Formal Epistemology

Winter 2021/2

Instructor: Gerard Rothfus
Classroom: G530
Day/Time: W; 1:30-3:00pm
Office Hours: W; 3-4:00pm or by appointment
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Description

This course surveys (some of) the rich field of formal epistemology, with an emphasis on exploring different ways of mathematically modelling uncertainty and its rational management. The course will be structured as a guided tour through several sections of Joseph Halpern's classic text, *Reasoning About Uncertainty*. Select topics covered include formal representations of uncertainty (esp. probability theory), rules for updating beliefs, and the relationship between full and partial belief. Along the way, we'll have occasion to examine a variety of famous epistemological puzzles. No specific mathematical background is assumed, but basic familiarity with propositional logic is recommended, as well as some previous exposure to writing simple proofs in either mathematics or logic.

Learning Objectives

This course will equip students to enter the exciting world of formal epistemology by gaining a basic understanding of its motivation, methods, and relationship to traditional epistemology.

Course Materials

There is no required text for the course as all readings will be made available online via Ilias. However, an excellent graduate-level textbook in the field that we will draw on throughout the course is:

- *Reasoning About Uncertainty* by Joseph Halpern, 2017, OUP.

Course Structure

This course will be organized around a weekly lecture/discussion period, where various topics in formal epistemology will be explored and discussed in person. You are encouraged, though not required, to do the suggested readings before each lecture in order to be better prepared to engage and ask questions, make suggestions in discussion, etc. Periodically, I may also release short, prerecorded videos to the ILIAS site (as well as YouTube), summarizing different ideas covered in the course. You may view these videos to help with homework problems or just to get a better grip on key ideas in the course.

I will also hold office hours on Wednesdays after class until 4pm. Feel free to come to office hours and ask any questions you may have about the course! If you are unable to make this time any week, you are welcome to set up an appointment for another time. In these office hours, I am happy to go over past homework assignments or discuss questions about upcoming assignments, new material, etc. Whether in or out of office hours, please feel free to reach out to me any time!

Course Assignments

Homework will be due at the start of class every few weeks (dates listed below). Students are encouraged to discuss homework problems with other students and work together, though every student must write/type out their own homework. Your lowest homework grade will be dropped.

If you wish to write a term paper for the course, this is certainly possible, though it is not required as grading will be based solely on your homework performance. Feel free to reach out to me about this possibility!

Academic Integrity

Academic dishonesty will not be tolerated. Though collaboration among students is encouraged, any work a student turns in must ultimately be their own. Students who have any questions or uncertainty about this policy are responsible for meeting with the instructor to discuss the policy.

Disabilities

Please notify me in advance of the need for accommodation of a University verified disability. I will gladly provide the required accommodations. If you have any questions or concerns about disability accommodations, please don't hesitate to speak with me; I am happy to help out.

Course Outline

Week:	Topic:
Oct 27	**The Objects of Belief** • Possible Worlds, Propositions, Sentences, Set Theory **Reading:** • *Formal Representations of Belief* by Genin and Huber: §1, "Preliminaries". • *Reasoning About Uncertainty* by Joseph Halpern: Chapter 2.1, "Possible Worlds". **Homework One Due Nov 10**
Nov 3	**Probability Measures** • The Probability Axioms and Rules, Countable Additivity, De Finetti's Lottery, Non-Measurability **Reading:** • *Reasoning About Uncertainty* by Joseph Halpern: Chapter 2.2, "Probability Measures".
Nov 10	**Probaility Dynamics** • Conditional Probability, Bayes' Theorem, the Monty Hall Problem, Conditionalization, Jeffrey Conditionalization **Reading:** • *Formal Representations of Belief* by Genin and Huber: 3.1.4, "Update Rules". • *Reasoning About Uncertainty* by Joseph Halpern: Chapter 3.2, "Probabilstic Conditioning" and 3.12, "Jeffrey's Rule". **Homework Two Due Nov 24**

Week:	Topic:
Nov 17	**Nonstandard Probability** • Renyi-Popper Measures, Lexicographic Probability, Nonstandard Probability, Williamson's Infinite Coin Toss **Reading:** • *Reasoning About Uncertainty* by Joseph Halpern: Chapter 2.5, "Lexicographic and Nonstandard Probability Measures" and 3.3, "Conditional (Nonstandard) Probability and Lexicographic Probability". • "Lexicographic probability, conditional probability, and nonstandard probability" by Joseph Halpern: • "Non-Archimedean Probability" by Benci, Horsten, and Wenmackers.
Nov 24	**Imprecise Probability** • The Ellsberg Paradox, Lower and Upper Probabilities, Inner and Outer Measures **Reading:** • *Formal Representations of Belief* by Genin and Huber: 3.2, "Imprecise Probabilities". • *Reasoning About Uncertainty* by Joseph Halpern: Chapter 2.3, "Lower and Upper Probabilities". • "A Defense of Imprecise Credences in Inference and Decision Making" by James Joyce. **Homework Three Due Dec 8**
Dec 1	**Imprecise Probability Dynamics** • Conditioning Sets of Probability, the Problem of Inertia, Sets of Weighted Probability Measures **Reading:** • *Reasoning About Uncertainty* by Joseph Halpern: Chapter 2.4, "Sets of Weighted Probability Measures", 3.4, "Conditioning with Sets of Probabilities", and 3.5, "Conditioning Sets of Weighted Probabilities".. • "Imprecise Bayesianism and Global Belief Inertia" by Aron Vallinder.

Dec 8	**Dempster-Shafer Theory** • Belief Functions, Plausibility Functions, Dempster's Rule of Combination **Reading:** • *Formal Representations of Belief* by Genin and Huber: 3.2, "Dempster-Shafer Theory". • *Reasoning About Uncertainty* by Joseph Halpern: Chapter 2.6, "Dempster-Shafer Belief Functions". • *Uncertain Inference* by Kyburg and Teng: §5.4, "Dempster-Shafer Belief Functions". **Homework Four Due Dec 22**
Dec 15	**Possibility Theory** • Fuzzy Sets, Possibility Measures, Conditional Possibility Measures **Reading:** • *Formal Representations of Belief* by Genin and Huber: 3.3, "Possibility and Plausibility Theory". • *Reasoning About Uncertainty* by Joseph Halpern: Chapter 2.7, "Possibility Measures" and 3.9, "Conditioning Possibility Measures". • "Possibility Measures: Qualitative and Quantitative Aspects" by Dubois and Prade.
Dec 22	**Ranking Theory** • Ranking Functions, Conditional Ranking Functions, Belief and Ranking Theory **Reading:** • *Formal Representations of Belief* by Genin and Huber: 3.4, "Ranking Theory". • "Ranking Theory" by Franz Huber. • *Reasoning About Uncertainty* by Joseph Halpern: Chapter 2.8, "Ranking Functions" and 3.10, "Conditioning Ranking Functions". **Homework Five Due Jan 19**

Week:	Topic:
Jan 12	**Relative Likelihood and Plausibility Measures** • Relative Likelihood, Plausibility Theory **Reading:** • *Reasoning About Uncertainty* by Joseph Halpern: Chapter 2.9, "Relative Likelihood" and 2.10, "Plausibility Measures".
Jan 19	**Qualitative Probability** • Representing Orderings via Probabiltiies and Conditional Probabilities, Villegas' Theorem **Reading:** • *Foundations of Measurement* by Krantz et al., Chapter 5, "Probability Representations". **Homework Six Due Feb 2**
Jan 26	**Relative Entropy** • MaxEnt, Kullback-Liebler Divergence, the Judy Benjamin Problem, Adams Conditionalization **Reading:** • *Reasoning About Uncertainty* by Joseph Halpern: Chapter 3.13, "Relative Entropy". • "A New Resolution of the Judy Benjamin Problem" by Douven and Romeijn
Feb 2	**Full and Partial Belief I** • The Lottery and Preface Paradoxes, the Lockean Thesis, the Stability Theory of Belief **Reading:** • *Formal Representations of Belief* by Genin and Huberr: 4.1-4.2.3, "Full and Partial Belief". • "The Stability Theory of Belief" by Hannes Leitgeb. • "Beliefs, Buses and Lotteries: Why Rational Belief Can't Be Stably High Credence" by Julia Staffel

Week:	Topic:
Feb 9	**Full and Partial Belief II** • The Tracking Theory, Epistemic Decision Theory **Reading:** • *Formal Representations of Belief* by Genin and Huber: 4.2.4-5, "Full and Partial Belief". • "Propositional Reasoning that Tracks Probabilistic Reasoning" by Lin and Kelly. • "Dr. Truthlove or: How I Learned to Stop Worrying and Love Bayesian Probabilities" by Kenny Easwaran