Stat 238, Fall 2025
Project Minis

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Due: by **11:00 am** Tuesday, February 25, 2025

Submission Instructions

Project minis should be uploaded to Gradescope under the appropriate mini-assignment. If you work in a group (eligible projects are marked), you should submit one assignment, and link your partners. Please do not submit duplicated assignments.

Please read the project description in full before starting with your group. You do not need to read all the logistical details if you are not interested in this project, simply wait for a new one.

Mini Project 1: Dead Horse Talk

Is Bayesian statistics a valid epistemology?

The validity of Bayesian inference as a scientific epistemology (theory of knowledge) is one of the oldest and most acrimonious debates in statistics and the philosophy of science. It is often summarized as the "Bayesian vs. Frequentist" debate, and is, in many ways, a dead horse topic that most modern statisticians have decided to stop beating. Indeed, this class will follow the zeitgeist, which says "Oh, pha! (throws up hands) Enough with that albatross. We'll proceed with what works and leave the debate to the philosophers."

Does it matter?

Nevertheless, as members of a Bayesian stats class, you should be able to speak intelligently on this topic. In particular, you should be educated enough to clearly voice an opinion. After all, what is statistics, at its core, if not a philosophy of knowledge? To put it bluntly, what else do we really talk about when we talk about statistics?

A downside of the technocratic approach (let's only look at methods), is that it fails to prepare students to speak up and to defend their opinion regarding methods.[1] At worst, it can leave practitioners unequipped, or unwilling, to rebut criticism from "deeper" or more "rigorous" thinkers. It would be a real failure for Bayesian statisticians to cede their voice, and the value of their experience, in debates over the philosophy of their practice.

[1] In part, the trend here is cultural. Scientific training tends to avoid topics and exercises that are more traditionally associated with the humanities - in part - from a misplaced sense of exceptionalism or taboo.

So, while we will not discuss this debate at length in class, it is my hope that, if you are interested in it, you have the opportunity to learn about it, and to define your position. This project mini aims to provide that space. In this project, you will debate the validity of Bayesian statistics as a philosophy of science, as well as the relevance of philosophies of science to scientific practice. There are deep questions here regarding the effectiveness of mathematical models, the meaning of valid inference, the substance and mediums of scientific "progress", the existence and "know-ability" of ground truth, etc.

(a) **Group Formation:** This is a group discussion project. You may form groups of up to four. To find partners, either talk to your friends in class, your lab group, or, post in the Ed megathread associated to this project. If you intend to complete this project, you must have formed a group by the end of this week (Sunday, February 2nd).

(b) Consider the following extreme poles of opinion:

- **The cynic** argues against the validity of Bayesian statistics.
  Science advances deductively via falsification. We can only disprove hypotheses. Prior modeling encodes belief, but mixes it with apparently objective mathematics that obscure the introduced biases. Beware the modeler's safety blanket, "All models are wrong, some models are useful ... so it's ok if my model is wrong." Probability is only concretely meaningful in the frequency sense, with respect to variables that are, in principle observable (contrast with unknowns that are never directly observable, such as regression coefficients). Thus, in practice, and in theory, Bayesian statistics is mathematically consistent, but insidiously subjective.
  At worst, this opinion relapses into risk-averse pedantry that eschews the possibility of any positive theory of knowledge.
- **The believer** argues for the validity of Bayesian statistics.
  If it is valid to model observables as random given unknowns, then it seems inconsistent to insist that it is never valid to model the unknowns as random. Frequentist statistics feign objectivity, but don't discuss the subjectivity of likelihood modeling, or the reductionism of test frameworks. Arguing that we cannot reliably model prior knowledge argues, in its extreme, that we cannot, or do not, ever know things about our problems, that no unknowns are drawn from simple priors, or, that it is impossible to model complex distributions. Probability is an intuitive, self-consistent, and decision-theory optimal mathematical framework for expressing uncertainty and information. Science advances inductively by example. Information is acquired by conditioning on observations.
  At worst, this opinion relapses into recklessly subjective speculation - "my model told me so!" - or a tautology.
- **The pragmatist** argues that scientific practice should be shaped by utility/results.
  Philosophies of science are not relevant to scientific practice. The two communities are largely independent. Rather, science is as science does. Science does what worked. The astounding success of the scientific community need not be debated. Have you seen holograms? Lasers? Nuclear energy? Received an MRNA vaccine? Used plastic materials? Worked on a computer that uses microchips? Watched a video on a screen lit by LED's? *Blue* LED's? Gotten lost in the last fifteen years while synched to GPS? Need we debate this again? Let's get on with the work.

At worst, this opinion reduces into a statement of faith or into a small-mided exercise in drawing ever narrower boundaries around the problems we are willing to discuss.

- **The philosopher,** argues that scientific practice should be shaped by philosophical concerns regarding knowledge.

  All pragmatists are in the thrall of a dead methodologist. All scientific practices inherently advance an epistemology, implict or explicit. Applying methods without addressing their foundations surrenders a claim to the pursuit of truth.

  At worst, this opinion reduces to hopeless abstraction divorced from the lived practice of the communities of science, or from reasonably rich characterization of the real standards of evidence. Overly formal models of scientific progress are usually shabby fits to the real thing.

These poles have been arranged to caricature major sides of the debate. Imagine drawing a chart with two axes, and position the opinions on these axes. Take a moment, and work out, roughly, where you would place yourself in this space.

(c) **Positions:** For the sake of debate, each member of your group should adopt to represent a different corner of this space. Try to align your choices to your general beliefs, but, make sure that you are separated enough to hold a substantive debate.

(d) **Forum:** Create a time stamped Ed discussion channel with your group members. To do so, message the instructional staff stating your intention to complete this project and your team members. Email zhexiolin@berkeleu.edu with the header *[STAT 238] - Mini Project 1 Group.* We will create the channel for you.

The debate will proceed in stages. Please check the italicized timeline associated with the stages below. This timeline is to ensure that you have time to read, digest ideas, and substantively respond to each other. Make sure everyone in your group has read these instructions before starting. We may dock points from groups whose work veers too far from the suggested schedule. In particular, if all the work is done in the last week, then the debate will not be accepted.

(e) **Format:** Please abide by the format outlined below. Discussions that vary too far from the provided format may not be accepted until corrected. *For all stages except 5 (open discussion), please start your posts with* ***[Stage <insert stage number>].***

(f) **Etiquette and Group Problems:** Ed is an extension of the formal course, so the course behavior expectations applied. In particular, since this project is posed as a debate, be careful to remain respectful. You are encouraged to challenge each other intellectually, but must remain collaborative, open, and decent.

If your group is experiencing unresolveable issues, please contact us (see the equivalent statements in the lab group policy).

(g) **Materials:** Each participant must substantively cite at least two relevant sources. Collectively, the group must cite at least four sources.

Your comments must show genuine engagment with your sources. *Reading at least two opinions in this space is required for this project.* I encourage you to suggest reading to each other, and point your partners to sources you find/found interesting. Sources

must satisfy the usual standards of quality (e.g. no blog posts except by petition). Course resources and required reading may be referenced, but will not count to your two sources. If you are unsure about a source, come ask us. If you are unsure where to start, we can point you to the course librarian. As much as possible, your arguments should either be sourced, or rooted in your experience.

For inspiration, look to the resources posted here and sources therein. The bibliographical note at the end of the first chapter of BDA is a good starting point. As is the bibliography in the required week 2 reading on philosophy and practice (Gelman). Other influential voices here include Thomas Kuhn (see, *The Structure of Scientific Revolutions*), Karl Popper (search *falsification*), David Hume (see his *problem of induction*), and, for the really enthusiastic, Schafer and Shapin (on the origins of empiricism, see *The Leviathan and the Air Pump*).[2] I was also recently pointed to Aubrey Clayton's work (see *Bernoulli's Fallacy*).

On submission, please collate and attach a bibliography, and update your posts to reference sources by number. If you want to make a bibliography post at the start, you are welcome to.

(h) **Submission:** One group member should create a pdf print-out of the Ed discussion and upload it to Gradescope before the deadline. As with all project minis, you will have the opportunity to resubmit based on instructor feedback for your final project portfolio.

Go to the next page to see the debate format

[2]This last source is a bit tangential, but is great if you want to learn about the formative debates that shaped the scientific method. It speaks more to the second pole than the first.

Debate and Discussion Format

(a) **Stage 0:** Before beginning the debate, draft a clearly defined summary of your true position (4 - 8 sentences). Post this privately in the group.

(b) **Stage 1: Leading Statements** Then, in turns, each state your assigned opinion in 2 - 3 sentences. I encourage you to state it as strongly and emphatically as responsibly possible (i.e. without reducing to a strawmen).

(c) **Stage 2: Argument and Elaboration** Read your partners leading (this is to help position your argument), then argue your position (don't rebut yet). Elaborate on your leading statement. Elaboration should be a paragraph to three paragraphs. You may use the reply function on your own leading statements. *Stages 0 - 2 should be completed within a week of forming your group, and at least two weeks before submission.*

(d) **Stage 3: Rebuttal** In turns, respond to your group member's positions. Please do not use the reply function. Instead, make successive posts so that the channel runs in order. You may use links to reference specific posts. Rebuttals should be a paragraph to three long.

(e) **Stage 4: Defense and Elaboration** Respond to your group members comments. Again, post linearly and link for reference. Your defense should not exceed four to five paragraphs.

(f) **Stage 5: Open Discussion** You may make short, open replies to your partners. These need not be oppositional/argumentative. This stage is an attempt to reach consesus, cede points, and to balance opinions. For this stage, you may use the reply function to nest your comments under specific posts. *Stages 3 - 5 should be completed at least one week before submission.*

(g) **Stage 6: Conclusions** Make a final post summarizing how your (true) position has, or has not changed, based on the discussion. Please be honest and reflective. You may use this space to cite comments a partner made that impacted your position, to suggest a question or source you would like to follow up on, how your opinion has evolved as you've learned more through the course, etc. This section must include a reference to your original position statement (private, stage 0). *Stage 6 should be completed in the last week before submission.*