to hallucination and geospatial inaccuracies (e.g., ask MS CoPilot what is the distance from Canada to the US?).

The nature of geographic data has changed as well. Large and streaming datasets, called big data and scraped from sources such as social media and mobile sensors, are commonplace. This includes facial pattern recognition from autonomous vehicles and CCTV cameras. Entire industries have sprung up to harness the power of interpreting patterns revealed by alphanumeric and image data. These industries also have the capability to influence policy and society as they monetize what has been termed the “ambient awareness” of pervasive space-time data collection. The sheer amount of data with spatial attributes, produced in a single day, could not have been created a mere ten years ago. Whereas the underlying technology has rapidly evolved, our understanding of the information we generate has not kept pace. This calls to question issues of accuracy, rights, and privacy. Should we be able to scrape for user generated content and trust in its validity? Or should we use uncritically utilize crowdsourced asserted data (i.e., location-based sentiments and observations from non-experts called volunteered geographic information {VGI})? The data is far more unstructured and is sourced to a myriad of

multimedia (e.g., videos, graphs, and photos). This geospatial data constitutes a departure from traditional authoritative datasets of latitude, longitude, projection and attributes, and introduces varied data structures, potentially disputed sources and one record of information at a time. GPTs are the newest addition, enabling the mass harvesting of content, regardless of intellectual property, and generation of text, audio and imagery from text prompts. Thus, the user is simultaneously the producer of new forms of spatial data, as well as user and commodity.

In this course we will cover the principles of this paradigm, called the Geospatial Web or Geoweb. Like GIS, the Geoweb has broad applicability that extends well beyond the traditional discipline of geography. Numerous examples can be seen in health provision (e.g., fitness tracking, epidemic control), wildlife and natural resources (e.g., with sensors), criminology (e.g., predictive mapping of likely offenders, redlining), warfare and surveillance (e.g., swarming drones, doorbell cameras), psychology (e.g., therapy AI) and transportation (e.g., Uber, Lyft, as well as docked/dockless vehicles). The Geoweb can be used in retail target marketing, political mobilization (e.g., disinformation), tourism development, journalism and the humanities. The Geoweb also is fully linked to social networking platforms and mobile apps. For instance, when was the last time you used a physical map to navigate?

The course combines theory and practice of the Geoweb. Students won't learn specific skills, but 'learn how to learn'. Geoweb software changes constantly so students need to learn about resources and strategies to anticipate innovations in geospatial technologies. The course will cover the following topics:

- Exploring the underlying methods of digital earth architectures, including georeferent systems. These architectures underlie all digital earth platforms (e.g., Google Maps and OpenStreetMap)
- Critically analyzing the concept of VGI, for example, spatial data accuracy and uncertainty of heterogeneous data sources (spatial data quality)
- Understanding the infrastructure of the Geoweb, including the geospatial software stack, Application Program Interfaces (APIs), and the Document Object Model (DOM)
- Comparing and contrasting GIS and the Geoweb
- Repurposing geographic digital content (secondary data), for example via web scraping
- Understanding issues related to real time streaming data (e.g., changes in sampling)
- Working with live-location from mobile devices
- Identifying basic problem-solving requirements for geospatial apps. For proposed solutions, critically evaluating and justifying various existing and emergent geospatial technologies and enabling software stacks
- Writing and interpreting code from GPT prompts.

Finally, and time willing, we will hear from experts and host some workshops outside class time to assist in learning. Experts will come from the geospatial industry or are

practical users (e.g., in cities). Among possible topics are HTML and CSS, the Document Object Model, GIT and Scalable Vector Graphics. Stay tuned for times and locations.

### Course Prerequisites

GEOG 201 and COMP 202/GEOG 333 are required (COMP 202 can taken in parallel). OR permission of the instructor.

### Required Books and Other Reading Material

During the course, students will read a variety of articles, working papers and other material. These will be posted on the course website (neogeoweb.ca). Students must learn Javascript. The reason why is because JavaScript remains the de facto language for web development. Moreover, this course assumes no prior web dev experience and minimal coding experience so learning JavaScript, which most students in the course don't know, levels the playing field.

This will be done via playcode.io and W3Schools. There is no one perfect platform for learning code online. Many sites that were free have now moved to a freemium model, which have placed practice tests and certificates behind paywalls. We're trying playcode successfully in the past. It does require payment but is reasonable compared to similar platforms. If you require additional help in learning material such as geoJson, markup languages, web scraping, or Javascript, you may wish to purchase books (e.g., Eloquent JavaScript: A Modern Introduction to Programming). There are other excellent online resources as well—[freecodecamp](https://www.freecodecamp.org/) or [javascript.info](https://www.javascript.info/). This course assumes you will pick up HTML and CSS; the afore-mentioned sites are excellent resources for those as well.

We encourage students to seek assistance from GPTs like MS CoPilot. Keep in mind that GPTs can offer some preliminary code generation but be aware that you need to evaluate the quality of the code. Additionally, when you seek help for APIs like Mapbox, it will generate the exact same code available on the Mapbox site so sometimes it's best to return to the source.

### Evaluation

Title	Weight	Description	Due Date	Considerations and Late Penalties
Participation	10% (5% in-class and 5% online)	Participation in class discussions, asking relevant questions, constructively engaging other students' responses. Same rubrics apply online.	NA	Grades for in class participation may be adjusted for classes missed for valid reasons.
Quizzes	20% (2* 10%)	Short questions that require coding and debugging.	Announced 1 week prior to day the quiz is held	If 1 quiz missed then other quiz will count for both.

Assignments (5)	40% (each 15%-25% of that 40%)	Group-based app development	One approximately every 2 weeks.	Late assignments receive a 10% penalty per day.
Final Exam	30% (2 parts *15% each)	Part 1: short answer questions. Part 2: coding, which resembles quiz & practice questions.	In department but scheduled during the final exam period.	Missed final exams are handled by instructor and Service Point.

*In-class and online participation:* Student preparation and participation as well as performance during class will be assessed for half (5%) of the participation grade. We are looking for quality of contributions over the quantity of contributions. Class participation will be evaluated based on evidence that students have read assigned readings, done exercises and otherwise prepared for class. Students also will be assessed in their ability to thoughtfully and reflectively build on other students' contributions. The other five percent of the participation grade will be based on online contributions on our Discord. Similar to in-class participation, students should not only contribute original content but also react to their colleagues' content. Last year, students found great value in exchanging tips on the Discord channel. Once again, quality of contributions is preferred over number of contributions.

*Assignments:* Assignments allow the student to apply lecture material and/or programming to real world cases of geospatial representation on the web. There are five assignments in the course. All assignments are completed in groups of two to three students. The goal is to balance levels of computational experience, so every group possesses a similar level. All assignments are graded as a group regardless of individual contribution.

Note 1: The temptation in all assignments is to let the experts in the team handle the "hard" technical details. RESIST THIS TEMPTATION because it will hurt you in the quizzes and final lab exam, which are individual based. As you know from working with GIS or RS, knowing the tech ONLY comes from doing (and occasionally, creatively failing) the tech.

Note 2: With the advent of GPTs, the temptation is to have transformers to write all of the code for you. RESIST THIS TEMPTATION because it will hurt you in the quizzes and final lab exam, which are individual based. Moreover, learning the logic of coding (like the logic of a natural language) requires practice, for example, how to debug software.

*Quizzes:* Approximately half of the assignments require the use of JavaScript, which the quizzes are based on. There will be two one-hour quizzes during the semester. The dates of quizzes will be announced the week prior to the day the quiz is held. You will be tested on JavaScript material up to that point.

*Learning JavaScript:* During the course you need to demonstrate your knowledge of JavaScript. To do this, you must email a screenshot from playcode by the instructor by the beginning of Week 6. This screenshot will demonstrate that you have completed the

required modules. It is possible to waive out of the coding requirement if you know JavaScript. Contact the instructor for details.

*Final Exam:* The final exam is comprehensive of all material in the course. It is divided into two equally weighted components—a written exam and a lab practical exam. The final exam is *four* hours long with a one-half hour break in between.

### **Obligatory Statements**

Assessments in this course are governed by the [Policy on Assessment of Student Learning](#) (PASL), which provides a set of common principles to guide the assessment of students' learning. Also see [Faculty of Science-specific rules](#) on the implementation of PASL.

Legally mandated academic accommodations are handled by Student Accessibility and Achievement. For more information see <https://www.mcgill.ca/access-achieve/>

In accord with McGill University's [Charter of Students' Rights](#), students in this course have the right to submit in English or in French written work that is to be graded. This does not apply to courses in which acquiring proficiency in a language is one of the objectives." (Approved by Senate on 21 January 2009)

Conformément à la [Charte des droits de l'étudiant](#) de l'Université McGill, chaque étudiant a le droit de soumettre en français ou en anglais tout travail écrit devant être noté, sauf dans le cas des cours dont l'un des objets est la maîtrise d'une langue. (Énoncé approuvé par le Sénat le 21 janvier 2009)

McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the [Code of Student Conduct and Disciplinary Procedures](#)" (Approved by Senate on 29 January 2003) (See [McGill's guide to academic honesty](#) for more information).

In the event of extraordinary circumstances beyond the University's control, the content and/or assessment tasks in this course are subject to change and students will be advised of the change.

### **ADDITIONAL STATEMENTS**

We endeavor to provide an inclusive learning environment in this course. If you are experiencing barriers to learning in this course, do not hesitate to discuss them with a member of the teaching team and/or the [Office for Student Accessibility and Achievement](#), 514-398-6009.

We value intellectual freedom and we also value creating a safe and respectful classroom environment. If you do not feel safe in the classroom by virtue of comments related to your race, gender, sexual orientation, physical ability or for any other reason, please come speak with the course instructors.

Student well-being is a priority for the University. All of our health and wellness resources have been integrated into a single Student Wellness Hub, your one-stop shop for everything related to your physical and mental health. If you need to access services or get more information, visit the Virtual Hub at [mcgill.ca/wellness-hub](http://mcgill.ca/wellness-hub) or drop by the Brown Student Services Building (downtown) or Centennial Centre (Macdonald Campus). Within your faculty, you can also connect with your Local Wellness Advisor (to make an appointment, visit [mcgill.ca/lwa](http://mcgill.ca/lwa)).

McGill has policies on sustainability, paper use and other initiatives to promote a culture of sustainability at McGill. (See the [Office of Sustainability](#).)

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permission of the instructor. Note that infringements of copyright can be subject to follow up by the University under the Code of Student Conduct and Disciplinary Procedures.

Last, due to transformations of technologies like foundation models, the syllabus may change slightly.

## Syllabus

### Introduction

Overview of Geoweb and goals of the course.

In-class exercise: Work with existing Geoweb platform, Mapbox GL JS.

Set up to the Discord for online participation

Sign up at OpenAI and/or copilot

Answer a few questions about your comfort level with various concepts

Get set up on the course server

Sign up for playcode.io

Sign up to the Discord channel

Sign up for Mapbox account

Create a story map <https://www.mapbox.com/solutions/interactive-storytelling/>

Topic 1: History and evolution of geospatial data handling and visualization.

Definitions and types of digital earths (e.g., Google Maps). Georeferent systems, tiling, and projections. Differences between data structuration in GIS compared to the Geoweb. Introduction to concepts of markup languages (XML, HTML) and list-based ways of storing data.

In-class exercise: use [geojson.io](https://geojson.io) Create your first dataset in geojson, with one point, line, polygon, extrusion, photo.

Assignment 1: Create a storymap with [geojson.io](https://geojson.io)

Topic 2: Everything You See in Cloud is a Data Source

Introduction to web architectures, software stacks. Principles of web harvesting/scraping. Legal issues in “repurposing” data, for example, intellectual property and liability. Example from tourism. Structured and unstructured data.

In-class exercise: Work with Unstructured Content

Conduct web scraping. Tag content with XML. Create a web page.

Explore what happens when you prompt a GPT to scrape web content.

Assignment 2: Use Google Spreadsheets and XPath to automatically scrape and then map a popular classified advertising site

Topic 3: Fundamentals of Coding in an Era of GPTs

Variable Typing  
Data Structures  
Control Logic  
Functions  
User Input, Prompts, Alerts and Event Coding  
Debugging (e.g., use of console.log)  
The foundation of foundation models  
The opportunities & limits of GPTs for coding

In-class exercise: Write sample code with control logic. OR use copilot.

Topic 4: Democratization of Data and Algorithms: Volunteered Geographic Information (VGI) and GeoAI Ethics

Concepts in VGI (e.g., social sensing and crowdsourcing). Motivations for volunteers to contribute. Common methods to assessing accuracy of VGI. Legal issues underlying VGI (e.g., copyright and intellectual property {IP} of using non expert-generated content). Emergence of citizen science, crisis mapping and open data.

Fundamentals of GeoAI Societal impacts (e.g., privacy, surveillance, IP, environmental impacts); Ethics of Geofoundation Models (i.e., GeoGPTs).

In-class exercise: Create and edit your own VGI.

Assignment 3: Create tracker app with the Mapbox on the browser with Javascript and HTML and utilizing Google spreadsheets as the Internet database

Topic 5: Streaming, real time BIG Geospatial Data

Introduction to concepts of big data and data-intensive science. Brief discussion of geosensors, which are a prime source of geolocated data. Challenges to working with big data, like sampling.

In-class exercise: Envision a stream of data

Assignment 4: Create a weather fashion app based on user-chosen locations

Topic 6: Geo- and Data Visualization

Principles of cartographic/ geo-visualization and the emergence of data visualization. Exploratory data visualization vs explanatory data visualization. Visualization as storytelling.

In-class exercise: Explore the “maps” of D3JS. Tell a story with a Geoweb platform.

Assignment 5: Conduct data journalism via D3JS visualizations

TBD: Final exams