QTM 110: Introduction to Scientific Methods

Section 2
Class Nbr 1440
Emory University
Fall 2019

Meeting room:	New Psyc Bldg 290 (36 Eagle Ro)
Meeting times:	Monday , Wednesday 4:00pm-5:15pm

Instructor:	Rodrigo Azuero
Email:	razuero@emory.edu
Office:	Tarbutton Hall, Room 217B
Office hours:	Tuesday 10:00am-11:00am, Wednesday 10:00am-11:00am

Overview

QTM 110 is the first course in the sequence of requirements for the Quantitative Sciences (QS) major; as an introductory course, there are no prerequisites. The course is designed to introduce students to the style of analytic thinking required for research and the concepts and procedures used in the conduct of empirical research. In short, this course teaches a set of skills that are essential for both understanding the research you will encounter in substantive classes, and being able to produce high-quality original research of your own. Beyond simply learning how to be a more critical participant in the academic research community, you will also be better-prepared for career opportunities using statistical tools and the products thereof.

Students will be introduced to the basic toolkit of researchers which includes sampling, hypothesis testing, Bayesian inference, regression, experiments, instrumental variables, differences in differences, and regression discontinuity. More importantly, students will learn the principles of critical thinking essential for careful and credible research.

Administrative Policies

Email policy I will not respond to questions on the course material via email. All such questions should be directed to the message board on the the Piazza discussion board. I will check for questions posted to the board regularly and respond there. This policy is in place so that all students can benefit from additional clarification and explanation on points that come up during the semester. Piazza allows you to post privately to instructors in case you need to

Late policy All assignments are due on the announced due date and time specified on the assignment and should be submitted via Canvas. Any assignment submitted after this time will be considered one day late. One letter grade will be deducted for each day the assignment is late. Plan ahead to avoid any problems with electronic submission.

Office hours I will hold weekly office hours at the times listed above. I encourage you to visit during these hours.

Some students only attend office hours immediately before papers or exams are due or after grades are returned. These are the times when the longest lines form, and consequently at such times instructor availability will be limited. I therefore strongly urge you to use office hours throughout the rest of the semester to discuss the course and your progress.

Students with disabilities Emory University is committed under the Americans with Disabilities Act and its Amendments and Section 504 of the Rehabilitation Act to providing appropriate accommodations to individuals with documented disabilities. If you have a disability-related need for reasonable academic adjustments in this course, provide the instructor(s) with an accommodation notification letter from Access, Disabilities Services and Resources office. Students are expected to give two weeks-notice of the need for accommodations. If you need immediate accommodations or physical access, please arrange to meet with instructor(s) as soon as your accommodations have been finalized. Students requiring any academic accommodation should consult with the Office of Disability services (http://www.ods.emory.edu/) and discuss the issue with me within the first week of class.

Academic integrity The honor code is in effect throughout the semester. By taking this course, you affirm that it is a violation of the code to cheat on exams, to plagiarize, to deviate from the teachers instructions about collaboration on work that is submitted for grades, to give false information to a faculty member, and to undertake any other form of academic misconduct. You agree that the teacher is entitled to move you to another seat during examinations, without explanation. You also affirm that if you witness others violating the code you have a duty to report them to the honor council. http://catalog.college.emory.edu/academic/policies-regulations/honor-code.html

Class notes Much of the material needed to succeed on the exams and problem sets will be covered in lecture and subsequent discussions. I will provide lecture notes on Canvas sometimes before class and sometimes after, but be advised that these notes are only a rough guide for discussion and will not include all the material discussed in lecture. **They are not a substitute for coming to class and taking notes**.

Grading and Evaluation

Student performance will be evaluated through several problem sets, two midterms, and a cumulative final exam. The final exam will take place at the place and time assigned by the registrar and will be a mix of essays and short answer questions. The final grade will be computed using the following weights:

4 Problem sets. 7.5% each.

Midtern 1: 20%

Midterm 2: 20%

Final Exam: 25%

Participation: 5%

The participation grade will be based on your activity on Piazza. Although I will not be able to answer all questions on Piazza, I encourage students to answer questions posted on this forum. I will keep track of student participation based on the quality of the questions and, more importantly, the answers provided on this online forum. You can post privately and still in the aggregate I will be able to see how many 'good' participations you had. I expect that you treat each other with absolute respect. No offensive language will be tolerated.

Procedure for Appealing a Grade If you believe that your grade on any assignment or exam question is incorrect or unfair, you should submit your concerns, in writing, to the professor within a week after the exam has been returned. The written appeal should fully summarize what you believe the problems are and why. The professor and the TA responsible for the particular problem will consider your appeal. Grade changes will be noted via an announcement on chalk with your student number and the change in grade. If you are not satisfied with the response, you may resubmit the assignment or question for regrading in its entirety by the professor. This grade will be final. Note that grades may go up or down during an appeal.

Attendance Attendance is mandatory in this class. No points are deducted on the basis of an absence alone; however, anything taught in class is testable material, and not everything covered will be in the course reading material. In addition, participation and attendance may influence letter-grading decisions in borderline cases.

Incomplete grades Incomplete grades will not be given unless there is an agreement between the instructor and the student prior to the end of the course. The instructor reserves the right to determine if the incomplete grade will be given; requests for incompletes will generally be granted only in extreme circumstances. The Office for Undergraduate Education will need to sign off on all such requests.

Important Due Dates All problem sets should be uploaded to Canvas by 9:30 a.m on the due date.

Problem Set 1, September 25

Midterm 1, October 7 (in class)

Problem Set 2, October 28

Midterm 2, November 11 (in class)

Problem Set 3, November 25

Problem Set 4, December 10

Final Exam, December 18, 11:30am-2:00pm.

Texts

The required textbooks are:

> Ellenberg, Jordon. 2014. How Not to Be Wrong: The Power of Mathematical Thinking. Penguin Books.
>
> Bueno de Mesquita, Ethan. 2014. Thinking: A Practitioner's Guide. Unpublished manuscript (available on the course website).

Additional readings listed in the course schedule will be provided in PDF format on the Canvas site. The readings should be completed *before* coming to class on the day they are listed. I will modify some of the readings if necessary and will make the announcements on Canvas+Piazza ahead of time.

Comments about the class

I have enabled a Free Suggestion Box so that you can make anonymous comments about the class. All comments will be anonymous. Please, be respectful in your comments. The link for the Suggestion Box is available at: http://freesuggestionbox.com/pub/gixzbne.

Class schedule

Key takeaway concepts are denoted with (!). Schedule is tentative and is subject to changes. Any change will be announced on Canvas+Piazza.

1 Causation and Fundamental Problems in Learning from Data

In this section of the class we discuss definitions of correlation and causation and why they are different. We arrive at our final key definition of causation: Counterfactual Dependence and discuss limits to coherent causal questions. We then discuss fundamental mistakes in identifying causal relationships in data.

Week I

Wednesday, August 28 Course intro: Overview, Quantitative Analysis and Critical Thinking.

Bueno de Mesquita, Introduction

Ellenberg, Introduction (When Am I Going to Use This?)

Takeaway: Data and Thinking. Example of best practices.

Week II

Wednesday, September 4 Answering Questions vs. Modeling

Ellenberg, Chapters 1 and 3

Takeaway: Definition of Correlation (!). Basics of Prediction. Linearity.

Week III

Monday, September 9 Philosophy of Causation

Wednesday, September 11 Always Compare

Bueno de Mesquita, Chapter 1

Takeaway: Problem with selecting on dependent Variable (!)

Takeaway: Data and Thinking. Example of best practices. Definition of Counterfactual Dependence (!)

Week IV

Monday, September 16 Compare Apples to Apples

Bueno de Mesquita, Chapter 2

Problem Set 1 Distributed

Takeaway: Selection/Common Cause/Invalid Comparisons (!)

Wednesday, September 18 Think about the Direction of Causality

Bueno de Mesquita, Chapter 3

Takeaway: Reverse Causation (!)

Week V

Monday, September 23 Randomized Experiments I

Angrist and Pischke, Chapter 1

Schultz, Paul (2004). "School subsidies for the poor: evaluating the Mexican Progresa poverty program." *Journal of Development Economics*, Vol. 74, pp. 199-250.

Takeaway: Experiments as a solution to the fundamental problem of causal inference (!)

Wednesday, September 25 Randomized Experiments II

Problem Set 1 Due

Takeaway: Basics of statistical inference (!), Hypothesis Testing

Week VI

Monday, September 30 Randomized Experiments III

Takeaway: Threats to Experiments

Wednesday, October 2 Catch-Up Review

Week VII

Monday, October 7 Midterm Exam

Wednesday, October 9 Observational Design I: Regression, Matching, and Selection on Observables

Angrist and Pischke, Chapter 2

Week VIII

Wednesday, October 16 Observational Design II: Comparing Apples to Apples is Harder than it sounds

Problem Set 2 Distributed

Takeaway: Problems with Causal Inference with Simple Regression, Selection (!)

Week IX

Monday, October 21 Observational Design III: Difference-in-Difference Design

Takeaway: Basics of Diff-in-Diff estimator

Wednesday, October 23 Catch-up Review

Week X

Monday, October 28 Catch-up Review. **Problem Set 2 Due**

Wednesday, October 30 . Observational Design IV: Natural and quasi-experiments.

Card, D., and Krueger, A. B. (1994). "Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania." *The American Economic Review*, 84(4), 772-793.

Takeaway: Benefits and Limits of Natural Experiments (!)

Week XI

Monday, November 4 Observational Design V: Instrumental variables and Regression Discontinuity

Angrist, Joshua, and Victor Lavy (1999). "Using Maimonides' Rule to Estimate the Effect of Class Size on Scholastic Achievement." *The Quarterly Journal of Economics*, Vol. 114, No. 2, pp. 533–575.

Takeaway: IV estimator, RDD

Wednesday, November 6 Multiple Testing, Reporting Bias, and Misinterpreting Outliers

Bueno de Mesquita, Chapter 5

Ellenberg, Chapters 6, 7 and 9

Takeaway: The Problem of Multiple Testing (!)

Week XII

Monday, November 11 *Midterm 2 (in class)*

Wednesday, November 13 Bayesian Inference I

Ellenberg, Chapter 10

Takeaway: Bayes' Rule (!)

Week XIII

Monday, November 18 Bayesian Inference II

Problem Set 3 Distributed

Takeaway: Using our Priors

Wednesday, November 20 Signal to Noise and Regression to the Mean.

Ellenberg, Chapter 14 and 15

Takeaway: Definition of Regression to the Mean (!)

Week XIV

Monday, November 25 Signal to Noise and Regression to the Mean continued.

Wednesday, November 27 Adaptation

Bueno de Mesquita, Chapter 4

Problem Set 3 Due

Takeaway: The problem of Behavioral Adaption

Week XV

Monday, December 2 Remember the Question. Perils and Pitfalls of Quantitative Analysis.

Bueno de Mesquita, Chapter 6

Ellenberg, Chapter 4 and 5

Bueno de Mesquita, Ethan. 2013. The Perils of Quantification. The Aims of Public Policy Address, University of Chicago (available on the course website)

Takeaway: Big versus Small Questions. The Problem with Quantification.

Wednesday, December 4 Topics on Prediction and Machine Learning. (Optional topic).

Takeaway: Basic notions of supervised and unsupervised learning.

Week XVI

Monday, December 9 Exam Review. Problem Set 4 Due.

Final Exam

Wednesday, December 17, 11:30 A.M - 2:00 P.M