# GEOL 145
# Lies, damn lies and statistics

Julien Emile-Geay

Spring 2019

## General Information

*Where/When* Class meets Mon/Wed/Fri, 11:00–11:50 am in SAL101.
Discussions (2h / week) meet in ZHS 130. (register separately)

*Instructors*

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|---|---|---|---|
| Professor: | Julien Emile-Geay | ZHS 275 | julieneg@usc.edu |
| Teaching Assistants: | Marshall Rodgers-Martinez | ZHS B13 | rogersma@usc.edu |
| | Yifang Cheng | ZHS 264 | chengyif@usc.edu |

*Office Hours* MWF 10-11 in ZHS 275, or by appointment.

## Course Description

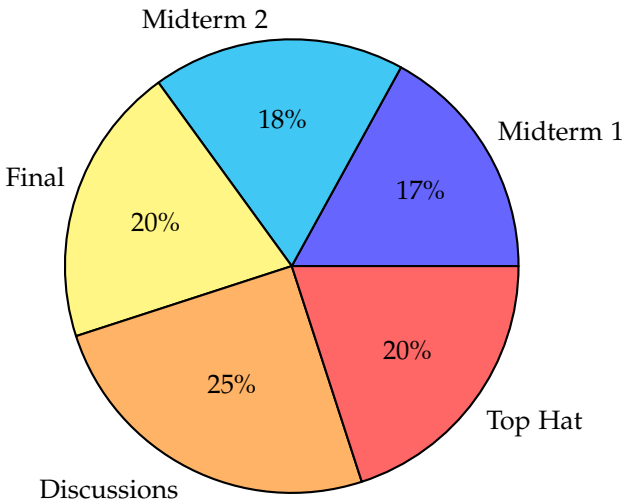
*Synopsis* No sooner have we entered the Information Age that we find ourselves shrouded in misinformation. "Alternative facts", "post-truth" and "fake news" have replaced the age-old propaganda. With most of us increasingly seeking information from disjoint opinion bubbles, how is an informed person to make a rational judgment on hot-button issues such as climate change, evolution, gun violence, vaccine safety, genetically modified organisms, or nuclear risk? What separates truth from denial? Fact from fiction? Rational risk assessment from alarmism?

This class (GE-F Quantitative Reasoning) will introduce you to evidence-based methods to form reliable judgements on any topic where quantitative measurements exist. The class will first focus on man-made climate change as a parable for any complex topic where expert consensus and societal perceptions differ. Along the way, you will learn the basics of statistics and data science and how to apply them to almost any problem. In so doing, you will learn a bit about physics, psychology, biology, and yes, maths. Finally, a series of case studies will apply the quantitative reasoning skills to a number of contemporary controversies, partially guided by class student interest.

*Course Catalog Description* Quantitative reasoning tools to form reliable judgements from quantitative evidence, discerning truth from lies, science from pseudoscience. Application to contemporary scientific and social issues.

*Learning Objectives* Students will learn to soundly reason from quantitative evidence. They will learn to: empirically analyze data; understand the logical structure of evidence-based arguments; deconstruct common logical fallacies that use the data incompletely or improperly ("lying with data"). Students will apply skills such as inductive, deductive, and mathematical reasoning to solve problems. Students will learn how to apply probabilistic reasoning to discriminate between competing hypotheses based on factual evidence. Students will learn how to critically evaluate quantitative claims in visual and written forms. Students will demonstrate proficiency in the visual display of quantitative information and associated plotting and editing software.

*Requirements* This course requires the ability to adjust your beliefs when exposed to data that contradicts prior opinions. A personal computer with Python 3 installed[1] is helpful, but not required.




*Grade*

The class is worth 4 units, which means that it requires substantial work. Attendance to discussion sections is mandatory (register separately, please).

Table 1: Numeric to letter grade conversion (cutoffs)

| $< 60$ | 60 | 64 | 67 | 70 | 74 | 77 | 80 | 84 | 87 | 90 | $\geq 94$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F | D- | D | D+ | C- | C | C+ | B- | B | B+ | A- | A |

*Rules* There are few rules, and they're all important. First, you should read the syllabus (if you've gotten this far, you're on the right track). Second, please check BlackBoard and make sure you receive its announcements. Third, please ask questions when you don't understand things; chances are you're not alone. Fourth, don't miss class or lab. Fifth, please do not email the instructor with questions whose answer is in the syllabus. Sixth, under no circumstance should you ever even think of haggling for your grade. Seven, read the syllabus once more (just in case). If you still have questions, we'll be glad to answer them.

## Reading

**Books**

- Gonick, L. & Smith, W. *The Cartoon Guide to Statistics*, URL, IBSN: 978-0062731029.
- Levitin, D. *A Field Guide to Lies and Statistics*. URL, ISBN-13: 978-0241974872.

**Blackboard**

Weekly readings will be posted on BlackBoard. Check it!

[1] https://www.continuum.io/downloads

# Course Schedule

## I Settled Science that Unsettles People

### Week 1 — 01/07/19— Introduction

**Lectures** Class roadmap; Facts, myths, theories, measurements, experts. Operation Infektion.

**Assignment:** 5 quantitative claims you wish to investigate. (see this for inspiration)

### Week 2 — 01/14/19— Vaccines

**Lectures** Climate denial; Vaccine efficacy & denial; Evolution & Creationism

**Reading** 8 common arguments against vaccines

**Discussion** Why are vaccination rates declining?

### Week 3 — 01/21/19— Life and death

**Lectures** (Monday: MLK day). Sugar vs fat; Tobacco mortality

**Assignment:** The Disinformation Playbook

**Discussion** The Tobacco Strategy

## II Evidence-based Reasoning

### Week 4 — 01/28/19— Principles of Data Science I

**Lectures** Data Description & Visualization. Probability calculus.

**Discussion** Data analysis with Python

### Week 5 — 02/04/19— Principles of Data Science II

**Lectures** Distributions. Exploratory Data Analysis. Normality.

**Assignment** G&S, chapter 1–5

**Discussion** Probability Lab. Quincux game.

### Week 6 — 02/11/19— Principles of Data Science III

**Lectures** Monday: President's Day. Correlations. Linear regression. Statistical tests.

**Assignment** G&S, chapters 9–11

**Discussion** Fitting trends to data

**Exam** Friday **Midterm 1**

### Week 7 — 02/18/19— Statistical Booby Traps

**Lectures** Bayes' Theorem and the Prosecutor's Fallacy. Means & Medians. p-hacking. Censoring. Long-tailed distributions.

**Assignment** G&S, chapter 6–8

**Discussion** Spurious correlations. Storks deliver babies ($p = 0.008$)

### Week 8 — 02/25/19— On the shoulders of giants

**Lectures** Scientific reasoning; Good Science, Bad Science, and Ugly Science; Scientific Legitimacy

**Assignment** How do you know a paper is legit?; Fake Scientists

**Discussion** Expert identification game

### Week 9 — 03/04/19— Logical Reasoning

**Lectures** How to fool others: informal fallacies. How to fool yourself: motivated reasoning, confirmation bias, cultural cognition;

**Assignment** Harstorf & Cantril, *They Saw a game*

**Discussion** Logical Fallacies, argumentative robots, and witch-burning arguments.

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### SPRING RECESS : March 10 – 17

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### Week 10 — 03/18/19— Deception

**Lectures** Merchants of doubt, parts 1 and 2.

**Exam** Friday: **Midterm 2**.

## III Spotlight: Anthropogenic climate change

We finish this class with a survey of climate science, one of the topics where the gap between scientific consensus is the largest. We explore the reasons for this gap in detail.

### Week 11 — 03/25/19— Climate Change

**Lectures** The discovery of global warming. The climate data patchwork

**Assignment** Weart, *The Carbon dioxide greenhouse effect*

**Discussion** Reasoning with the temperature record

### Week 12 — 04/01/19— Climate Physics

**Lectures** Energy conservation; Greenhouse effect; Carbon Cycle;

**Assignments** S. Weart, The Carbon Cycle.

**Discussion** Planetary energy balance

### Week 13 — 04/08/19— Climate models

**Lectures** 1D climate models. General circulation models. Forcings, Feedbacks & Climate Sensitivity.

**Discussion** Reasoning with general circulation models

### Week 14 — 04/15/19— A greenhouse world

**Lectures** Attribution. Climate Projections & Impacts.

**Assignment** A. Hoffman, *Climate Science as Culture War.*.

**Discussion** Climate Tribalism

### Week 15 — 04/22/19— Agnotology

**Lectures** The American Denial of Global Warming. Climate change in the media. Can we be rational about climate change?

**Assignment** The Collapse of Western Civilization: A View from the Future.

**Discussion** Climate Narratives

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### Wed May 1 – Final Exam (cumulative) –

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## IV Technology

### Blackboard

BlackBoard is our primary medium of communication outside the classroom. It is where I post class notes, announcements, and assignments. Is is where you access that content, participate in discussions, and check your grades. **It is your responsibility to ensure that you receive BlackBoard announcements**. Make sure you enable email notifications, and importantly, make sure your inbox is not full; every year I get emails bounced from students too neglectful to clean up their inbox. If you have a doubt about when an assignment is due, go check it on BlackBoard. Also note that BlackBoard messages are richer than the email notifications they generate. Frequently, the announcements I'll send will have links to content archived on BlackBoard – those links will not appear in the emails. If the email digest you read does not make sense, please check it on BlackBoard; it might have the answer you need over there. If it still doesn't, please email me.

### Top Hat

The tool we will use to gather live, in-class feedback is called Top Hat. You may submit your responses in one of three ways: Text messages, a Smartphone App, or a Web browser. In case you have not received an invitation to join the course on Top Hat, here's how to get started.

The economics are as follows: $20 for a semester-long license or $38 for a 5-year license (unlimited number of classes). **Purchase of a license is required to get in-class discussion points (10% of the grade)**. The course code is _.

Our class registration code is 152725.

### Email etiquette

Email is a relatively new advent in the world of education. It allows an unparalleled level of access to professors, which has both pros and cons. In some cases you will spot a mistake of mine in an assignment or a grade, and pointing it out will save everyone a lot of time. In many cases, however, emails unnecessary clog my inbox. Here are some rules to use email wisely:

- Check BlackBoard before you type. Chances are the answer you seek is already there.
- Direct all lab-related queries to your TA.
- Write exactly as if you were speaking to me in person. Not more, not less formally.

Emails that break any one of these rules will not receive an answer. If you can spare the time, please come to office hours or see me after class. I'd much rather talk to a human than a computer, and I have yet to bite a student. Other email etiquette tips may be found here.

### Laptops & Tablets

Laptops and tablets look way cool, but they have proven far less effective than good old pen&paper at information retention. Moreover, their use in the classroom can be disruptive to you and people around you if you use them for activities unrelated to the class. Please exercise best judgment and be considerate of others around you.

## V Student Affairs

### Plagiarism

Presenting someone else's ideas as your own, either verbatim or recast in your own words, is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Section 11, Behavior Violating University Standards. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct.

### Discrimination

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the Office of Equity and Diversity or to the Department of Public Safety . This is important for the safety whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. The Center for Women and Men provides 24/7 confidential support, and the sexual assault resource center webpage describes reporting options and other resources.

### Support Systems

**Student Counseling Services (SCS)** (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.
`https://engemannshc.usc.edu/counseling/`

**National Suicide Prevention Lifeline** –1-800-273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.
`http://www.suicidepreventionlifeline.org`

**Relationship & Sexual Violence Prevention Services (RSVP)** – (213) 740-4900 – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.
`https://engemannshc.usc.edu/rsvp/`

**Sexual Assault Resource Center** For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: `http://sarc.usc.edu/`

**Office of Equity and Diversity (OED)** (Title IX compliance) – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. `https://equity.usc.edu/`

**Bias Assessment Response and Support** Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. `https://studentaffairs.usc.edu/bias-assessment-response-support/`

**Student Support & Advocacy** – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic.
`https://studentaffairs.usc.edu/ssa/`

**Diversity at USC** Tabs for Events, Programs and Training, Task Force (including representatives for each school), Chronology, Participate, Resources for Students.
`https://diversity.usc.edu/`

## GradeBuddy

The following is a reminder from Academic Policies memo 11/25:
*Any student selling or distributing notes taken in a classroom is in violation of the University's Academic Integrity policy and is subject to university sanctions. This policy is clearly stated in Section 11.12 of the student handbook, SCampus, which identifies the following as violations of community standards:*

- *Acquisition of term papers or other assignments from any source and the subsequent presentation of those materials as the student's own work, or providing term papers or assignments that another student submits as his/her own work.*
- *Distribution or use of notes or recordings based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes, but is not limited to, providing materials for distribution by services publishing class notes. This restriction on unauthorized use also applies to all information which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the Internet or via any other media. (See Section C.1 Class Notes Policy.)*
- *Recording a university class without the express permission of the instructor and announcement to the class. Recording can inhibit future free discussion and thus infringe on the academic freedom of other students as well as the instructor.*