GEOSPATIAL HEALTH: CAUSAL ANALYTICAL METHODS

PUBH 5497 - F01 Class #12206

Fall, 2026

DetailedSYLLABUS or Tinyurl.com/GEOCAUSAL2

https://classes.uconn.edu/?details&srcdb=1268&crn=12206

Day and time: Mondays, 5:30-8:30 pm, mainly in HuskyCT Collaborate (or Teams, occasionally in Hartford, and Storrs too)

Location: **TBD – in person can alternate to Farmington, Hartford, and Storrs**

Instructor: **Emil Coman, PhD, PStat, Assistant Professor (in residence), DPHS**

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Office Hours: **TBD** *(but see a taste at Tinyurl.com/GEOCAUSAL)*

Overview: Place matters when it comes to individual disease and mortality and public health, yet how much of our health is determined by geography/space, and not by individual treatments or behaviors, is not well understood. Place reflects social and economic deprivation and environmental conditions that can result in significant health disparities, but epidemiologic investigations and health research rarely go behind simple maps illustrating regional qualitative differences. This AI-assisted course equips students with practical skills to explore how place and space come together with individual factors in determining health and preventing and reducing health problems and disparities. It develops familiarity with spatial data manipulation and visualization tools, but also with formal analysis of geographic health data, separately or combined with individual data.

Learning Objectives: This course will equip students to specifically:
(i). Extract evidence from geographic/spatial health data;
(ii). Conduct spatial epidemiologic investigations;
(iii). Utilize confidently: **(1).** Geoda (free); **(2).** Policymap.com (free to UConn Health students through HDI or library); **(3).** Stata (free to UConn students); **(4).** QGIS (free); **(5).** Dagitty (free online); **(6).** UConn ArcGIS Dashboards online variant; **(7).** R ; **(7).** Others, as GenAIs tell us: CLAUDE GEMINI COPILOT GROK CHATGPT PERPLEXITY + CHATBOX + SCISPACE

No prerequisites are required for this course; it is aimed at public health graduate students, but is open to other UConn graduate students.

Text: **All readings and materials will be posted on HuskyCT. Class discussions and collaborations happen in HuskyCT and Teams. (**Book contents will be borrowed from as needed]

1. Anselin, L. (1988). Spatial econometrics: methods and models https://drive.google.com/file/d/1qLlFsVyh_o1h4IEO0OxhNSD6sdX4lJ20/view?usp=sharing (Vol. 4): Springer Science & Business Media.
2. Anselin & Rey (2014) Modern spatial econometrics in practice A guide to GeoDa, GeoDaSpace and PySAL
3. LeSage, J., & Pace, R. K. (2009). Introduction to Spatial Econometrics https://drive.google.com/file/d/1C8uLaa9BpdszYRal6iMnRINHqU5arCf2/view?usp=sharing
4. Souris M. Epidemiology and geography: principles, methods and tools of spatial analysis: John Wiley & Sons; 2019.

Additionally:

A1. Lawson AB. Statistical methods in spatial epidemiology: John Wiley & Sons; 2013.

A2. Elliot P, Wakefield JC, Best NG, Briggs DJ. Spatial epidemiology: methods and applications; 2000.

A3. Lawson AB. Bayesian disease mapping: hierarchical modeling in spatial epidemiology: Chapman and Hall/CRC; 2018.
A4. Westreich D. Epidemiology by design: a causal approach to the health sciences: Oxford University Press; 2019.
A5. Hernán M, Robins J. Causal Inference. Online drafts at https://www.hsph.harvard.edu/miguel-hernan/causal-inference-book/. 2018.
A6. Susser M. Causal thinking in the health sciences: concepts and strategies of epidemiology https://search.worldcat.org/title/5909501973. xii, 181-xii, p.
A7. Rothman KJ, Greenland S, Lash TL. Modern epidemiology 2008.

Assignments: Detailed in the **Weekly CLASS SCHEDULE** Table *below*

Course approach: - Students will learn to uncover those spatial patterns, explore causal pathways, and communicate their findings effectively. By end of course, they will be ready to design a geospatially grounded, causally sound public health study.

- This course will be fully **AI-assisted**: class time will be devoted to answering a series of questions proposed by the teacher covering each weekly topic: the list will be first examined and expanded with the students, and the co-discovery process will involve creating AI 'prompt' (detailed inquiries/questions) and unpacking them as a group.
- Modern AI assistants will be relied upon (ChatGPT and Grok seem to be leading now) and recent additions to teaching tools, like the Husky Ultra **ChatBot** discussion space.
- We will use AI to: **(1).** Troubleshoot bumps in the road: *(a)*. when teacher's explanations fall flat, *(b)*. such that we leave "no learner is behind" (ask on the spot clarifications); **(2).** Review reading materials (and online sources), and come up with better explanations/walk-throughs; **(3).** Assist students in completing weekly homeworks.
- The course will focus on causality; the faculty has developed an extensive intro to causality at https://health.uconn.edu/causality/

Weekly CLASS SCHEDULE *[these topics are aspirational; the content will be likely scaled down to match student needs and preferences]*

Week / Dates	**Topic** & Learning Objectives	Content Questions / AI Prompts	Class Discussion	Homework / Reading / Assignments/ AI Component	Recommended Readings
Week 1 8/31/2026	**Health geography, spatial data, mapping, and epidemiology** Distinguish spatial from non-spatial data, define spatial autocorrelation and heterogeneity, and understand how mapping adds inferential value in public health. Learn to use AI to locate spatial data sources and articulate an initial research question grounded in geography.	What isn't spatial data? What is spatial autocorrelation and heterogeneity? Where does geospatial causal analytics fit among related fields?	Discuss examples of spatial clustering in health data. Brainstorm student research areas.	Use AI to identify 3 publicly available spatial datasets relevant to your interest area.	See below
Week 2 9/7/2026	**Types of spatial data and structures in the U.S.** Identify and compare point and areal data types and understand U.S. spatial hierarchies (ZIPs, tracts, towns, etc.). Apply AI-assisted reasoning to link research questions to the appropriate geographic scale and manage data alignment issues.	How do we represent spatial data? What are point vs. areal data? How to handle geocoding and misalignments?	Compare CT and U.S. geographic units and discuss sources of bias from mismatched boundaries.	* Draft a preliminary research question (RQ). * Submit a revised, geographically explicit RQ. * Use AI to map and describe suitable geographic units for your RQ	[**backread** for W.1; Souris Ch. 1–2, *optional* Ch.4 * Anselin, L. (1995). Local Indicators of Spatial Association -LISA.Geographical Analysis, 27(2), 93–115]. Souris Ch. 3–4
Week 3 9/14/2026	**From basic statistical analyses to spatial analytics** Differentiate traditional regression from spatial regression, describe the impact of spatial dependence, and visualize spatial patterns. Use AI to explain spatial lag and error models and communicate these ideas conceptually.	How do we visualize and analyze spatial data? How do spatial dependence and heterogeneity affect inference?	Demonstrate GeoDa use; discuss differences between OLS and spatial regression models.	Use GeoDa/QGIS to visualize your dataset. Ask AI to explain spatial lag and spatial error models and summarize insights in your own words.	Anselin & Rey, Ch. 3–5; *optional* Anselin 1988, Ch. 2–4; Souris Ch. 5
Week 4 9/21/2026	**Health disparities in geospatial context** Conceptualize how geography shapes inequities, learn to construct spatial indices of deprivation, and evaluate equity metrics. Use AI to critique their measures and justify indicator selection.	How does the spatial perspective alter health disparity and equity research? How to build spatial inequity indices?	Discuss examples of spatial health inequities and potential data proxies.	Develop a spatial index of inequity or vulnerability. Use AI to critique and refine your measure, documenting rationale.	Souris Ch. 4–6; & Diez Roux, A. V. (2001). Investigating neighborhood and area effects on health. American Journal of Public Health, 91(11), 1783–1789

Week 5 9/28/2026	**Applied spatial regression and path analysis** Integrate structural equation modeling and spatial regression approaches, compare methods across software, and interpret model outputs. AI will serve as a translation and cross-validation tool for syntax and results.	How to integrate mapping and SEM/path modeling? What are spatial regression extensions (GWR, sp errors)?	Demonstrate Stata/sp models and compare with SEM; discuss model interpretation.	Run preliminary analysis in GeoDa or Stata. Use AI to translate model syntax across platforms and compare outputs.	Anselin & Rey (2014), selected spatial regression chapters & LeSage & Pace Ch. 2; *optional* Anselin 1988, Ch. 4–5;
Week 6 10/5/2026	**Causal inference with spatial data** Identify confounding in spatial datasets and design causal diagrams (DAGs) to clarify relationships among variables and geographic levels. Use AI to visualize causal structures and refine hypotheses.	What is confounding in the spatial context? How do we combine multi-scale areal data?	Explore multilevel spatial causal examples and QGIS shape joining.	Use AI to generate DAGs for your study question in Dagitty and interpret causal pathways. Submit annotated diagram.	Ogburn-2014-Causal diagrams for interference. Statistical Science, 29(4); *optional* Reich -2020-A Review of Spatial Causal Inference Methods for Environmental and Epidemiological Applications.
Week 7 10/12/2024	**Geospatial structures – place, location, and relation** Analyze how physical, social, and economic spatial factors define communities and health outcomes. Draft a short abstract integrating geography and variables, and use AI to propose alternative analytic structures.	What is a 'community'? How do spatial, social, and economic factors interact?	Class debate: is geography or social interaction more defining for 'community' in health?	Draft a 2-page research abstract integrating your variables and geography. Use AI to suggest alternative model formulations.	Souris Ch. 2-3; *optional* LeSage & Pace Ch. 8
Week 8 10/19/2024	**Naïve vs. spatial analytic approaches** Compare naïve and spatial analytic models, conduct sensitivity analyses, and evaluate how parameter variation affects causal inference. Use AI to simulate comparisons and interpret implications.	What are sensitivity analyses? How to compare analytic alternatives across geographic scales?	Work through sensitivity scenarios. Discuss AI's potential to suggest parameter variations.	Use AI to simulate two competing models and summarize differences. Write short reflection on insights gained.	Anselin 1988, on spatial dependence, spatial effects, model specification and estimation & Anselin & Rey (2014), spatial diagnostics specification section
Week 9 10/26/2024	**Spatial vs. multilevel analytic approaches** Compare spatial and multilevel analytic models, and evaluate why parameter s vary and this it affects causal inference.	How to compare spatial vs. multilevel analytic alternatives across geographic scales?	Discuss AI's suggested explanations for parameter variations.	Use AI to run competing models and summarize differences. Write short reflection on insights gained.	LeSage & Pace Ch. 6; optional Anselin 1988 on spatial heterogeneity/model specification; *optional* Paciorek 2010 The importance of scale for spatial-confounding bias and precision of spatial regression estimators
Week 10 11/2/2026	**Generic, simulated vs. real geospatial health data**	How can we simulate spatial data and what	Group exercise: building synthetic	Use AI to generate pseudo-data mimicking your study and perform	LeSage & Pace Ch. 4 &

	Understand spatial data simulation principles, evaluate statistical power, and visualize spatial spillover. Use AI to generate pseudo-datasets for exploration and testing.	are the power implications? How to visualize spatial flow?	datasets; discuss their limitations.	simple spatial clustering test.	Anselin & Rey, spatial weights/model specification sections
Week 11 11/9/2026	**Communicating geospatial health research** Learn to write proposals, abstracts, and visual narratives that communicate spatial analyses clearly. Use AI as a co-writer for initial drafts and learn to critically edit and humanize AI-generated text.	How to write spatial epidemiology proposals and abstracts? How to combine maps with text/visuals?	Review strong and weak abstracts. Identify linguistic cues of spatial vs. non-spatial framing.	Use AI to co-draft a conference abstract (MMM Modern Modeling Methods target). Include reflection describing what edits you made to AI output.	Souris, Ch. 4 Cartographic Representations and Synthesis Tools
Week 12 11/16/2026	**Health equity dashboards and dissemination** Build and interpret geospatial dashboards (e.g., Tableau), integrating multiple data sources. Use AI to assist in code translation, dashboard storytelling, and dissemination strategies. 11/10-12 **DPHS special events – no formal DPHS classes meeting – Storrs students will meet**	How to build dashboards (e.g., Tableau)? How to integrate multiple data levels?	Demonstrate live dashboard examples. Discuss AI's role in code translation and visualization.	Use Tableau or similar to create an equity map. Use AI to translate R to Stata or vice versa. Submit dashboard and reflection. Finalize project proposal draft. Include AI-generated conceptual map of spatial tools and explain your synthesis process.	Souris Ch. 4 + Ch. 6
Week 13	11/22-28/2026 Thanksgiving Recess				
Week 14 11/30/2026	**Positioning spatial analytics in broader health epistemology** Compare methodological paradigms across epidemiology, medicine, and public health, reflecting on how AI reshapes scientific reasoning. Use AI to generate and critique epistemological arguments.	How do methodological philosophies differ across health fields?	Seminar on epistemological contrasts; discuss AI's influence on scientific method.	Prepare short presentation. Use AI to generate argument outlines and critique them manually for accuracy.	Reading of choice [e.g. Keil & Kamenetsky (2026), Bringing spatial confounding into the causal inferential fold, American Journal of Epidemiology]
Week 15 12/7/2026	**Final projects and synthesis** Integrate all learned methods and AI collaboration practices into a final geospatial causal project. Present results and reflect critically on the ethical and intellectual role of AI in research.	What have we learned about AI-supported geospatial causal inference? One methodological idea I initially misunderstood, and	Final project presentations and feedback.	Submit final project and reflection on AI collaboration and ethical use in public health research.	

		how my understanding changed!			
	Fri, Dec 11 Last day of fall semester classes				

Grading: AI-integrated assessment framework (*ChatGPT suggested*)

- Philosophy: This framework distinguishes student learning from AI contribution while embracing AI as a pedagogical tool. It relies on expanding the 'learning' process to span over 'explaining', operationalized as 'detailed AI prompting': how to develop specific enough questioning context such that AI tools can provide sought after results with minimal returns/revisions?

Grading Breakdown (Total: 100%)

Assignment Type	*Points*	*Description*
Weekly AI Logs	15%	Document AI interactions: prompt, response, evaluation, and correction if needed
In-Class Mini-Quizzes	20%	Short problems solved without AI (5 minutes each, best 10 of 12 count)
Peer Teaching Sessions	10%	Lead 10-minute session explaining a concept to classmates (whiteboard & AI)
AI Correction Portfolio	10%	Curated collection of 10+ AI errors you caught with explanations
Midterm Oral Exam	10%	15-minute one-on-one discussion of concepts (no notes, no AI)
Final Project	35%	Research project with AI usage documentation and live presentation defense

CEPH and MPH Program Competencies Addressed in Course

Competencies:

	EVIDENCE-BASED APPROACHES TO PUBLIC HEALTH
X	1. Apply epidemiological methods to the breadth of settings and situations in public health practice
X	2. Select quantitative and qualitative data collection methods appropriate for a given public health context
X	3. Analyze quantitative and qualitative data using biostatistics, informatics, computer- based programming and software, as appropriate
X	4. Interpret results of data analysis for public health research, policy or practice
	PUBLIC HEALTH & HEALTH CARE SYSTEMS
	5. Compare the organization, structure and function of health care, public health and regulatory systems across national and international settings
X	6. Discuss the means by which structural bias, social inequities and racism undermine health and create challenges to achieving health equity at organizational, community and societal levels
	PLANNING & MANAGEMENT TO PROMOTE HEALTH
X	7. Assess population needs, assets and capacities that affect communities' health
	8. Apply awareness of cultural values and practices to design or implementation of public health policies or programs
	9. Design a population-based policy, program, project or intervention
	10. Explain basic principles and tools of budget and resource management
	11. Select methods to evaluate public health programs
	POLICY IN PUBLIC HEALTH
	12. Discuss multiple dimensions of the policy- making process, including the roles of ethics and evidence
	13. Propose strategies to identify stakeholders and build coalitions and partnerships for influencing public health outcomes
	14. Advocate for political, social or economic policies and programs that will improve health in diverse populations
X	15. Evaluate policies for their impact on public health and health equity
	LEADERSHIP
	16. Apply principles of leadership, governance and management, which include creating a vision, empowering others, fostering collaboration and guiding decision making
	17. Apply negotiation and mediation skills to address organizational or community challenges
	COMMUNICATION
X	18. Select communication strategies for different audiences and sectors

X	19. Communicate audience-appropriate public health content, both in writing and through oral presentation
	20. Describe the importance of cultural competence in communicating public health content
	INTERPROFESSIONAL AND/OR INTERSECTORAL PRACTICE
X	21. Perform effectively on interprofessional teams
	SYSTEMS THINKING
	22. Apply systems thinking tools to a public health issue
	UCONN MPH: INTERPROFESSIONAL PRACTICE / PUBLIC HEALTH METRICS & EVALUATION
	1. Define skills, knowledge, and ability of health-related professions relevant to effective interprofessional public health practice
X	2. Communicate one's skills, knowledge, ability when engaging with community partners in interprofessional public health practice
	3. Demonstrate high personal and professional ethical conduct in contributing to team- based activities
	4. Employ legal-ethical reasoning to advance interprofessional public health policy & practices
	5. Demonstrate use of Systems Thinking (ST) in promoting effective public health programs and policies

Commitment to Fair and Ethical Dealings

The Master in Public Health Program is committed to fair and ethical dealings and adheres to the relevant policies of the University of Connecticut Health Center on affirmative action, racism and acts of intolerance, educational opportunity for persons with disabilities, HIV/AIDS non-discrimination, rules of conduct, confidentiality and prohibition on sexual harassment.

The University of Connecticut Compliance Program requires all individuals to report any known or suspected violations of laws, regulations, standards, policies and procedures that apply to the Health Center. The investigation of compliance inquiries is the responsibility of the UCHC Corporate Compliance Office. The Office may delegate investigations to appropriate units such as Human Resources, the Office of Diversity & Equity, or the Research Safety Office. Depending upon your preference and comfort level,

If you suspect a violation , contact: the program administration, the Assistant Dean of the Graduate School, the Compliance Officer of the appropriate UCHC domain (there are five domains: Administration, Clinical, Research, Finance, and Education), or the REPORTLINE-this is a confidential telephone reporting system operated by a private firm under contract with the Health Center (1-888-685-2637).

Office of Diversity and Equity Website: http://diversity.uchc.edu/
Policies: *Affirmative Action*, *Racism and Acts of Intolerance*, *Equal Employment and Educational Opportunities for Persons with Disabilities*, *Prohibition on Sexual Harassment, HIV/AIDS Non-Discrimination*

Office of Audit, Compliance, and Ethics Website: compliance.officer@uchc.edu
Policies: *Code of Conduct*, *Confidentiality*, *Reporting Compliance Concerns*

Safety Issues. Website: http://www.ors.uchc.edu/overall.html
Emergency within the Health Center: x 7777
Emergency off campus: 911
Non-emergency: 860-679-2121
Police station: Located on the ground floor of the Health Center. After 7 pm; if you are concerned for your safety; a police officer will take you to your car

Scholarly Misconduct

Scholarly activity at the graduate level takes many forms, including, but not limited to, classrooms, laboratories or field experience, writing for publication, presentation, and forms of artistic expression. Integrity in all of these activities is of paramount importance, and the Graduate School of the University of Connecticut requires that the highest ethical standards in teaching, learning, research, and service be maintained.

Scholarly misconduct is broadly defined as a failure to uphold standards of scholarly integrity in teaching, learning, research, or service that includes, but is not limited to:

- *Cheating* involves dishonesty during a course, on an examination or at other times during graduate study, e.g., copying the work of another student.
- *Plagiarism* involves using another person's language, thoughts, data, ideas, expressions, or other original material without acknowledging the source.
- *Distorted reporting* involves the omission or misrepresentation of the information necessary and sufficient to evaluate the validity and significance of research.
- *Fabrication or Falsification of Grades* involves any form of falsification of coursework or tampering with grades.
- *Misrepresentation* involves taking an examination for another student, submitting work done by another individual as one's own, submitting the same work for evaluation in two or more courses without prior approval, unauthorized use of previously completed work or research for a thesis, dissertation, or publication, or making false, inaccurate, or misleading claims or statements when applying for admission to the Graduate School or in any scholarly or research activity, including publication.
- *Academic or Research Disruption* involves unauthorized possession, use, or destruction of examinations, library materials, laboratory or research supplies or equipment, research data, notebooks, or computer files, or it might involve tampering with, sabotage of, or piracy of computer hardware, computer software, or network components.
- *Fabrication or Falsification in Research* involves falsification of, tampering with, or fabricating results or data.
- *Research Violations* include violation of protocols governing the use of human or animal subjects, breaches of confidentiality, obstruction of the research progress of another individual, or disregard for applicable University, local, State, or federal regulations.
- *Professional Misconduct* involves violation of standards governing the professional conduct of students in particular fields (e.g., pharmacy, nursing, education, counseling, therapy).
- *Deliberate Obstruction* involves hindering investigation of any alleged act of scholarly misconduct.
- *Aiding or Abetting* involves actions that assist or encourage another individual to plan or commit any act of scholarly misconduct.

Allegations of scholarly misconduct will be addressed in accordance with the procedures set forth by UConn (See: https://grad.uconn.edu/faculty-staff-resources/advising-mentoring/scholarly-misconduct/).

ChatGPT suggested Assessment Components

1. Process Documentation (25% of grade)

Students must document their AI interaction process

Criteria:

Quality of prompts: Are questions well-formulated and iterative?
Critical evaluation: Do students identify AI errors and limitations?
Prompt refinement: Evidence of learning through improved questioning
Documentation: Clear record of AI interactions with timestamps and versions

Rubric:

Excellent: Sophisticated prompts showing deep engagement; identifies	**Good:** Clear prompts with some iteration; recognizes some AI limitations; adequate documentation	**Developing:** Basic prompts without refinement; accepts AI output uncritically; incomplete documentation

and corrects AI errors; demonstrates prompt evolution		

2. Conceptual Understanding (30% of grade)

Assessed through in-class activities and verbal explanations

Criteria:

Ability to explain concepts without AI in real-time class discussions
Whiteboard problem-solving without digital tools
Peer teaching moments: Can they explain to classmates?
Connection-making: Linking concepts across weeks without prompting

Rubric:

Excellent: Explains concepts clearly and spontaneously; connects ideas fluidly; teaches peers effectively	**Good:** Understands core concepts; makes connections with guidance; explains adequately	**Developing:** Relies on notes/AI; struggles to connect concepts; cannot explain independently

3. Critical AI Evaluation (20% of grade)

Students must identify where AI was wrong and why

Criteria:

AI Error Log: Document instances where AI provided incorrect information
Correction Quality: Depth of understanding shown in corrections
Source Verification: Did student verify AI claims against course materials?
Learning Narrative: What did correcting AI teach you?

Rubric:

Excellent: Identifies subtle errors; provides well-reasoned corrections with sources; articulates meta-learning	**Good:** Catches obvious errors; corrects with some justification; shows awareness of AI limitations	**Developing:** Misses errors or makes incorrect 'corrections'; no verification process evident

4. Independent Analysis (25% of grade)

Assessed through timed in-class exercises and oral exams

Criteria:

Timed problem-solving (no AI access): Can they run basic models?
Output interpretation without AI: Understanding what results mean
Troubleshooting: Can they debug code/models without AI help?
Oral examination: Defend choices and explain reasoning verbally

Rubric:

Excellent: Solves problems efficiently without AI; interprets output correctly; debugs independently	**Good:** Completes tasks with some struggle; interprets correctly with prompting; fixes common errors	**Developing:** Cannot complete tasks without AI; misinterprets output; unable to troubleshoot

Grading Principles

- **Transparency:** Students know exactly how AI use affects grading from day 1
- **Process over product:** How they learned matters more than polished final output
- **Metacognition:** Reflection on AI-assisted learning is explicitly valued
- **Authenticity:** Multiple assessment modes prevent AI-only work
- **Growth mindset:** Iteration and improvement in both prompting and understanding is rewarded
- ***Sample Rubric*: Week 5 Homework - Run preliminary analysis in GeoDa or Stata.**

Student Responsibilities (Graded):

- AI Log (5 pts): Document all AI interactions for this assignment
- Independent Verification (5 pts): Run models independently and compare to AI-suggested code
- Conceptual Explanation (5 pts): Write interpretation without AI assistance (timed, in-class component)
- Error Analysis (5 pts): If AI code had errors, explain what was wrong and why

What AI Can Assist With:

- Code Generation: AI can help with syntax
- Initial Interpretation: AI can provide first-pass interpretation

- Troubleshooting: AI can suggest debugging strategies

What Student MUST Demonstrate:

- Understand why code works, not just that it works
- Interpret results in context of research question
- Identify when AI suggestions are inappropriate
- Explain choices to instructor if asked