MATH-UA 234: Mathematical Statistics
Fall 2020 Syllabus (short version)

- **Instructor:** Dr. Wayne Isaac Tan Uy
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  - Office hours: TBA
- **Teaching assistant:** Prof. Erik Dies
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- **Course information**
  - Lecture time: Tuesdays & Thursdays 2:00–3:15 pm via Zoom
  - Recitation time and location: Fridays 11:00am–12:15 pm or 3:30–4:45 pm via Zoom
  - Course website: NYU Classes, LinkedIn learning
  - Textbook: There is no required textbook but I will be referring to the following texts. I suggest you download a copy of the latter 2 books as soon as possible. Computing exercises will be taken from the 3rd book.
    - *Statistical Inference, 2nd Edition* by George Casella and Roger L. Berger. This is a classic textbook on statistical inference, covering essential parts of statistical inference in depth. You are not required to purchase this book. I will be mostly referring to this book.
    - *All of Statistics: A Concise Course in Statistical Inference* by Larry Wasserman. This is a very concise book spanning various topics on traditional and modern statistics. It is available free of charge at Springerlink if you are connected to the NYU wireless networks.
    - *An Introduction to Statistical Learning with Applications in R* by Gareth James et al. A good introduction to machine learning and R. We will primarily refer to it for the R tutorials. It is available free of charge at Springerlink if you are connected to the NYU wireless networks.
  - Prerequisites: Formal prerequisite: Math 233, Theory of Probability.
    Informal prerequisite: multivariable calculus, probability (knowledge of central limit theorem is important), familiarity with basic matrix manipulations and basic ideas from real analysis (convergence concepts), experience with mathematical proofs, and willingness to learn how to code.
- **Course content** This is not a class on data science or machine learning. Emphasis is on mathematical tools for statistical analysis.
  - Probability review
  - Basic sampling theory
    - random samples
    - commonly used statistics
  - Point estimation

    - method of moments
    - Bayesian statistics and Bayes estimators
    - MLE
    - MSE
    - UMVUE and Cramér-Rao inequality
    - Fisher information
  - Asymptotics
    - convergence concepts
    - Delta method
    - consistency
    - asymptotic normality and efficiency
    - Bootstrap basics
  - Confidence intervals
    - pivots
    - t, F, chi-square distributions
    - asymptotic confidence intervals
    - variance stabilization
  - Hypothesis testing
    - type I and II errors
    - power of a test
    - UMP and Neyman-Pearson lemma
    - LRT
    - connection with confidence intervals
    - p-values
    - asymptotics and goodness of fit test
  - Linear regression
    - multivariate Gaussian distribution
    - least squares
    - ANOVA
    - hypothesis tests and confidence intervals
    - prediction intervals
    - important theorems (Cochran's theorem)
  - Basic statistical computing in R
    - There will be no lectures on R. A series of videos and notes will be provided to ensure that you can complete the computing exercises
    - You will not be tested on R beyond the homework problems

- **Grade breakdown and test dates**
  - Written homework: 15%
  - Preliminary exams (written): 55%
    - Prelim 1: September 29, 2020

    - Prelim 2: October 27, 2020 (tentative)
    - Prelim 3: December 4, 2020 (tentative)
  - Final examination (oral): 30%. To be scheduled during finals week.
  - No extra credit projects will be offered

- **Academic integrity**
  - You are expected to follow codes of academic integrity as specified by the university and the College of Arts and Sciences:
    - https://www.nyu.edu/about/policies-guidelines-compliance/policies-and-guidelines/academic-integrity-for-students-at-nyu.html
    - https://cas.nyu.edu/content/nyu-as/cas/academic-integrity.html
    - http://cas.nyu.edu/content/nyu-as/cas/academic-integrity/honor-code.html