

Syllabus

Intermediate Statistics, 36-705 (Fall 2020)

Online, Via Zoom: MWF 1:20-2:10
All Course Materials on Canvas

The lectures will be recorded. But I encourage you to attend the lectures live, on Zoom, if possible.

1 Overview

This course covers the fundamentals of theoretical statistics. Topics include: concentration of measure, basic empirical process theory, convergence, point and interval estimation, maximum likelihood, hypothesis testing, Bayesian inference, nonparametric statistics and bootstrap resampling. This course is excellent preparation for advanced work in Statistics and Machine Learning.

Some course objectives for students in machine learning include: (1) Predict which kinds of existing machine learning algorithms will be most suitable for which sorts of tasks, based on formal properties and experimental results. (2) Evaluate and analyze existing learning algorithms.

There are several textbooks that we will use material from. The main textbook for the course will be “All of Statistics” (Wasserman 2004). You can get the pdf through the library for free. We will cover Chapters 1-12 from the text plus some supplementary material. There are several other useful references:

1. Casella, G. and Berger, R. L. (2002). Statistical Inference, 2nd ed.
2. Rice, J. A. (1977). Mathematical Statistics and Data Analysis, Second Edition.
3. (**Advanced**) van der Vaart, A. (2000). Asymptotic Statistics
4. (**Advanced**) Bickel, P. J. and Doksum, K. A. (1977). Mathematical Statistics.

2 Background and Prerequisites

I assume that you are familiar with basic probability and mathematical statistics. You should already know the following concepts: probability, distribution functions, density functions, moments, transformation of variables, and moments generating functions.

2.1 Is This The Right Course For You? 36-705 versus 36-700

We have another course, 36-700, that covers similar material but assumes less background. In 705 I assume you are already familiar with basic probability. **This course moves extremely fast.** If you want a course that requires less background, you should take 36-700 instead.

3 Grading

- 10% : Test I (Friday September 18)
- 10% : Test II (Friday October 30)
- 30% : Final Exam (Date set by the University)
- 50% : Homework

The tests will just be homework assignments where you will not be allowed to collaborate with other students.

3.1 Homework

Homework assignments will be posted, roughly weekly, on Canvas. You should submit your HW via Gradescope. If you need an extension due to illness, email me **BEFORE** the homework deadline.

The homeworks are meant for you to practice solving problems. **Do not search for HW solutions online.**

3.2 Reading and Class Notes

Class notes will be posted regularly. The notes are not meant to be a substitute for the book and hence are generally quite terse. Read both the notes and the text before lecture. Sometimes I will cover topics from other sources.

3.3 Group Work

You may work with others on the homework. But write-up your final solutions on your own. Please credit the students that you work with clearly.

The tests will just be homework assignments except that you are not allowed to collaborate.

We will use Piazza. This allows you to discuss the course with other students. You can also ask the TA's questions on Piazza but allow 48 hours for an answer.

3.4 Office Hours

My office hours and the TA office hours will be announced on Canvas.

4 Accommodations for Students with Disabilities

If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at access@andrew.cmu.edu.

5 Statement of Support

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is almost always helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at <http://www.cmu.edu/counseling/>. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

If you or someone you know is feeling suicidal or in danger of self-harm, call someone immediately, day or night:

1. CaPS: 412-268-2922
2. Resolve Crisis Network: 888-796-8226
3. If the situation is life threatening, call the police. On campus: CMU Police: 412-268-2323. Off campus: 911

Calendar on next page ...

6 Tentative Calendar

Date	Lecture Topic
August 31	Review
September 2	Concentration Inequalities
September 4	Concentration Inequalities
September 7	No Class (Labor Day)
September 9	Convergence
September 11	Convergence
September 14	Central Limit Theorem
September 18	Uniform Laws and Empirical Process Theory
September 18	Uniform Laws and Empirical Process Theory
September 21	Uniform Laws and Empirical Process Theory
September 23	Review
September 25	TEST 1
September 28	Likelihood and Sufficiency
September 30	Point Estimation (MLE)
October 2	Point Estimation (Method of Moments, Bayes)
October 5	Decision Theory
October 7	Decision Theory
October 9	Asymptotic Theory
October 12	Asymptotic Theory
October 14	Hypothesis Testing
October 16	NO CLASS (Community Engagement)
October 19	Goodness-of-fit, two-sample, independence
October 21	Multiple testing
October 23	NO CLASS (Mid-Semester Break)
October 26	Multiple testing
October 28	Confidence Intervals
October 30	Confidence Intervals
November 2	Confidence Intervals
November 4	Review
November 6	TEST 2
November 9	Bootstrap
November 11	Bootstrap
November 13	Bayesian Inference
November 16	Bayesian Inference
November 18	Linear Regression
November 20	Non-parametric Regression
November 23	NO CLASS
November 25	NO CLASS (Thanksgiving)
November 27	NO CLASS
November 30	Minimax Lower Bounds
December 2	Minimax Lower Bounds
December 4	High-dimensional Statistics
December 7	High-dimensional Statistics
December 9	Model Selection
December 11	Model Selection