

The History and Philosophy of Probability (Seminar in Metaphysics, 16:730:553)

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Philosophy Seminar Room, Fifth Floor, Room 524B, 106 Somerset Street, New Brunswick

As Ian Hacking explained in *The Emergence of Probability* (1975), the concept of probability is Janus-faced. One face looks at “degree of belief warranted by evidence,” while the other looks at “the tendency, displayed by some chance devices, to produce stable relative frequencies.” The first aspect has come to play a central role in epistemology and decision theory. The second is central to quantum mechanics, statistical mechanics, and other scientific models.

In this seminar, we will discuss the two faces of probability, their relations, and their history. Readings will include papers from Anthony Eagle’s *Philosophy of Probability: Contemporary Readings* (2011) and other sources. Students taking the seminar for credit will present one of the readings and write a research paper.

SCHEDULE

The readings marked with an asterisk will be discussed in class and should be read in advance. The other readings provide more perspective for those interested in the particular topic. Aside from the articles in Eagle’s *Philosophy of Probability*, which students should purchase, most of the readings listed will be posted on Sakai or are otherwise available online.

Week 1. September 11. Emergence of probability. In the 1970s, many scholars believed that the Janus-faced concept of mathematical probability first appeared in the 17th century. More recent scholarship has supported a less Euro-centric view. We now see the Janus faces in calculations taught in Paris in the 13th century, and it seems likely that these calculations came to Europe via the Arabs from much more ancient sources.

1. *Marie-France Bru & Bernard Bru (2017): Dice games. Translation by Glenn Shafer from *Le jeu de l’infinité et du hasard*, Presses universitaires de Besançon, forthcoming. 18 pp.
2. *Glenn Shafer et al. (2009): How to base probability theory on perfect-information games. Pages 1-7. <http://www.probabilityandfinance.com/articles/32.pdf>
3. *Ian Hacking (2006): *The Emergence of Probability*, Second Edition, Introduction and Chapters 1-2. 40 pp.
4. James Franklin (2001): *The Science of Conjecture: Evidence and Probability Before Pascal*, Chapter 11. Dice. 32 pp.
5. David R. Bellhouse (2000): *De vetula*: a medieval manuscript containing probability calculations. *International Statistical Review* 68(2):123-136.
6. Blaise Pascal & Pierre Fermat (1654): Letters concerning the problem of points. 15 pp. <http://www.cs.xu.edu/math/Sources/Pascal/Sources/pasfer.pdf>
<https://www.york.ac.uk/depts/maths/histstat/pascal.pdf>

Week 2. September 18. Bernoullian statistics. The two faces of probability co-exist in mathematical statistics. As Francis Edgeworth explained in 1884, “the object of the calculus [of probabilities] is probability as estimated by statistical uniformity: the partial belief about some unknown occurrence as the throw of a die, *together with* the observed fact or full belief, that any one face is thrown about as often as another.”

1. *Glenn Shafer (2017): Bayes, frequentist, fiducial. 45 pp. <http://www.probabilityandfinance.com/articles/50.pdf>
2. Jacob Bernoulli (1713). *Ars conjectandi*. Part IV. Translation by Edith Sylla. 25 pp.
3. Glenn Shafer (2016): Cournot in English. 29 pp. <http://www.probabilityandfinance.com/articles/48.pdf>

4. Erich L. Lehmann (2011): *Fisher, Neyman, and the Creation of Classical Statistics*. Springer. 115 pp.
5. Francis Edgeworth (1884): The philosophy of chance. *Mind* 9(34):223-235.

Week 3. September 25. Laplacean and Bayesian statistics. Laplace's method of inverse probability, first published in 1774, dominated mathematical statistics for over a century. It has lived on in "objective Bayesianism", but the development of game theory and decision theory in the 1940s and 1950s led to the creation of an avowedly subjective Bayesian approach to statistics.

1. *Pierre Simon Laplace (1814): General principles of the calculus of probabilities. Chapter 3 of *Essai Philosophique*. 9 pp.
2. *F. P. Ramsey (1931): Truth and probability. Eagle, Chapter 2. 24 pp.
3. *John P. A. Ioannidis (2005). Why most published research findings are false. *PLOS Medicine* 2(8):e124:0696-0701. 5 pp. <http://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.0020124>
4. *Henry E. Kyburg, Jr. (1978): Subjective probability: Criticisms, reflections and problems. Eagle, Chapter 3. 24 pp.
5. James Berger (2006): The case for objective Bayesian analysis. *Bayesian Analysis*, 1(3):385-402. https://projecteuclid.org/download/pdf_1/euclid.ba/1340371035
6. Stephen E. Fienberg (2006): When did Bayesian inference become Bayesian? *Bayesian Analysis* 1:1-40. <https://projecteuclid.org/euclid.ba/1340371071>
7. Karl Pearson (1890): The bases of Laplace's theory lie in an experience as to ignorance. Chapter IV, Section 15 of *The Grammar of Science*. 6 pp.
8. John Aldrich (2008): The enigma of Karl Pearson and Bayesian inference. 37 pp. <http://www.economics.soton.ac.uk/staff/aldrich/KP%20enigma.pdf>
9. John Aldrich (2008): Keynes among the statisticians. 52 pp. <http://www.economics.soton.ac.uk/staff/aldrich/hope%202008.pdf>
10. David Howie (2002): *Interpreting Probability*, Chapter 4. Harold Jeffreys and Inverse Probability. 48 pp.
11. Glenn Shafer (1986): Savage revisited (with discussion). *Statistical Science* 1:463-501. http://www.glennshafer.com/assets/downloads/articles/article25_savage.pdf

Week 4. October 2. Probability in physics. How did probability find a place in a science thought to be deterministic?

1. *David Albert (2015): *After Physics*, Chapter 1. Physics and Chance.
2. *Barry Loewer. Determinism
3. *Barry Loewer. Probabilities in Quantum Mechanics
4. * Barry Loewer (2001): Determinism and chance. *Studies in History and Philosophy of Modern Physics* 32(4):609-620.
5. *Sheldon Goldstein (2012): Typicality and notions of probability in physics. <http://sites.math.rutgers.edu/~oldstein/papers/typ.pdf>

Week 5. October 9. Conditional probability. How was the idea of "conditionalizing" probabilities invented? What is its justification?

1. *Glenn Shafer (1985): Conditional probability. 19 pp. http://www.glennshafer.com/assets/downloads/articles/article21_conditional.pdf
2. *David Lewis (1999): Why conditionalize? Eagle, Chapter 6. 3 pp.
3. *Felix Hausdorff (1901): Relative probability. Translation by Glenn Shafer of Section 1 of Beiträge zur Wahrscheinlichkeitsrechnung, *Sitzungsberichte der Königlich Sächsischen Gesellschaft der Wissenschaften zu Leipzig, Mathematisch-Physische Klasse* 53:152-178. 13 pp.
4. *Roger Rosenkrantz. Excerpts from *Foundations and Applications of Inductive Probability*, Chapter 3. Conditioning.
5. *Richard C. Jeffrey (1965): Probability kinematics. Eagle, Chapter 7. 15 pp.
6. Bas C. van Fraassen (1984): Belief and the will. Eagle, Chapter 8. 16 pp.
7. Patrick Maher (1993): Diachronic rationality. Eagle, Chapter 9. 17 pp.

Week 6. October 16. Probabilism and Bayesianism: Subjective and Objective. The role of Bayes in philosophy.

1. *William Talbot (2008): Bayesian epistemology. *Stanford Encyclopedia of Philosophy*. <https://plato.stanford.edu/entries/epistemology-bayesian/>
2. *Edwin T. Jaynes (1968): Prior Probabilities. *IEEE Transactions on Systems Science and Cybernetics* 4(3):227-241. <http://bayes.wustl.edu/etj/articles/prior.pdf>
3. *Roger Rosenkrantz (1981): *Foundations and Applications of Inductive Probability*. Excerpts from Chapters 3,4,4*.
4. Bas C. van Fraassen (1989): Indifference: the symmetries of probability. Eagle, Chapter 18. 21 pp.
5. James Joyce (1998): A non-pragmatic vindication of probabilism. Eagle, Chapter 4. 24 pp.
6. Ellery Eells & Branden Fitelson (2002): Symmetries and asymmetries in evidential support. Eagle, Chapter 16. 11 pp.
7. Darren Bradley & Hannes Leitgeb (2006): When betting odds and credences come apart: more worries for Dutch book arguments. Eagle, Chapter 12. 8 pp.
8. D. C. Stove (1986): Is the theory of logical probability groundless? Eagle, Chapter 20. 10 pp.
9. Lukas M. Verburgt (2015): "A terrible piece of bad metaphysics"? Towards a history of abstraction in nineteenth and early twentieth-century probability theory, mathematics and logic. 35 pp. https://pure.uva.nl/ws/files/2685357/166221_01.pdf.
10. Christopher A. Fuch (2010): QBism, the perimeter of quantum Bayesianism. <https://arxiv.org/pdf/1003.5209.pdf>

Week 7. October 23. Bayesian confirmation theory. Bayesianism has become a general way of understanding evidence, induction, and confirmation.

1. *Michael Strevens (2017): Notes on Bayesian confirmation theory. <http://www.nyu.edu/classes/strevens/BCT/BCT.pdf>
2. *Rudolf Carnap (1955): Statistical and inductive probability. Eagle, Chapter 19. 10 pp.
3. *Roger Rosenkrantz (1981): *Foundations and Applications of Inductive Probability*. Excerpts from Chapters 5,6.
4. *Clark Glymour (1980): Why I am not a Bayesian. Eagle, Chapter 15. 18 pp.
5. Colin Howson & Peter Urbach (1993): Bayesian versus non-Bayesian approaches to confirmation. Eagle, Chapter 14. 28 pp.
6. Alvin Goldman (1979): What is justified belief? In George Pappas (ed.), *Justification and Knowledge*, D. Reidel, pp. 1-23.
7. John Earman (1996): *Bayes or Bust* http://fitelson.org/confirmation/earman_bayes_or_bust.pdf

Week 8. October 30. Self-locating belief.

1. *Adam Elga (2000): Self-locating belief and the sleeping beauty problem. Eagle, Chapter 10. 4 pp.
2. *Frank Arntzenius (2003): Some problems for conditionalization and reflection. Eagle, Chapter 11. 4 pp.
3. *Tamar Lando. Runaway credences and the principle of indifference
4. Carroll and Sebens (2015): Self-locating uncertainty and the origin of probability in Everettian quantum mechanics. <https://arxiv.org/pdf/1405.7577.pdf>

Week 9. November 6. Dempster-Shafer belief functions. This alternative to Bayesian theory allows provides more flexibility in expressing ignorance. It was popular in artificial intelligence in the 1980s and is now experiencing a revival in statistics.

1. *Glenn Shafer (1978): Two theories of probability. 25 pp. http://www.glennshafer.com/assets/downloads/articles/article07_TwoTheories1981.pdf
2. *Glenn Shafer (2016): A Mathematical Theory of Evidence turns 40. 43 pp. <http://www.glennshafer.com/assets/downloads/MathTheoryofEvidence-turns-40.pdf>

Week 10. November 13. Measure-theoretic and game-theoretic foundations. Mathematical probability can equally well be based on measure theory or game theory. What are the implications of this duality?

1. *Glenn Shafer & Vladimir Vovk (2013): The origins and legacy of Kolmogorov's *Grundbegriffe*. 107 pp. <http://www.probabilityandfinance.com/articles/04.pdf>
2. *Glenn Shafer et al. (2009): How to base probability theory on perfect-information games. 31 pp. <http://www.probabilityandfinance.com/articles/32.pdf>

Week 11. November 20. Frequency and complexity. Andrei Kolmogorov believed that a conceptual foundation required a finitary version of Richard von Mises idea of a collective. This thought evolved into an understanding of randomness in terms of complexity.

1. *Laurent Bienvenu, Glenn Shafer, and Alexander Shen (2009): On the history of martingales in the study of randomness. *Electronic Journal for History of Probability and Statistics* 5(1). 40 pp. <http://www.jehps.net/juin2009/BienvenuShaferShen.pdf>
2. *Jerzy Neyman (1960): Indeterminism in science and new demands on statisticians. *Journal of the American Statistical Association* 55:625-639.
3. *Jerzy Neyman (1977): Frequentist probability and frequentist statistics. *Synthese* 36:97-131.
4. Richard von Mises (1957): The definition of probability. Eagle, Chapter 22. 33 pp.
5. Richard C. Jeffrey (1977): Mises redux. Eagle, Chapter 23. 7 pp.
6. Alan Hájek (1996): "Mises Redux"-redux: Fifteen arguments against finite frequentism. Eagle, Chapter 24. 15 pp.
7. Alan Hájek (2009): Fifteen arguments against hypothetical frequentism. Eagle, Chapter 25. 23 pp.

Week 12: November 27. Propensities and best systems. How do deterministic and probabilistic laws have meaning and value?

1. *David Lewis (1994): Humean supervenience debugged. 18 pp. http://andrewmbailey.com/dkl/Humean_Supervenience_Debugged.pdf
2. **David Lewis (1980): A subjectivist's guide to objective chance. Eagle, Chapter 27. 30 pp.
3. *Barry Loewer (2004): David Lewis's Humean theory of objective chance. Eagle, Chapter 31. 9 pp.
4. Karl Popper (1959): A propensity interpretation of probability. Eagle, Chapter 28. 10 pp.
5. Ronald N. Giere (1971): Objective single-case probabilities and the foundations of statistics. Eagle, Chapter 29. 13 pp.
6. Paul W. Humphreys (1985): Why propensities cannot be probabilities. Eagle, Chapter 30. 9 pp.
7. Brian Skyrms (1977): Resiliency, propensities, and causal necessity. Eagle, Chapter 32. 9 pp.

Week 13. December 4. The Principal Principle. David Lewis had a distinctive way of reconciling subjective and objective probability.

1. *Ned Hall (2004): Two mistakes about credence and chance. *Australian Journal of Philosophy* 82(1):93-111.
2. *Wolfgang Schwarz (2014): Proving the principal principle. 21 pp. <https://www.umsu.de/papers/proving-pp.pdf>
3. Jenann Ismael (2008): Raid! Dissolving the big, bad bug. *Nous* 42(2):292-307.

Week 14. December 11. The Mentaculus: counterfactuals, time's arrow and causation. Should we understand time and causation in terms of probabilistic counterfactuals?

1. *Barry Loewer (2017) "The Mentaculus vision"
2. *Barry Loewer (2007): Counterfactuals and the second law. In *Causation, Physics, and the Constitution of Reality: Russell's Republic Revisited*, Huw Price and Richard Corry (ed.), New York: Oxford University Press, pp. 293-326.
3. David Albert (2015): *After Physics*, Chapter 2. The difference between past and future.
4. Barry Loewer (2012): The emergence of time's arrow and special science laws from physics. *Interface Focus* 2(1):13-19. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3262300/>
5. A. P. Dawid (2000): Causal inference without counterfactuals (with discussion). *Journal of the American Statistical Association* 95(450):424-448. http://www.ics.uci.edu/~sternh/courses/265/dawid_jasa2000.pdf