Geospatial Databases

HN 1090B-2, Fall 2023, Monday 5:30 - 8:20 PM
With both asynchronous and synchronous activities

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Course Description

Geospatial data, including their acquisition, cleaning, formatting, management, maintenance, update, and dissemination, are the core of most real-world GIS as the foundation for further visualization and analysis. On average, eighty percent of the cost of a GIS project is on data. Learning to design, create, populate, optimize, and maintain geospatial databases, therefore, is critical and essential for GIS professionals. This course is intended for students who want to learn the knowledge and skills of creating, querying, and managing large geospatial databases. More specifically, students will learn general (object-)relational databases and SQL (Structured Query Language) first with the open-source PostgreSQL. Then PostGIS will be introduced along with ST-SQL (Spatial Type-SQL) that allows spatial queries and analyses. Related to these spatial database operations, students will also learn the methods of cleaning spatial data, checking their qualities, and loading them into a geospatial database. The course has eight required task-oriented lab assignments and corresponding quizzes, two exams, with the option of using one final course project to replace one exam.

Learning Outcomes

At the end of the semester, students should be able to
- describe the basic concepts and principles of general and spatial databases.
- compose SQL statements to interact with (object-)relational databases.
- import data into PostGIS to build spatial databases with correct properties.
- perform basic spatial query, data manipulation, and spatial analysis using ST-SQL (spatial-type SQL).

Pre-requisite

GTECH 70900: Introduction to Geographic Information Science, preferably also GTECH 73200: Advanced GeoInformatics.

Course Materials

Recommended Books:
- Obe, Regina O. and Leo S. Hsu. 2021. **PostGIS in Action** (3rd ed.). Manning.
  Strongly recommended. Also check out the PostgreSQL book below by the authors.
- Obe, Regina O. and Leo S. Hsu. 2017. PostgreSQL: Up and Running: A Practical Guide to the Advanced Open Source Database (3rd ed.). O'Reilly Media, Inc.
- Mikiewicz, D., M. Mackiewicz, and T. Nycz. 2017. *Mastering PostGIS*. Packt Publishing.
- Lembo, A.J. 2015. *How Do I Do That in PostGIS: Illustrating Classic GIS Tasks*. CreateSpace Independent Publishing Platform.

Online documentation and Tutorials:
- PostgreSQL Documentation. https://www.postgresql.org/docs/15/index.html
- PostGIS Documentation. https://postgis.net/docs/manual-3.3/
- PostGIS Workshops. https://postgis.net/workshops/postgis-intro/

Course Structure and Logistics

This is a hybrid course with both asynchronous and synchronous activities. All its content, including announcements, learning materials, discussion forums, assignments, and exams, will be on Blackboard. Please make sure you can access CUNY Blackboard and also remember to update your Blackboard email to the one that you frequently check.

The course has the following components: readings and pre-recorded videos (asynchronous), lecture and lab sessions (synchronous), group discussions (asynchronous), lab assignments (for most weeks), and exams (see the schedule for details). You are expected to watch the pre-recorded lecture and read the readings before the synchronous lecture, in which we will revisit the important concepts and techniques and discuss your questions. In the synchronous lab sessions, we will start addressing the lab assignment questions.

You are encouraged to form and join a study group in the beginning of the semester. Through the semester, you will learn together with other group members, facilitated by messaging apps such as Slack, Discord, etc. As part of the participation, you are expected to communicate and discuss with other group members on the course content and lab assignments. Evidence such as screenshots of or statistics from your messaging apps will be requested to assess your participation.

Each one must submit answers to the lab assignment on the Blackboard Discussion Forum as a new thread (not by the group). Only after a student posts her own answers can she view other peoples' threads. All discussion forum posts cannot be edited or deleted. You can choose to submit one correction post to your original answer, if you learned the correct or better answers from the group or the forum.

Every student must post an evaluation of another student's answer to the lab assignment in the forum in terms of if the code would do the work and how efficient it is. In other words, you should evaluate the SQL code and examine if it is correct and whether further optimization is possible (for example, apply index, choose a better function or operator, etc.) The student being assessed must be from a different study group.

After the assignment due date, one group will be randomly chosen to briefly present their discussions during the lecture time, where the instructor will make comments and answer remaining questions. Following the discussion, all will take a 3-5 question quiz related to the assignment tasks. The questions could be multiple choice, true or false, or fill in the blank. It would take 5-10 minutes.

Grading Method & Scale

Evaluation of academic performance is based on the following components and breakdowns. Students must meet deadlines for assignments. In general, incomplete grades and time extensions are not an option for this course. There are no "extra-credit" assignments. Unless otherwise instructed, you will submit assignments in electronic forms through Blackboard.

Course Components	78519	38519
Lab Assignments		
Answers posted to Discussion Forum	30%	30%
Assessments of another one's answers	10%	15%
Quizzes	20%	20%
Exams		
Mid-term	15%	10%
Final *	15%	10%
Participation	10%	15%

Note: * The final exam can be replaced by a course project with the instructor's approval at least four weeks before the exam.

Incomplete (IN) and Credit

The instructor cannot accommodate students who are late in their work or do not show up for the exam or presentation. And, unless you produce a medical certificate or letter from the Office of Accessibility, the instructor will not give the final grade of IN (incomplete).

Software and Technologies

- PostgreSQL and PostGIS (Free and Open Source)
- QGIS (Free and Open Source) or
- ArcGIS Pro 2.x or ArcGIS 10.6 and above (available in the Geography Lab and for all CUNY students)

All our lab assignments and exams will be conducted on Windows or Mac computers. If you do not own a computer or your computer is not suitable for high-speed computing, you can always use the computers in our department computer classrooms, HN 1090B. If you have any problems accessing those computers, please contact our department IT support Ngoc Nguyen at nngoc@hunter.cuny.edu. If you have questions about ArcGIS software, please contact Amy Jeu at ajeu@hunter.cuny.edu. For Blackboard login issues, please visit Hunter College IT helpdesk at https://hunter.cuny.edu/information-technology/support/help-desk/.

Policies

Course Website

Web-enhancement in the context of this course means that everything pertaining to this course will be communicated through Blackboard. You are required to check the Blackboard course site on a daily basis. All changes to the syllabus will be announced on the course home page. All lecture and lab materials are accessible through Blackboard, and Blackboard is also the place where you upload your assignments. Your exams and lab assignments will be graded based on what you have uploaded to Blackboard and that is where you will find your grades and may access course statistics that help you to assess your standing at any given time.

Communication

All email messages about this course should be signed with your full name as it appears in CUNYfirst. [Professionalism] and "*[netiquette]*" are expected in the communication through emails (check out those links). If your emails are not replied to in a timely fashion, please consider rewriting your emails in a better way.

Hunter College Policy on Academic Integrity

Hunter College regards acts of academic dishonesty (e.g., plagiarism, cheating on examinations, obtaining unfair advantage, and falsification of records and official documents) as serious offenses against the values of intellectual honesty. The College is committed to enforcing the CUNY Policy on Academic Integrity and will pursue cases of academic dishonesty according to the Hunter College Academic Integrity Procedures.

ADA Policy

In compliance with the American Disability Act of 1990 (ADA) and with Section 504 of the Rehabilitation Act of 1973, Hunter College is committed to ensuring educational parity and accommodations for all students with documented disabilities and/or medical conditions. It is recommended that all students with documented disabilities (Emotional, Medical, Physical, and/or Learning) consult the Office of AccessABILITY, located in Room E1214B, to secure necessary academic accommodations. For further information and assistance, please call: (212) 772-4857 or (212) 650-3230.

Hunter College Policy on Sexual Misconduct

In compliance with the [CUNY Policy on Sexual Misconduct], Hunter College reaffirms the prohibition of any sexual misconduct, which includes sexual violence, sexual harassment, and gender-based harassment retaliation against students, employees, or visitors, as well as certain intimate relationships. Students who have experienced any form of sexual violence on or off campus (including CUNY-sponsored trips and events) are entitled to the rights outlined in the Bill of Rights for Hunter College.

   a. Sexual Violence: Students are strongly encouraged to immediately report the incident by calling 911, contacting NYPD Special Victims Division Hotline (646-610-7272) or their local police precinct, or contacting the College's Public Safety Office (212-772-4444).

   b. All Other Forms of Sexual Misconduct: Students are also encouraged to contact the College's Title IX Campus Coordinator, Dean John Rose (jtrose@hunter.cuny.edu or-212-650-3262) or Colleen Barry (colleen.barry@hunter.cuny.edu or 212-772-4534) and seek complimentary services through the Counseling and Wellness Services Office, Hunter East 1123.

Syllabus Change Policy

Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advance notice. Changes will be announced in class and on Blackboard, which students are expected to check regularly during the semester.

GTECH 38519/78519 Geospatial Databases
Schedule for Fall, 2023 (August 28 to December 20)

Week	Session	Date	Topic	Text and Video	Quiz	Lab Assignment	Due Date
1	1	8/28	Introduction: Relational, Object-Relational, and Spatial Databases; PostgreSQL and pgAdmin	PostgreSQL Up and Running (PUR) chapter 4; PostGIS in Action (PIA) (Chapter 1), Watch pre-recorded video lecture 01.	N/A	Get software ready	N/A
2		9/4	*No Classes – Labor Day*				
3	2	9/11	SQL Primer: pgAdmin Query tool, SQL SELECT, Data Types in PostgreSQL	PIA, Appendix C. PostgreSQL Documentation (PSD) Chapter 2.5, Chapter 7. Watch lecture 02.	Quiz for general databases	Lab1 SQL Basics I	9/17
4	3	9/18	SQL JOIN, AGGREGATE functions, Subselect, Create Tables, Indexes, and Views	PIA Appendix C, PSD Chapter 2.6. Watch lecture 03.	Quiz for lab 1	Lab2 SQL Basics II	10/1
5		9/25	*No Classes – College Closed*				
6	4	10/2	SQL with PostgreSQL: Update, Insert, Delete, Schema, Database, View	PIA Appendix C, PSD Chapter 2.8, 2.9. Watch lecture 04.	Quiz for lab 2	Lab 3 SQL Basics III	10/9
7	5	10/10	Spatial Databases and PostGIS: extensions, geometry and geography data types, reference systems	PIA Chapter 2, 3. Watch lecture 05.	Quiz for lab 3	Lab 4 PostGIS Basics; Lab wrapper	10/15

8	6	10/16	Spatial Functions for geometry and geography data types	PIA Chapter 6. Watch lecture 06.	Quiz for lab 4		
9	7	10/23	*Mid-term Exam;* Data Cleaning and Spatial Database Construction: import, export, load, clean, quality-check	PIA Chapter 4.		Lab 5 Spatial Functions	10/29
10	8	10/30	Spatial SQL I: Basics	PIA Chapter 9. Watch lecture 08.	Quiz for lab 5	Lab 6 ST-SQL I; Exam wrapper	11/5
11	9	11/6	Spatial SQL II: Spatial Query	PIA Chapter 10. Watch lecture 09.	Quiz for lab 6	Lab 7 ST-SQL II	11/12
12	10	11/13	Spatial SQL III: Spatial Analysis	PIA Chapter 11. Watch lecture 10.	Quiz for lab 7	Lab 8 ST-SQL III	11/19
13	11	11/20	Interacting with PostGIS from QGIS, ArcGIS, Python, and R	PIA Chapter 5.	Quiz for lab 8	Lab Wrapper	
14	12	11/27	Spatial Database for Raster	PIA Chapter 12,		Lab 9 ST-SQL for Raster (Optional)	12/04
15	13	12/4	Database Management and Performance Tuning.	PIA Chapter 14, 15	Quiz for lab 9		
16	14	12/11	Review, and Q/A				
17	15	12/18	*Final Exam*				