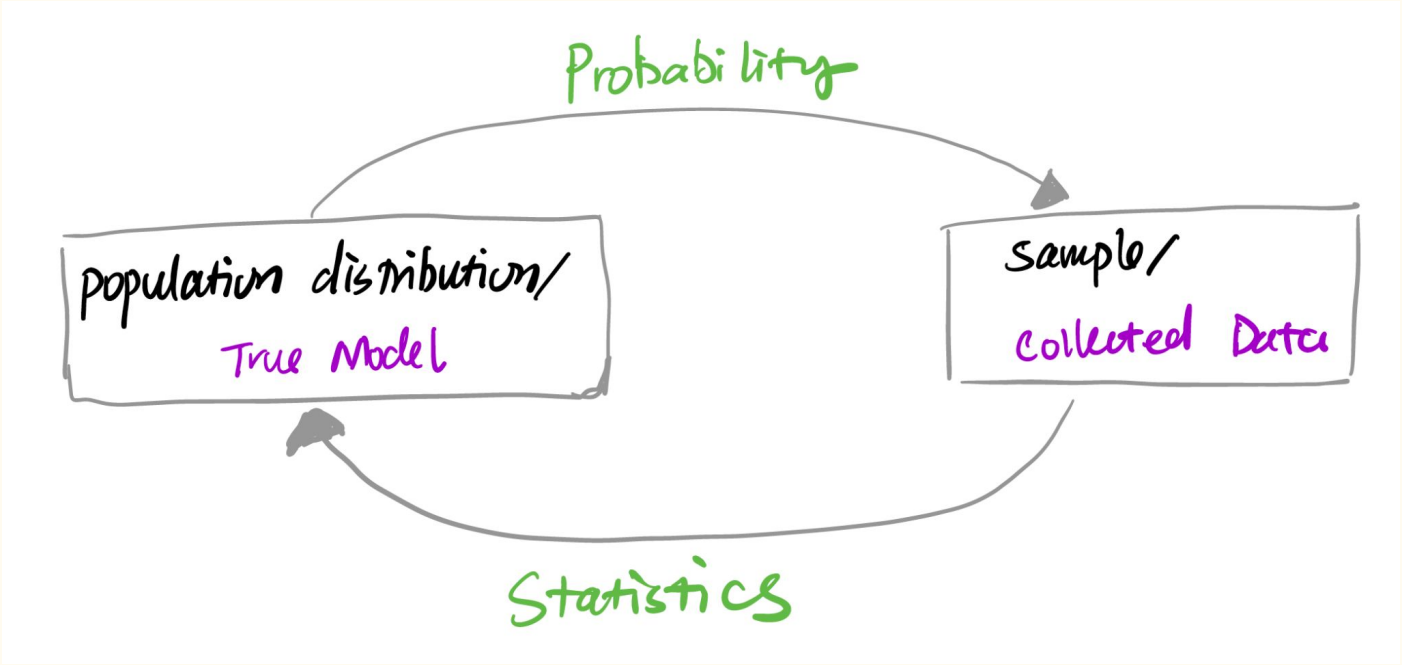
L1: Overview

- Overview of Topics
- Syllabus

Probability vs Statistics

Probability Theory and Statistical Inference



Probability Theory

Use mathematical permutations and combinations to study ALL the possible outcomes and distributions of random experiments/random events based on the truth like laws of physics, chemistry and/or other science.

The probability theory drives the behavior of your data.

Statistical Inference

Analyze limited sample/collected data to estimate the probability theory, aka, estimate the mathematical/physical/scientific rule of the true model.

Statistical methods test/estimate the hypothesis made based on probability theory.

Probability (Population → Sample) and Statistics (Sample → Population) go opposite directions but can not exists without each other:

- Learn Probability theory to understand certain behavior of data indicate certain true model
- Learn Statistical inference to design analytical method to use the data to estimate the details of the true model

Topics

Probability Theory

- Basic Concepts for Probability and Distributions:
  - Random experiment/event: outcome and probability
  - Properties of Probabilities
  - Random variable and its distribution and key parameters
- Commonly used discrete and continuous distributions
- Dealing with two or more random variables:
  - Joint distribution
  - Independence and correlation
  - Distributions and theories associated with normal distributions (transition to independent samples)

Statistical Inference

- Point estimation of key distribution parameters:
  - Estimation method (most general): maximum likelihood estimation
  - Evaluate your estimation: unbiased and small variance
  - Commonly used estimators
- Range estimation or estimation with error bars: Confidence intervals
- Testing for the key distribution parameters: Hypothesis test:
  - You can almost test for anything about the true distribution.
  - Commonly used tests and use cases: z test, t test, chi-square test, F test, Kolmogorov-Smirnov test

About the class

Course Materials

The **lecture notes (most important)** are a summary from several books and online resources.

- Hogg, Robert V. and Elliot A. Tanis. Probability and Statistical Inference, 8th or 9th edition (Strongly recommend to obtain a copy)
- Ghahramani, Saeed. Fundamentals of Probability, with Stochastic Processes, 4th edition (optional)
- Freund, John. Mathematical Statistics, 8th edition (optional)

Lecture notes and other courses materials are available on Canvas. Some book chapters can be found from "MSDS Admitted 2023" canvas course.

Assessments

Attendance	**5%**	In-person attendance and graded by class practice; No phone or laptop	Absence or attending remotely need approval ahead of time
Homework	**20%**	Due weekly on Wednesday before **4pm**	No late assignment will be accepted
Quiz	**50%**	In-person weekly on Thursdays 9-10am	30-60 minute written quiz
Final Exam	**25%**	In-person on Friday 08/11 1-3pm	120-minute cumulative written exam

Homework 1	Homework 2	Homework 3	Homework 4	Homework 5
Wed 07/12	Wed 07/19	Wed 07/26	Wed 08/02	Wed 08/09

Quiz 1	Quiz 2	Quiz 3	Quiz 4
Thu 07/13	Thu 07/20	Thu 07/27	Thu 08/03

Final Exam
Fri 08/11 1-3pm

The quizzes and final exam are closed book exams, but you can bring

- One-page two-sided A5 cheatsheet for each quiz
- Two-page two-sided A5 cheatsheet for the final
- Blank papers
- Hand calculator
- No phone or laptop allowed

Q&A (ordered by priorities)

- In-person office hours: Tuesdays and Thursdays after class 3-3:45, in the same classroom
- Online office hours: Wednesdays 9-10 am (Zoom link on Canvas)
- Slack course channel: #summer-2023-Prob-Stats
- Slack DM
- Email: swang151@usfca.edu (slowest)

Questions Regarding Grades: please wait until AFTER you see the assignment answer posted.

Please do not mix office hours with EDA class.

Please let me go at 3:45 to catch ferry

Class Rules

- Attendance is mandatory.
  - I run random in-class quizzes to count attendance. You have to contact me **BEFORE** the class if you are going to miss it, and the approval is case by case.
- You have to attend all quizzes and final exam
  - I do not provide make-up quiz unless you can provide official evidence of absence (doctor's note and etc.) **BEFORE** the exam.

- Academic Integrity
  - Group discussion on the homework is okay. But do the homework yourself
  - Don’t cheat in the quiz
  - Don’t share course materials, assignments and answers outside the program
- Respect your professors and your fellow students. Professionalism is key.