

HAP 823: Causal Analysis & Comparative Effectiveness

**Department of Health Administration, Policy, Informatics
College of Public Health
George Mason University**

Course Description

Apply knowledge of discovery and data science methods to create network models of health data to predict population and public health outcomes. Analyze massive, high-dimensional data, using repeated and chained LASSO regressions, to create Causal Networks, and understand competing effects of multiple causes and mediators.

Pre-Requisites

This course assumes you know, and can do, regression (HAP 719) and Standard Query Language (HAP 671). *These topics are not taught but are expected.*

Course Objectives

Upon completion of the course, students will be able to:

1. Create a counterfactual framework for causal analysis for observational health data.
2. Develop a network statistical model using repeated measures, chained equations, and LASSO regressions
3. Compare LASSO regression and Markov blankets in controlling confounding.
4. Isolate causal effects by closing backdoor pathways and adjusting for confounders in observational health data.
5. Evaluate multiple mediation effects by manipulating structure of network models.

Required Textbooks

- *Statistical Analysis of Electronic Health Records* by Farrokh Alemi, 2020.
- *Causal Inference in Statistics: A Primer*, Judea Pearl, Madelyn Glymour, Nicholas P Jewell, 2016

Pedagogical Approach

Each class will consist of four parts:

1. **Learn one:** instructor provides didactic lectures
 - Brief lectures of 10-15 minutes per module
 - Extensive online resources
 - Interactive lectures requiring active student participation
 - Q&A using text

2. **Do one:** practical laboratory work within each lecture.
 - Complete assignments during class time
 - Work in groups
 - Work on real datasets
3. **Teach one:** Students teach the topic they have learned to one another.
 - All assignments are done individually but with help from others. The students who are most helpful will receive a bonus grade increase.
4. **Evaluation**
 - Students evaluate each lecture, not just at end of the course
 - Students work individually but they can get help from each other. In this context, help means (1) giving advice on how to proceed, (2) checking that you have the same answer as other team members, but not (3) copying code from each other.

Use Text for Rapid Response

You are invited to ask and receive answers on text. Questions asked are answered so all students can receive the answer. Answers typically include videos.

LinkedIn ®

You are encouraged to maintain a LinkedIn ® presence and connect with the instructor. Through the instructor's page, you can find other alumni of the program/course. The instructor can endorse your skills. You can find job postings.

Teach One Assignment

We rely on a method typically used in training of medical residents: "Learn one, do one, teach one." Each student is expected to not only learn the concepts in the course, and do the assignments, but also teach a portion of the course. This active participation in teaching helps students learn the concepts in the course in more depth. The best way to learn a topic is to teach it. Students are expected to teach by preparing a brief video. The steps to follow are:

1. Select which topic you wish to teach. Typically, students teach about an assignment in the week's topic. The teach one selection is done in first day of class. Email your selection to the instructor.
2. A week prior to class lecture complete the assignments.
3. During class time, help students assigned to you to get started on the assignments
4. After class time, contact students assigned to you to see if they have run into a problem.

Prepare Intelligent Tutors

Students are required to prepare intelligent tutors for their assigned teaching sessions. The highlighted text is required in all intelligent tutors. To prepare an intelligent tutor, break the assignment into components. Details for how to create Intelligent Tutors are provided on the

open site for the course:

Students' Evaluation

1. **Teach One Assignment (25%):** The Teach One assignment must be completed one week ahead of the related lecture. Missing this deadline reduces the Teach One grade by 20%. The URL for the Teach One assignment must be emailed to all students including the instructor on the day of lecture. Teach one assignments are scored based on number of times the student teacher's name appears in the survey of students about "Who helped you most in this session?"
2. **Weekly Assignments (25%):** You are required to complete all assignments one week after end of lecture on the topic. Late assignments are accepted. Late assignments will receive 20% less grade. All assignments must be completed with an additional student. No two students should work on more than one assignment together. Working together means discussing the assignment, showing how to solve the assignment and verifying that you have exactly same answers. It does not mean that one person does one part and the other another part. Do not copy code or work from each other. Each person hands in the entire assignment and lists the names of team members.
3. **Post Midterm Exam (25%):** The midterm is completed in class. Exam is similar to assignments and involve same problem sets with minor changes.
4. **Final Paper and Project (25%):** Students are expected to complete a multiple mediation analysis within All of Us data or using other data provided by the instructor. If the student has access to a database of their own, they can ask permission to substitute analysis of their own data with the analysis of data provided by the instructor. Reports on portions of the final projects must be submitted at designated intervals throughout the semester. It is not reasonable to provide a report at the end of the semester and portions of the report must be provided at designated intervals.

University grading policies are followed.

A	4.00	94-100%
A-	3.67	90-93%
B+	3.33	87-89%
B	3.00	83-86%
B-	2.67	80-82%
C	2.00	70-79%
F		69% and below

Topical Outline

Please note that course syllabus may change at any time prior to the date of the lecture. Do not print ahead of schedule. Check this page regularly for updates. Assignments are due within 7 days of date of topic, unless otherwise noted.

1. **Preliminaries**
2. **Markov Blanket**
3. **Do Operation**
4. **LASSO Regression**
5. **Temporal Analysis**
6. **Regression Networks**
7. **Mediation**
8. **Exam**

Sample semester long projects:

9. **All of Us Project**
10. **Diabetes**
11. **COVID-19**
12. **Vaccination**

Exam Guidelines

Exam is in-person, timed, with open access to Internet and course web pages. Exam questions are similar to assignments.

Honor code

“To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University community and with the desire for greater academic and personal achievement, we, the student members of the university community, have set forth this honor code: Student members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work” (George Mason University Catalog, 2006-2007, p. 31).

Individuals with Disabilities

George Mason University is committed to complying with the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 by providing reasonable accommodations for disabled applicants for admission, students, applicants for employment, employees, and visitors.

Applicants for admission and students requiring specific accommodations for a disability should contact the Disability Resource Center at 703-993-2474, or the Equity Office at 703-993-8730.

Applicants for employment and employees should contact Human Resources at 703-993-2600 or the Equity Office. Students are responsible for providing appropriate documentation and requesting reasonable accommodation in a timely manner (George Mason University Catalog).

Working E-Mail & Tweeter Accounts

All communications are facilitated by email and tweeter. Students must be able to receive emails and to regularly, at least daily, review emails. Do not allow the mailbox to become full. Tweeter or texting is used for quick responses.

Instructor

This course was organized by Farrokh Alemi. Recent publication of Dr. Alemi are available on the web. You are encouraged to text Dr. Alemi between 9 am to 9 pm. Please email the instructor and obtain the phone number for sending text.

AI Policy

Basic Principle: Use of AI in any aspect of the course, including exams, is allowed and encouraged but not required.

What Tools: Students can use any tool, including text-focused chatbots like ChatGPT, Copilot, or Claude; it may include image- or video-generation tools like Runway or Midjourney; it may include tools like Grammarly or other editors; it may include basic text-prediction or text-completion tools.

When and How: AI tools may be used for completing assignments, creating outlines, interpreting statistical models, coding, and editing. There are no restrictions on what AI tools can be used for. Comply with GMU AI guidelines, especially those that serve to protect students' privacy and ensure accessibility. AI tools can be used in exams.

No Reporting: There is no need to report you have used AI tools. The citation of AI tool's contributions is optional.