# PHIL 5210: Advanced Inductive Logic

Fall Semester 2025

TuTh/12:25PM-01:45PM
BU C 302: 1635 E Campus Center Dr

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## Course Description

An advanced treatment of inductive logic. Students are expected to have previously taken either PHIL 3200 (Deductive Logic) or PHIL 3210 (Inductive Logic). Topics to be covered include frequentist and Bayesian statistical inference, Bayesian epistemology, belief revision, as well as formal and statistical learning theory. A prior proof-based math course would be helpful.

## Course Outcomes and Objectives

By the end of the course, students should be familiar with the main schools of inductive inference, including Bayesian, frequentist and learning-theoretic approaches. We are aiming less at the technical detail than at the philosophical foundations: understanding the animating goals and values of each school as well as their sympathies with schools of thought in epistemology.

## Course Requirements

Student evaluation is based on attendance (33%), 3-4 homework assignments (33%) and a final paper (33%). Reasonable barriers to attendance will be accommodated. Collaboration on homework assignments is encouraged, although you must indicate your collaborators in your submission. The final paper (max 4000 words) should be written independently, on a topic of your choice. Students are first required to submit a 1-page paper proposal. Graduate students are welcome to submit longer work.

## Required and Recommended Readings

For technical material from probability and statistics we will use

Wasserman, Larry (2013). *All of Statistics: A Concise Course in Statistical Inference*. Springer.

For topics in formal epistemology, we will use

Pettigrew, Richard and Jonathan Weisberg (2019). *The Open Handbook of Formal Epistemology.* PhilPapers.

The following is recommended background reading:

Genin, Konstantin and Franz Huber (2022). "Formal Representations of Belief." *Stanford Encyclopedia of Philosophy.*

## University Policies

Updated mandatory syllabus policies regarding the ADA Act, Safety at the U, Addressing Sexual Misconduct, and Academic Misconduct can be found at: https://cte.utah.edu/instructor-education/syllabus/institutional-policies.php

## Preliminary Course Schedule

| Date | Topic/Discussion | Due Dates: |
| --- | --- | --- |
| ***Week 1:*** | Course Introduction.<br>Probability, Random Variables,<br>Expectation, Variance, Covariance | |

*Wasserman Chapters 1-3.*

Do not worry too much about the details in chapters 2-3. Try to understand the definition of a random variable (2.1); cumulative distribution function (2.5); bivariate distribution (p. 31); marginal distribution (2.23); independence (2.29); conditional distribution (2.35); and i.i.d random variables (2.41).

In chapter 3 focus on the definition of expected value (3.1); variance (3.14); covariance (3.18); conditional expectation (3.22).

***Week 2:*** Concentration Inequalities,
Laws of Large Numbers

*Wasserman, Chapters 4-5.*

The goal is to be able to prove the weak law of large numbers together. For this we will need Markov's inequality (Theorem 4.1) and Chebyshev's Inequality (Theorem 4.2). Try to understand the statement and proof of these theorems.

In Chapter 5, focus on Definition 5.1: what is the difference between convergence in probability and in distribution? We will prove Theorem 5.6 together, but give it a shot on your own. Finally, focus on Section 5.4. What does the Central Limit Theorem tell you that the Law of Large Numbers does not?

***Week 3:*** Hypothesis Testing
Power, Significance, p-Values
Confidence Regions

*Wasserman,* Chapter 6, 10.

Read all of Chapter 6 (it is short). In Chapter 10 make sure you understand the definition of power and size (10.1) and p-value (10.11).

***Week 4:*** Hypothesis Testing: Severe Testing Problem Set #1 Due

Mayo, Deborah G., and Aris Spanos. (2006) "Severe testing as a basic concept in a Neyman–Pearson philosophy of induction." *The British Journal for the Philosophy of Science.*

Now we have enough statistics to do something *serious*: philosophy of science!

***Week 5:*** Bayesian Epistemology

Titelbaum, Michael (2019). “Precise Credences,” in Richard Pettigrew and Jonathan Weisberg, eds., *The Open Handbook of Formal Epistemology.* PhilPapers Foundation. pp. 1-57.

***Week 6:*** Bayesian Epistemology 1-page proposal Due

Sprenger, Jan, and Stephan Hartmann. “Variation 1: Confirmation and Induction”. In: *Bayesian Philosophy of Science.* Oxford University Press, (2019).

***Week 7:*** Decision Theory

Thoma, Johanna (2019). “Decision Theory,” in Richard Pettigrew and Jonathan Weisberg, eds., The Open Handbook of Formal Epistemology. PhilPapers Foundation. pp. 57-107.

***Week 8:*** Decision Theory Problem Set #2 Due

Chandler, Jake (2024). "Descriptive Decision Theory", *The Stanford Encyclopedia of Philosophy*.

***Week 9:*** Statistical Learning Theory

Von Luxburg, Ulrike, and Bernhard Schölkopf. "Statistical learning theory: Models, concepts, and results." *Handbook of the History of Logic.* Vol. 10. North-Holland, 2011. 651-706.

***Week 10:*** Statistical Learning Theory

Belkin, Mikhail. "Fit without fear: remarkable mathematical phenomena of deep learning through the prism of interpolation." *Acta Numerica* 30 (2021): 203-248.

***Week 11:*** Belief Revision Theory

Lin, Hanti (2019). “Belief Revision Theory,” in Richard Pettigrew and Jonathan Weisberg, eds., *The Open Handbook of Formal Epistemology*. PhilPapers Foundation. pp. 349-397.

***Week 12:*** Formal Learning Theory Problem Set #3 Due

***Week 13:*** Formal Learning Theory

***Week 14:*** Formal Learning Theory

***Final Exam Period:*** Final papers due

**This syllabus is subject to change at the discretion of the instructor.**