# Reasoning in an Uncertain World: An Introduction to Critical Thinking

Spring, 20??

Instructor: Gerard Rothfus
Classroom: Online
Day/Time: M, W, F; 9-9:50am
Office Hours: M, W, F; 11-11:50am or by appointment
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## Description

This course introduces students to the basics of logic and critical thinking. In order to develop their skills in representing and analyzing arguments, students will first be introduced to the basics of deductive logic. We will then look at inductive arguments and various pitfalls humans often fall into when reasoning inductively. This will lead us to seek out ways we might avoid such pitfalls and to investigate probability theory as a model for how to reason inductively. Classical philosophical problems (e.g. the Problem of Induction, the interpretation of probability, various probabilistic puzzles) will be explored along the way while students are equipped with tools they can use to improve their own critical thinking and probabilistic reasoning in everyday contexts.

## Learning Objectives

This course will equip students to:

- Represent and analyze arguments via propositional logic and probability theory.
- Identify cognitive biases that commonly afflict human inductive reasoning.
- Correct for these biases by applying Bayes' Rule and other principles of probability to assess the quality of arguments.

## Course Materials

There is no required textbook for this course. All readings and exercises needed to succeed in this course will be made available online via CANVAS. However, I will be drawing some of these readings and exercises from several textbook sources. Any of these texts may prove helpful resources for students interested in diving deeper into the course material. These sources are (listed in order of relevance for this course):

- *Choice and Chance: An Introduction to Inductive Logic* (4th edition) by Brian Skyrms, 2000, Wadsworth. [This text will be made available on CANVAS.]
- *A Course in Behavioral Economics* (2nd edition) by Erik Angner, 2016, Palgrave. [Part 2]
- *An Introduction to Probability and Inductive Logic* by Ian Hacking, 2001, Cambridge University Press.
- *Superforecasting: The Art and Science of Prediction* by Philip Tetlock and Dan Gardner, 2015, Broadway Books. [This is a popular level text that covers probabilistic prediction at an informal level.]

## Course Structure

This course will be taught entirely online. Each week at lecture time, I will release two or three pre-recorded, short videos to the CANVAS site, each covering a different topic. I will also release a simple but mandatory participation poll accompanying each lecture video. Filling out these polls by the end of the week (Saturday at 11:59pm) is the way to earn participation points in the course. You should watch the lecture videos before attempting the questions and you may return to re-watch the lecture videos as needed.

I will also hold office hours over Zoom at various times during the week. You are encouraged to attend any of these office hours that you like! During these, I will go over the past week's homework assignment and may (anonymously) review students' submitted answers. You are also encouraged to come for the purpose of asking any questions you may have about the course! Please feel truly free to reach out to me at any time.

## Homework and Exams

Homework will be due at the beginning of every week (Monday at 11:59pm) and should be submitted via Gradescope. Late homework will not be accepted, though your two lowest homework grades will be dropped. There will also be

three exams: two midterms and a final. The final will be cumulative. All exams will be made available on the CANVAS site at 9am on exam day and will replace that day's lecture. You will have all day to complete the midterm exams and upload them back onto Gradescope (so they will be due by 11:59pm that day). You will have a bit longer to complete the final. (See schedule below.) Late exams will be penalized 5 points for every hour late. Feel free to use any notes or books during both the exams and homeworks. You may also discuss problems together, though every student must write/type out their own exam/homework. Your lowest midterm exam grade will be raised to its average with your final exam if your final exam grade is higher. If you need to miss a test for a serious reason, you will need to provide documentation (e.g. a medical note) in order to take a make-up exam on a different day.

## Forecasting Project

Inductive reasoning involves estimating the likelihood of uncertain events on the basis of one's current knowledge. One theme of this course will be that there are better and worse ways to go about doing this. To give ourselves some practice employing sound methods of inductive reasoning (and to illustrate how hard doing so can be), our final project for the course will involve holding a forecasting tournament. The details of this project can be found in a separate document uploaded to CANVAS.

In short, you will be asked to assign a probability to 25 future events whose truth will become public knowledge sometime between Week 5 and Week 9 of this quarter. Your initial probabilities will be due by the end of Week 2 and you should feel free to do as little or as much research as you wish before assigning your probabilities. You will be then given an opportunity to revise these probabilities and submit knew ones just before Week 5. At the end of the quarter, the accuracy of your final probabilistic predictions will be measured by the Brier score (explained in the full project description) and your performance will be compared to both the class average and to the accuracy of your initial estimates. A 1-2 page summary of your reasoning in forming your forecasts will be due at the end of finals week. You will be graded on completing the assignment and on the quality of your write up, not on the accuracy of your predictions. However, you will receive extra credit both for outperforming the class average and for being on the best performing team.

## Grading

- Exam One: 15%
- Exam Two: 15%
- Final Exam: 25%
- Forecasting Project: 15%
- Homework: 20%
- Participation: 10%

## Grade Scale

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|---|---|---|---|---|
| A: 90-100 | B: 80-89 | C: 70-79 | D: 60-69 | F: $< 60$ |

## Academic Integrity

Academic dishonesty will not be tolerated. The UCI Academic Integrity Policy will be followed in this course, and it is the resposnibility of the student to adhere to these policies: https://aisc.uci.edu/students/academic-integrity/index.php. 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: | Reading: |
|---|---|---|
| March 30 | **The Basics of Logic**<br>• Lecture 1.1<br>– Introduction<br>– What is Logic?<br>• Lecture 1.2<br>– Propositional Logic<br>– Truth Tables<br>• Lecture 1.3<br>– Inductive and Epistemic Probability<br>– Two Problems for Inductive Logic | Ch. 1, 2 (*Hacking*), Ch. 1, 2 (*Skyrms*) |
| April 6 | **The Problem of Induction**<br>• Lecture 2.1<br>– Hume's Traditional Problem of Induction<br>– The Inductive Justification<br>• Lecture 2.2<br>– The Pragmatic Justification<br>– The Nomological-Explanatory Soultion<br>• Lecture 2.3<br>– The New Problem of Induction/the Grue Paradox | Ch. 20 (*Hacking*), Ch. 3, 4 (*Skyrms*) |
| **April 13** | **Initial Probabilities for Forecasting Project Due at 11:59pm** | |

| Week: | Topic: | Reading: |
|---|---|---|
| April 13 | **The Psychology of Inductive Reasoning**<br>• Lecture 3.1<br>– A Psychological Solution?<br>– The Gambler's Fallacy<br>• Lecture 3.2<br>– The Conjunction and Disjunction Fallacies<br>– Base-rate Neglect<br>• Lecture 3.3<br>– Confirmation Bias<br>– Availability and Overconfidence | Ch. 3 (*Hacking*), Ch. 5 (*Angner*) |
| April 20 | **Forecasting**<br>• Lecture 4.1<br>– Forecasting Intro<br>• Lecture 4.2<br>– Measuring Accuracy: The Brier Score<br>– Foxes and Hedgehogs<br>• Lecture 4.3<br>– Fermi Problems<br>– Outside and Inside Views | Online reading from Tetlock |
| **April 25** | **Final Probabilities for Forecasting Project Due at 11:59pm** | |

| Week: | Topic: | Reading: |
|---|---|---|
| April 27 | **The Probability Calculus**<br>• Lecture 5.1<br>– The Probability Axioms<br>• Lecture 5.2<br>– Some Probability Rules<br>– Probability Card Examples<br>• **Exam 1 Due at 11:59pm on May 4** | Ch. 4-6 (*Hacking*), Ch. 6 (*Skyrms*) |
| May 4 | **Bayes' Theorem and Conditional Probability**<br>• Lecture 6.1<br>– Conditional Probability<br>• Lecture 6.2<br>– Conditional Probability Card Examples<br>– Conditional Probability Coin Examples<br>• Lecture 6.3<br>– Bayes' Theorem<br>– The Monty Hall Problem | Ch. 7, 15 (*Hacking*), Ch. 6 (*Skyrms*) |

| Week: | Topic: | Reading: |
|---|---|---|
| May 11 | **Probability Dynamics and Kinds of Probability**<br>• Lecture 7.1<br>– Conditionalization<br>– Jeffrey Conditionalization<br>• Lecture 7.2<br>– Relative Frequency<br>• Lecture 7.3<br>– Chance and the Principal Principle | Ch. 18, 19 (*Hacking*)<br>Ch. 7 (*Skyrms*) |
| May 18 | **Justifying Bayesianism**<br>• Lecture 8.1<br>– Convergence I<br>• Lecture 8.2<br>– Convergence II<br>• **Exam 2 Due at 11:59pm on May 25** | Ch. 7, 8 (*Skyrms*) |

| Week: | Topic: | Reading: |
|---|---|---|
| May 25 | **Justifying Bayesianism**<br>• Lecture 9.1<br>– Dutch Book Arguments<br>• Lecture 9.2<br>– Accuracy Arguments | Ch. 7, 8 (*Skyrms*) |
| June 1 | **Review**<br>• Lecture 10.1<br>– Probability as Inductive Logic<br>• Lecture 10.2<br>– Live Review<br>• **Final Exam Due at 11:59 pm on June 8** | Review |
| **June 11** | **Summary Report for Forecasting Project Due at 11:59pm** | |