Philosophy of Statistics

Munich Center for Mathematical Philosophy
Ludwig-Maximilians-Universität München
Summer Semester 2015

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Coursepage:	http://gregorywheeler.coursesites.com

Course Description

Statistics is the methodology for measuring uncertainty and determining the logical consequences of that uncertainty for the purposes of designing experiments and interpreting observations. The philosophy of statistics examines the foundations of statistical methodology; it is a quantitative branch of epistemology.

This course is an introduction to the philosophy of statistics. The course will cover elementary probability theory; different interpretations of probability; representation theorems of von Neumann and Morgenstern, Anscombe and Aumann, and Savage; synchronic and diachronic Dutch Book arguments; an extended comparison of Frequentist and Bayesian methods, including point estimation, interval estimation, hypothesis testing, significance testing, and the likelihood principle; and an introduction to the theory of lower previsions—otherwise known as the theory of imprecise probabilities.

Course Goals

The goal of the course is to provide students with a broad introduction to the philosophy of statistics, including a familiarity with the rudimentary mathematical methods used in statistical reasoning, and to give students an opportunity – through a series of short essays – to sharpen their philosophical writing.

Online Registration

To access course materials and submit assignments, students **must register** for *Philosophy of Statistics* online at gregorywheeler.coursesites.com. Email me for login details.

Requirements

There are four requirements for the course: (1) Ten weekly written assignments ("Weeklies"), submitted online at gregorywheeler.coursesites.com; (2) in-class participation; (3) three exercise sets; and (4) three short (∼1000 word) philosophical essays.

1. *Weeklies*: These assignments ask you to formulate one or two questions or objections in short but clear and precise prose. These assignments will be graded anonymously. Your

weekly assignments may be viewed as an opportunity to "vet" the questions that you have about each week's readings. Instructions for each weekly will be given online.

2. *In-class participation*: The weekly assignments and feedback on those assignments are designed to prime in-class discussion. You will be evaluated attendance and by the quality, rather than quantity, of your contributions to class discussion.

3. *Three exercise sets*: There are three exercise sets for the course which cover rudimentary probability theory, discrete random variables, and Bayesian inference for discrete random variables. These exercise sets are intended to familiarize you to the quantities and basic methods that the course will engage with philosophically.

4. *Three short papers*: There are three short paper assignments for the course, each should be **no longer than** 1000 words each. Each paper should present a clear thesis statement and argument which engages with one of the readings discussed in the course. The point to doing these short papers is to force you to economize your writing, since you *only* have 1000 words with which to make a substantive philosophical point. You may rewrite each essay once for a better grade; rewrites are due one week after you receive comments and your grade. You are not required to rewrite an essay.

Grading

Your final grade will be calculated by a weighted average using the following weights:

Weeklies: 10%

In-class participation: 10%

Exercises: 20%

Short papers: 60%

Reading Schedule

Week 1: Introduction

Hajek (2011), §1 and §2

Suppes (2002), pp. 55 – 71.

Week 2: Elementary Probability Theory

Bolstad (2004), Chapters 4 and 5

Week 3: Subjective Probability

Bolstad (2004), Chapter 6.

Kadane (2011), §1.1 to §1.7.

de Finetti (1937).

Savage (1972), pp. 1–26.

Week 4: Subjective Probability and Utility

Anscombe and Aumann (1963).

Von Neumann and Morgenstern (1953), Ch 1, §3

Savage (1972), pp. 27–40.

Week 5: Conditionalization

Levi (1987), pp. 193–211.

Savage (1972), pp. 43–44.

Skyrms (1987), §1, §2, §5.1, §6.

Week 6: Logical Interpretations of Probability

Suppes (2002), Ch 5, §5.5

Wheeler and Williamson (2011), §2 (pp. 307–314)

Week 8: Propensity Interpretations of Probability

Suppes (2002), pp. 202–225.

Humphreys (1985).

Strevens (1998).

Wasserman (2005), Ch 5.

Week 9: Relative Frequency Interpretations & Randomness

Suppes (2002), §5.3 and §5.4

Week 10: Bayesian and Frequency Methodology

Bolstad (2004), pp. 147–164

Wasserman (2004), Ch. 6

DeGroot (1970), Ch 6, §6.1-§6.4.

Week 11: Significance Testing & the Likelihood Principle

Berger and Wolpert, (1988), Ch1 and Ch 2.

Greenland and Poole, (2013).

Gelman, (2013).

Howson and Urbach, (2005), Ch 5.

Week 12: Frequentism Defended

Mayo and Spanos (2011), pp. 153–183.

Week 13: Lower Previsions

Miranda and de Cooman, (2014)

Week 14: Conditional Lower Previsions

Troffaes and de Cooman, (2014), Ch 13, pp. 240–264.

Course Schedule

	Date	Topic	Assignments
1	13 apr	introduction	
		Overview of the Course	
2	20 apr	Elementary Probability Theory	
		– *No Lecture* –	
3	27 apr	Subjective Probability	weekly 1
		Dutch Books, Comparative Probability, and de Finetti's Theorem	Exercise 1 due
4	4 may	Subjective Probability and Utility	weekly 2
		Representation theorems of von Neumann and Morgenstern, Anscombe and Aumann, and Savage	Exercise 2 due
5	11 may	Conditionalization	weekly 3
		Dynamic Dutch Book Arguments	Exercise 3 due
6	18 may	Logical Interpretations	weekly 4
		Keynes, Jeffreys, Carnap, Kyburg, & Gaifman	
7	25 may	holiday: no class	
8	1 jun	Propensity Interpretations	weekly 5
		Propensities and probabilities	
9	8 jun	Relative Frequency & Randomness	weekly 6
		von Mises, Church, and Kolmogorov Complexity	Paper 1 due
10	15 jun	Bayesian and Frequentist Methodology	weekly 7
		Point Estimation, Interval Estimation, and Hypothesis Testing	
11	22 jun	Criticism of Frequentist Methodology	weekly 8
		Significance Testing, & Likelihood Principle	
12	29 jun	Frequentism Defended	weekly 9
		Error Statistics	Paper 2 due
13	6 jul	Lower Previsions	weekly 10
		Coherent lower previsions, avoiding sure loss, extensions	
14	13 jul	Conditional Lower Previsions	
		Coherent conditional lower previsions, updating	Paper 3 due

References

[1] Anscombe, F., and Aumann, R. (1962). A Definition of Subjective Probability *Annals of Mathematical Statistics* 34(1):199–205.

[2] Bolstad, W. (2004). *Introduction to Bayesian Statistics*. Wiley, Hoboken, NJ.

[3] Berger, J.O., and Wolpert, R. (1988). The Likelihood Principle. In *IMS Lecture Notes – Monograph*, Volume 6. Institute of Mathematical Statistics.

[4] Birnbaum, A. (1962). On the Foundations of Statistical Inference. *Journal of the American Statistical Association*, 57(298): 269–306.

[5] Carnap, R. (1962). *Logical Foundations of Probability*. University of Chicago Press, second edition.

[6] Cooke, R. (1986). Conceptual fallacies in subjective probability. *Topoi 5*, 21–27.

[7] de Finetti, B. (1937). Foresight: Its logical laws in subjective sources. English translation in Kyburg and Smokler, editors *Studies in Subjective Probability*, 1964.

[8] DeGroot, M. (1970). *Optimal Statistical Decisions*. McGraw-Hill.

[9] Gelman, A. (2013). *P* Values and Statistical Practice. *Epidemiology 24*(1), 69–72.

[10] Greenland, S., and Poole, C. (2013). Living with *P* Values: Resurrecting a Bayesian Perspective on Frequency Statistics. *Epidemiology 24*(1), 62–68.

[11] Hayek, A. (2011). Interpretations of Probability. In Zelta, E., editor, Stanford Encyclopedia of Philosophy. http://plato.stanford.edu/entries/probability-interpret/

[12] Howson, C., and Urbach, P. (2005). *Scientific Reasoning: The Bayesian Approach.* Open Court, Chicago.

[13] Humphreys, P. (1985) Why Propensities Cannot be Probabilities *Philosophical Review 94*, 557–570.

[14] Kadane, J. (2011). *Principles of Uncertainty* volume 92, Chapman & Hall.

[15] Kyburg, Jr., H. E. (1978). Subjective probability: criticisms, reflections, and problems. *Journal of Philosophical Logic*, 157–180.

[16] Levi, I. (1987). The Demons of Decision. *The Monist 70*(2),193–211.

[17] Mayo, D., and Spanos, A. (2011). Error Statistics. In *Philosophy of Statistics*, North Holland Press, San Diego, pp. 153–198.

[18] Miranda, E., and de Cooman, G. (2014). Lower Previsions. *Introduction to Imprecise Probabilities*, Wiley, pp. 28–55.

[19] Salmon, W. C. (1967). *The Foundations fo Scientific Inference*, volume 28. Pittsburgh: University of Pittsburgh Press.

[20] Savage, L. J. (1972). *Foundations of Statistics*. New York: Dover.

[21] Skyrms, B. (1987). Dynamic Coherence and Probability Kinematics. *Philosophy of Science*, *54*(1), 1–20.

[22] Stigler, S. (1986). *The History of Statistics*. Cambridge, MA: Belknap Press of Harvard University.

[23] Suppes, P. (2002). *Representation and Invariance of Scientific Structures.* CSLI Publications, Stanford.

[24] Troffaes, M., and de Cooman, G. (2014). *Lower Previsions*. Wiley.

[25] von Neumann, J. and Morgenstern, O. (1953). *Theory of Games and Economic Behavior,* third edition. Princeton University Press.

[26] Walley, P. (1991). *Statistical Reasoning with Imprecise Probabilities*. Chapman and Hall, London.

[27] Wasserman, L. (2004). *All of Statistics: A Concise Course in Statistical Inference*, Springer.

[28] Wheeler, G., and Williamson, J. (2011). Evidential Probability and Objective Bayesian Epistemology In *Philosophy of Statistics*, North Holland Press, San Diego, pp. 307–331.