Syllabus: Philosophy of Science

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Course Description

Science constitutes the most successful human endeavor in cumulative acquisition of knowledge of the natural world. Why? What, if anything, separates science from pseudoscience? How literally should we interpret our best physical theories? What does scientific explanation consist in? Can we precisely formulate the relationship of evidence to theory? When and why is a simpler theory better? And how are we to understand the current replication crisis in the social and life sciences? Together, we'll explore these questions, and others, in weekly readings and discussions, and embark together on a path to a richer understanding of philosophy of science.

Student Learning Outcomes

By the end of this course, you will be able to:

1. Summarize some of the central debates in philosophy of science;
2. Evaluate arguments and evidence for the various positions in these debates;
3. Write a paper defending a thesis on a philosophical topic.

Course Texts

You do not need to purchase any texts for this course. All readings will be made available on the course site.

Course Structure

Each week, we will do readings and discuss a different topic in the philosophy of science.

- There will be a weekly reading posted on the course site
- There will be weekly *reading summary*
- There will be a weekly *reflection question*
- There will be a *course paper*, submitted at multiple stages

Assignments

Participation. You are expected to actively participate in class discussions by bringing your own questions, listening thoughtfully, and responding to the questions of your peers.

Reading summaries. Each week you will be asked to submit concise reading summaries demonstrating that you have read and made an effort to understand that week's readings.

Reflection questions. Each week you will be given one or more 'reflection questions' during lectures meant to have you grapple with some philosophical or practical problem. There is no correct answer to these; rather, they are meant to get you to think deeply about the nature of a problem.

Final paper: You will write a 1000-1500 word essay that does one of the following: (1) surveys the positions on some topic of your choice within philosophy of science, broadly construed; (2) presents an extended criticism of some position in philosophy of science; or (3) articulates an original position in some topic in philosophy of science. All of these are valid options. That said, articulating an original position (3) tends to be harder than criticizing one (2) which tends to be harder than surveying existing positions (1).

Extra Credit. There will be an opportunity to earn extra credit by diving deeper into one of the 'further readings' for a week of your choice and writing an additional essay (500-1,000 words) summarizing the logical structures of its main arguments.

Grading Breakdown

You final grade for the course will be determined by:

Active participation	20%
Reading summaries	20%
Refelction questions	20%
Paper, thesis & outline	10%
Paper, first draft	10%
Paper, final draft	20%

Grading Scale

A+ : 100–98 % $\geq$ A : 97–93 % $\geq$ A– : 92–90 % $\geq$

B+ : 89–88 % $\geq$ B : 87–83 % $\geq$ B– : 82–80 % $\geq$

C+ : 79–78 % $\geq$ C : 77–73 % $\geq$ C– : 72–70 % $\geq$

D+ : 69–68 % $\geq$ D : 67–63 % $\geq$ D– : 62–60 % $\geq$

F : 59–0 %

Late Work Policy

Late work suffers a penalty of 10% of the maximum grade per day. So, an assignment that is two days late can at best get an 80%.

Exceptions to this policy are only made in cases where either (1) official, school-sanctioned documentation is provided, or (2) you have contacted me at least a week ahead of the assignment due date and we have come to some sort of alternative arrangement together.

Also, your lowest grade in each the reading quizzes and reflection questions will be dropped. So, you can effectively be arbitrarily late on one one reading summary and one reflection question without suffering any penalty to your grade.

Participation and Attendance

You get your participation grade by showing up to both lectures with me and recitations with your TA. You can miss two lectures without any loss to your participation grade. You are not required to give a reason for these. You can also miss two recitations without any loss to your participation. You are not required to give a reason for these. For any more than two missed lectures or recitations, however, you must have a doctor's note or equivalent official documentation, otherwise you will lose part of your participation grade.

How to Succeed in this Course

My advice for succeeding in this course is as follows:

- show up to the lectures and recitations and be prepared to participate;
- do the weekly readings and complete the weekly reading summaries;
- complete the weekly reflection questions;
- begin the paper assignment early and allocate reasonable time for it.

If you do all these things, I predict that you will do very well in the course!

Office Hours and Getting Help

The TA and I will hold office hours at set times during the week. You are enthusiastically encouraged to come to these hours! The purpose of these office hours is for you to ask any questions you may have about lectures, assignments, or the course; to discuss any difficulties, concerns, or questions regarding the course or your performance; and just to enjoy chatting about philosophy!

You can also contact me or the TA via email. When write to the TA, always do so very respectfully. You should typically allow for 48 hours for a response to an email.

Academic Honesty

This course will follow the University policy on academic integrity. If you are unsure about the University's policies and definitions regarding academic integrity and plagiarism see: `https://upenn.edu/code-of-academic-integrity/`.

Disabilities

If you have any questions or concerns about disability accommodations, please don't hesitate to speak with me; I am very happy to help out! In general, if you have a disability for which you may be requesting an accommodation, you are encouraged to contact the Disability Services Center (`https://wlrc.vpul.upenn.edu/disability-services/`). The Disability Services Center will verify your disability and ensure you get appropriate accommodations for this course.

Course Calendar

The schedule is open to change in response to our evolving interests. Below are the readings that should be completed by beginning of each class. All readings will be made available on the course website.

WEEK 1. **The Demarcation Problem: Falsifiability & Testabilty**
Karl Popper (1935) "A Survey of Some Fundamental Problems" in *The Logic of Scientific Discovery*, pp. 3–27
Elliott Sober (1999) "Testability" *Proceedings and Addresses of the American Philosophical Association,* 73 (2):47-76
Further Reading
Richard Jeffrey (1975) "Probability and falsification: Critique of the popper program" *Synthese* 30 (1975) 95-117.

WEEK 2. **Confirmation Holism and Undeterdetermination**
Pierre Duhem (1954) "Physical Theory and Experiment" in *The Aim and Structure of Physical Theory* pp. 180-195, 208-218
Jon Dorling (1979) "The Methodology of Scientific Research Programmes, and Duhem's Problem" in *Studies in History and Philosophy of Science*, 10:177-87.
Further Reading
Deborah Mayo (1997) "Duhem's Problem, the Bayesian Way, and Error Statistics" *Philosophy of Science*, 64:222–44

WEEK 3. **Old and New Problems of Induction**
David Hume (1739) Book 1, Part 3, Section 6 in *A Treatise of Human Nature*
Nelson Goodman (1955) "The New Riddle of Induction" in *Fact fiction and forecast*
Further Reading
John Norton (2005)"A Little Survey of Induction," in *Scientific Evidence: Philosophical*

Theories and Applications 9-34.
D. H. Wolpert and W. G. Macready (1997) "No free lunch theorems for optimization," in *IEEE Transactions on Evolutionary Computation* 1(1):67-82

WEEK 4. **Theory Change: Normal Science and Scientific Revolutions**
Thomas Kuhn (1962) "Progress through Revolutions" in *The Structure of Scientific Revolutions*
Imre Lakatos (1978) "A methodology of scientific research programmes" in *Methodology of Scientific Research Programmes*
Further Reading
Feyerabend (1975) Chapter 1 in *Against Method*, pp. 14–19

WEEK 5. **Realism and Antirealism: The Status of Unobservables**
Laudan (1981) "A Confutation of Convergent Realism" *Philosophy of Science*, 48 (1):19-49
Worrall (1989) "Structural Realism: The Best of Both Worlds?" *Dialectica*, 43(1):99-124
Further Reading
Kyle Stanford (2019) "A Middle Path Forward in the Scientific Realism Debate"

WEEK 6. **Scientific Models & Representation**
Ludwig Boltzman (1911) "Model" *Encyclopedia Britannica*. Transcribed version.
Ron Giere (2004) "How Models are used to Represent Reality," *Philosophy of Science*, 71:742–752.
Further Reading
William Wimsatt (2007) "False Models as Means to Truer Theories " in *Re-Engineering Philosophy for Limited Beings: Piecewise Approximations to Reality*

WEEK 7. **Scientific Idealization of Various Kinds**
Ernan McMullin (1985) "Galilean Idealization" *Studies in History and Philosophy* 247-273.
Michael Weisberg, "Three Kinds of Idealization," *The Journal of Philosophy*, 104 (12):639-659.
Further Reading
Callender, Craig and Jonathan Cohen (2006) "There is No Problem of Scientific Representation," *Theoria* 55:67–85

WEEK 8. **Scientific Explanation: Nomological, Causal, and Pragmatic**
Carl Hempel and Paul Oppenheim (1948) "Studies in the Logic of Explanation" *Philosophy of Science*, 15 (2):135-175
James Woodward (2007) "Causation with a Human Face" in *Causation, Physics, and the Constitution of Reality* pp. 66–105.
Further Reading
Bas Van Fraasen (1980) "To Save the Phenomena," Ch. 3 in *The Scientific Image*
Philip Kitcher (1989) "Explanatory Unification and the Causal Structure of the World"

in *Scientific Explanation: Minnesota Studies in the Philosophy of Science*, 13(4):430-48

WEEK 9. **Theories of Evidence: Severe Testing** | *paper thesis & outline due*
Lyon, Aidan (2009). "Philosophy of Probablilty." In *Philosophies of the Sciences: A Guide* Mayo Deborah G. & Cox, David (2006). "Frequentist statistics as a theory of inductive inference. in *Error and Inference: Recent Exchanges on Experimental Reasoning, Reliability, and the Objectivity and Rationality of Science.*

Further Reading

American Statistical Association (2016). "Statistical tests, P values, confidence intervals, and power: a guide to misinterpretations." European journal of epidemiology. 31(4), 337–350

WEEK 10. **Theories of Evidence: Bayesian Confirmation Theory I**
Michael Titelbaum (2019). Precise Credences. In *The Open Handbook of Formal Epistemology.* pp. 1-55
Peter Fishburn (1986) The Axioms of Subjective Probability *Statistical Sciences* 1(3): 335-345

Further Reading

Frank Ramsey (1926) "Truth and Probability", in *Foundations of Mathematics and other Essays*
James Joyce, "Bayes' Theorem" in *The Stanford Encyclopedia of Philosophy*

WEEK 11. **Theories of Evidence: Bayesian Confirmation Theory II**
Easwaran (2011) "Bayesianism I: Introduction and Arguments in Favor" Philosophy Compass 6(5):312–320
Colin Howson and Peter Urbach, "Bayesian vs Non-Bayesian Approaches to Confirmation," from Ch. 7 of *Scientific Reasoning: The Bayesian Approach.*

Further Reading

Alan Hajek (2008) "Arguments For, and Against, Probabilism?" *Journal for the Philosophy of Science*, 59(4):793-819
John Earman (1992) "The Problem of Old Evidence" in *Bayes or Bust? A Critical Examination of Bayesian Confirmation Theory* pp. 119-136

WEEK 12. **The Social Structure of Science I**
Philip Kitcher (1990) 'The Division of Cognitive Labor" *The Journal of Philosophy* lxxvii (1):5–22
Michael Strevens (2006) "The Role of the Priority Rule in Science" *Journal of Philosophy*, 2:55–79

Further Reading

Dasgupta, P., & David, P. A. (1994). Toward a New Economics of Science. Research Policy, 23(5), 487–521.
Weisberg, M., & Muldoon, R. (2009). "Epistemic Landscapes and the Division of Cognitive

Labor." *Philosophy of Science*, 76(April), 225–252.

WEEK 13. **The Social Structure of Science II** | *first draft of paper due*
Mayo-Wilson, Kevin J.S. Zollman, and David Danks (2011) "The Independence Thesis: When Individual and Social Epistemology Diverge" *Philosophy of Science* lxxviii, 4:653–77.
Kevin Zollman (2018) "The Credit Economy and the Economic Rationality of Science" *Journal of Philosophy,* 115 (1):5-33
Further Reading
Zollman, K. J. S. (2009). "The Epistemic Benefit of Transient Diversity." *Erkenntnis* 72, 17–35
Grim et al (2013). "Scientific Networks on Data Landscapes: Question Difficulty, Epistemic Success, and Convergence." *Episteme*, 10(04), 441–464.

WEEK 14. **The Replication Crisis I**
John Ioannidis (2005) "Why Most Published Research Findings Are False" *PLoS Med* 2(8)
False-Positive Psychology (2011) "False-Positive Psychology: Undisclosed Flexibility in Data Collection and Analysis Allows Presenting Anything as Significant" *Pyschological Science* 11:1359-1366
Further Reading
Freedmanet al (2018) "The Economics of Reproducibility in Preclinical Research." *PLoS Biology,* 13(6):e1002165
Camerer et al. (2018) "Evaluating the replicability of social science experiments in Nature and Science between 2010 and 2015" Natture: Human Behavior, 2:637–644

WEEK 15. **The Replication Crisis II**
Remco Heesen (2018) "Why the Reward Structure of Science Makes Reproducibility Problems Inevitable" *The Journal of Philosophy*, 115 (12):661-674
David Grimes, Chris Bauch, and John Ioannidis (2017) "Modeling science trustworthiness under publish or perish pressure" *Royal Society Open Science*
Further Reading
John Ioannidis (2014) How to Make More Published Research True. *PLoS Medicine* 11(10): e1001747
John et al (2012) "Measuring the Prevalence of Questionable Research Practices With Incentives for Truth Telling." *Psychological Science*, 23(5), 524-532

WEEK 16. **Finals Week** | *final draft of paper due*