LINES ON CLAY
Academic Journeys

Descriptive Statistics: What Data Can & Can Not Tell You

Class Syllabus

What Is Statistics

What it is, Why it Matters, and How this Course is Different

- Read: **FREE PREVIEW: Your Authors**
  Optional
- Watch: **FREE PREVIEW: Getting Started**
  Optional
- Read: **FREE PREVIEW: Randomness & Probability**
  Optional
- Read: **FREE PREVIEW: Populations and Samples**
  Optional
- Read: **Parameters & Statistics**
  Optional
- Listen: **Representative Samples**
  Optional

How Do Any of Us Know Anything?

Theoretical vs. Empirical Frameworks for Knowledge

- Read: **Organizing Observations**
  Optional
- Take: **Confirmation Bias**
  Optional
- Read: **Was Julius Ceasar a Real Person?**
  Optional

Kinds of Data

Data Type and Measurement Level

Read: **Quantitative vs. Qualitative Data**
Optional

Watch: **Levels of Data**
Optional

Absolute and Relative Comparisons

Thinking carefully about subtraction and division

Read: **Absolute Change**
Optional

Read: **Relative Change**
Optional

Read: **What You Now Know**
Optional

Submit: **Your Turn: Your First Big Bad Assignment**
30 Points

A Very Quick Hop Through Classical Probability

Only What We Absolutely Need

Read: **What is Probability?**
Optional

Read: **Experiments, Trials, Outcomes, and Sample Spaces**
Optional

Watch: **Events, Singular Events, and the Empty Set**
Optional

Watch: **Classical Probability**
Optional

Watch: **When You Change the Rules a Little...**
Optional

Watch: **The Ultra-Useful Complement Rule**
Optional

Intuition Builder: You Lost Your Wallet. How Do You Find It (Before Someone Else Does)?

Read: **Set Up**
Optional

Watch: **"Where Do I Remember Last Having It?"**
Optional

Read: **Pragmatism: Don't Build A Complicated Model**
Optional

Free Tools That We'll Need For Our Journey

Desmos, Google Sheets, R

Submit: **Your Turn: Check Out Desmos!**
30 Points

Watch: **Why Not Excel for Spreadsheets?**
Optional

Submit: **Your Turn: Spreadsheet Basics in Google Sheets**
30 Points

Watch: **Downloading R and R Studio for Free**
Optional

Read: **Why Use the R Programming Language?**
Optional

Data: Making it Up, Finding it, Modifying it

We're going to do a lot of cool things with data. Let's have some fun with making some of it up ourselves, and also a couple places where we can find real data.

Submit: **Your Turn: Making Up a Scenario and Its Data**
Optional

Submit: **Your Turn: Watch Me Download Free Data**
100 Points

Read: **Accessing Data from FRED on Unemployment**
Optional

Submit: **Your Turn: Collect Data on the "Misery Index"**
30 Points

Read: **Quick Warning: Getting Data from Different Sources**
Optional

Intuition Builder: Bring Out the Scales

Read: **Which Has More Mass?**
Optional

Watch: **Which Has More Mass - Take Two!**
Optional

Empirical Probability

Likelihood Derived Through Careful, Independent Observation

Watch: **Empirical Probability**
Optional

Read: **Empirical Probability v. Classical Probability**
Optional

Watch: **The Law of Large Numbers and the Law of Small Numbers**
Optional

Intuition Builder: How Long Will You Have to Wait?

C'mon, Greg!

Read: **Taking Reciprocals**
Optional

Read: **Just a Long-Run Average Frequency**
Optional

Building Frequency Tables With Qualitative Data

Frequency, Relative Frequency, Cumulative Relative Frequency

Watch: **Scenario: How Do Employees Commute?**
Optional

Watch: **Building a Frequency Table in Google Sheets**
Optional

Read: **Relative Frequency**
Optional

Watch: **Cumulative Relative Frequency**
Optional

Watch: **What YOU Just Learned is Huge**
Optional

Submit: **Your Turn: Build Your Own Frequency Table**
30 Points

Visualizing Qualitative Data

Watch: **Venn Diagrams**
Optional

Watch: **Bar Charts in All Their Glory**
Optional

Submit: **Your Turn: Pie Charts (Should We Use Them?)**
30 Points

Read: **Pictographs...Tread Carefully (But Don't Knock 'em)**
Optional

Intuition Builder: Which is More Likely?

Read: **Heads 5 Times in a Row v. Snake Eyes**
Optional

Watch: **{Heads, Tails, Heads} or {Tails, Tails, Tails}?**
Optional

Read: **Unlikely Does Not Mean Impossible!**
Optional

Random Variables

Turning Events Into Numbers

Watch: **Defining a Random Variable**
Optional

Read: **Turning Categorical Outcomes into Random Variables**
Optional

Watch: **Turning Quantitative Events into Random Variables**
Optional

Submit: **Your Turn: Construct Your Own Random Variables!**
40 Points

Watch: **Really Quick! Why the Hype?**
Optional

Discrete and Continuous Random Variables

Watch: **What are Discrete Data?**
Optional

Watch: **What are Continuous Data?**
Optional

Read: **Discrete v. Continuous Data**
Optional

Read: **Discrete and Continuous Random Variables**
Optional

Submit: **Your Turn: Model Your Own Discrete Random Variable**

Submit: **Your Turn: Model a Continuous Random Variable**

Extending Frequency Tables to Quantitative Data

How the processes are similar, and likely more useful to us

Watch: **Discrete Frequency Tables**
Optional

Submit: **Your Turn: Building and Interpreting the Frequency Table**
30 Points

Read: **Using Ranges to Construct a Frequency Table for a Continuous Random...**
Optional

Watch: **Building Ranges Appropriately (Spoiler Alert!)**
Optional

Intuition Builder: How Will That Stock You Like Do Over the Next Week?

Submit: **Your Turn: Download the Data Together, and Plot out Returns**
30 Points

Read: **Lots of Data V. Recent Data**
Optional

Visualizing Quantitative Data

Segway into Descriptive Statistics

Submit: **The Line Graph**
Optional

Submit: **The Area Chart**
Optional

Submit: **The Scatterplot**
100 Points

Read: **When It's Best to Use a Line Graph, Area Chart, or Scatterplot**
Optional

Watch: **The Histogram - How It's Different Than a Bar Chart**
Optional

Submit: **Your Turn: Make a Histogram in Desmos**
30 Points

Submit: **Your Turn: Make a Histogram in Google Sheets**
30 Points

Exam 1

Take: **Exam**

Collective Exhaustion and Mutual Exclusivity

Exactly One Event is Going to Win Out

Read: **Grouping Events**
Optional

Watch: **Collective Exhaustion**
Optional

Watch: **Mutual Exclusivity**
Optional

Watch: **Putting Together What We Know**
Optional

Intuition Builder: How Many Swallows Does a Spring Make?

Read: **What is Inference?**
Optional

Watch: **Flirtatious Banter as Inference**
Optional

Probability Distributions

Watch: **Review of Discrete v. Continuous Data & Random Variables**
Optional

Read: **Seeing Old Ideas in a New Way**
Optional

Read: **At Last - Probability Distributions Defined**
Optional

Read: **What Does a Discrete Probability Distribution Look Like?**
Optional

Read: **What Does a Continuous Probability Distribution Look Like?**
Optional

Read: **Which One is Not a Probability Distribution?**
Optional

Probability Mass Functions

Read: **Review: Relative Frequency**
Optional

Read: **Probability Mass Function**
Optional

Read: **How are Relative Frequency and Probability Mass Different Ideas?**
Optional

Important Notation Part I

Summation Notation

Read: **Do You Know These Symbols?**
Optional

Watch: **Adding a Bunch of Things Together: Discrete Case**
Optional

Read: **Adding a Bunch of Numbers Together: Continuous Case**
Optional

Cumulative Mass Functions

Read: **Review: Cumulative Relative Frequency**
Optional

Read: **Cumulative Mass Functions**
Optional

Read: **Grouping Probabilities**
Optional

Read: **That Mighty Useful Complement Rule**
Optional

Read: **Important Skill: Slicing and Dicing**
Optional

Hall of Fame Distributions

Meet and Greet - Nothing too Serious

Read: **Hall of Fame Discrete Distributions**
Optional

Read: **Hall of Fame Continuous Distributions**
Optional

Watch: **What About The Gnarly Distributions?**
Optional

Intuition Builder: Is It Random?

Watch: **Determinism v. Random Walk**
Optional

Read: **Randomness is Not an All-or-Nothing Proposition**
Optional

Probability Density Functions (PDFs)

What they Look Like Mathematically, and Computing them with Free Technology

Read: **Frequency Tables with Continuous Data**
Optional

Read: **Quick Review: Probability Mass Functions**
Optional

Watch: **The Paradox of Continuity**
Optional

Read: **The Intuition Behind Probability Density**
Optional

Read: **Defining the PDF**
Optional

Watch: **The Leap from PDF to Probability**
Optional

Watch: **Examples of PDFs**
Optional

Watch: **Two Rules for PDFs**
Optional

Read: **PDF or PMF?**
Optional

Cumulative Density Functions (CDFs)

The continuous path from 0% to 100%. Don't worry - most of these paths are quite short!

Watch: **CDFs: What Do They Look Like, and Why Do We Need Them?**
Optional

Take: **Very Quick Review: CRF and CMF**
Optional

Read: **Quick Review: Probability Density Functions**
Optional

Read: **Very Quick Review: CMF as Very Helpful Analogue to CDF**
Optional

Read: **What the CDF Tells Us**
Optional

Watch: **Calculating a CDF On Computers**
Optional

Read: **Two Rules for CDFs**
Optional

Watch: **Where Do We Get the Formulas for CDFs?**
Optional

Two Important Uses of CDFs

Complement Rule and area between two cdf values

Read: **That Mighty Useful Complement Rule (CDF Edition)**
Optional

Watch: **Slicing and Dicing: Calculating the Probability X Falls on Interval [a,b]**
Optional

Watch: **Watching Pr[a<X<b] in Google Sheets**
Optional

Watch: **The Complement Rule in Google Sheets**

Features of Distributions

Thinking About the Shape of Our Data

Read: **Very Brief Comparison Between Discrete & Continuous Distributions**
Optional

Read: **Shaping Up Our Data: Shape & Outliers**
Optional

Read: **Shaping Up Our Data: Center & Spread**
Optional

Watch: **Treat it Like an Etch-a-Sketch**
Optional

Intuition Builder: Which Would You Rather Own?

Read: **Two Investments - You Decide**
Optional

Read: **Experiencing V. Remembering Self**
Optional

Important Notation Part II

Population v. Sample

Read: **Review Population V. Sample**
Optional

Watch: **Notation that We Use for the Population Parameters**
Optional

Read: **Notation that We use for our Sample**
Optional

Watch: **Recognize the Importance of What You Just Learned**
Optional

Exam #2

Take: **Exam #2**

Measures of Central Tendency

Crystalizing How Our Data Cluster, Center, and Balance

Watch: **Introducing the Concept**
Optional

Watch: **The Mode**
Optional

Watch: **The Median**
Optional

Watch: **Benefits of the Mode(s) V. the Median**
Optional

Watch: **Outliers - What Do We Do with Them?**
Optional

Watch: **The Mean**
Optional

Read: **Why We Care About the Mean So Much**
Optional

Watch: **Three Ways to Take an Arithmetic Mean**
Optional

Read: **Want to Try? Compute an Arithmetic Mean**
Optional

Read: **Computing the Mean for Grouped Data**
Optional

Expected Value

In One or More Variables

Watch: **Review: Random Variables Copy**
Optional

Watch: **What's an Expected Value?**
Optional

Read: **Review: Three Ways to Take an Arithmetic Mean**
Optional

Watch: **Calculating an Expected Value: The Categorical Case**
Optional

Read: **Calculating Discrete Random Variables**
Optional

Read: **Calculating an Expected Value: The Continuous Case**
Optional

Read: **Example of an Expected Value of Continuous Random Variable**
Optional

Read: **Expected Value as the Balance Point of Our Random Variable**
Optional

Intuition Builder: Would You Rather Divide a Fixed Pot of Money Between Two, Ten, or One Hundred People?

Read: **When the Numerator Stays the Same, but the Denominator Changes**

Degrees of Freedom

What they are, When and Why they Matter

Read: **The Simple Version**
Optional

Read: **Population and Degrees of Freedom**
Optional

Watch: **A Sample and Degrees of Freedom**
Optional

Intuition Builder: Which Sleep Schedule Would You Rather Have?

Read: **Get Your Rest!**
Optional

Measures of Dispersion

Min, Max, Range, Variance, and Standard Deviation

Watch: **Introducing the Concept**
Optional

Read: **Min, Max, & Range: Advantages and Limitations**
Optional

Read: **Measures of Dispersion: Take Two**
Optional

Read: **Setting Up Population Variance**
Optional

Watch: **Population Variance**
Optional

Watch: **A Hop, Skip and Jump to the Population Standard Deviation**
Optional

Read: **When to Use the Variance, and When to Use Standard Deviation**
Optional

Watch: **Population Dispersion Measures to Sample Dispersion Measures**
Optional

Read: **What Have You Learned?**
Optional

Intuition Builder: As Long As A Few Of 'Em Love You

Making Dispersion Your Friend

Watch: **You Don't Have to Get Everyone on Your Side**

Watch: **You Don't Have to Get Everyone on Your Side Copy**

Combining What We Know

Coefficient of Variation measures consistency within our data. Z-scores measure exceptionalism within or between data sets (they're a really big deal).

Watch: **Coefficient of Variation - Demonstrating Consistency of the Data as a ...**

Watch: **Z-scores: Measuring Exceptionalism Within and Between Data Sets**

To-Do: **Ready to Go On?**

Take: **Can you Find the COV?**

Take: **Calculating the Mean and the Standard Deviation**

Correlation is not Causation (Except for When It is)

How we calculate it, and what it tells us

Watch: **Moving From Variation to Association**

Watch: **Introduction to Covariance**

Read: **Turning Covariance into Something We Can (Mis)use**

Take: **Covariance and Correlation Recap**

Watch: **Visualizing Correlation**

Watch: **Correlation Abuse: Most Wanted**

Read: **Correlation is Not Causation, Except a Lot of the Time it Is**

Fleshing Out Our Probability Skills

Independence and Intersections

Read: **Dependence and Independence Defined**

Watch: **Intersections and Independent Random Variables**

Take: **Probability Review**

Read: **Putting it Together (Mutually Exclusive and Independent Events)**

Take: **Independence Tests**

Listen: **Correlation = 0 Does Not Mean Independent**

The Simplest Distributions to Understand

Geometric Distribution, Uniform Distribution(s)

Read: **The Most Intuitive: The Discrete Uniform Distribution**

Read: **Expected Value of a Discrete Uniform Random Variable**

Take: **Calculating the Intersection of Independent Random Variables**

Watch: **The Logic Behind the Geometric Distribution**

Read: **Interpreting the EV and the SD for the Geometric Distribution**

Watch: **The logic behind the uniform distribution**

Read: **Behind the Scenes - EV and the SD for the Uniform Distribution**

When Distributions Pair

Working with the Poisson and Exponential Distributions. We find a cool relationship between the exponential and the geometric distributions.

Watch: **That Special Number "e"**

Read: **The Poisson Distribution**

Take: **Geometric Distributions**

Watch: **The Poisson Distribution in Action**

Watch: **Pairing Distributions**

Read: **Comparing the Geometric and Exponential Distributions**

Read: **Mean and Variance - Exponential Probability Distribution**

Career Moves: Subjective Probability

Watch: **What is Subjective Probability?**

The Big, Bad, Beautiful Bell Curve.

Why is it such a big deal?

- Take: **Optional General Review**
- Read: **Core Properties of a Perfect Normal Distribution**
- Watch: **The PDF Explained**
- Watch: **Build a Bell Curve in Desmos!**
- Read: **The CDF explained**
- Read: **Warning: Huge Misconceptions About the Bell Curve**
- Take: **Putting It All Together**
- Take: **Just to Make Sure You are Up to Speed.**

Does the Famous Empirical Rule Always Apply?

And Why It Matters

- Take: **What Does the Empirical Rule State?**
- Read: **Testing the Empirical Rule - Small Sample or Population**
- Watch: **Testing the Empirical Rule**
- Read: **Chebychev's Rule**
- Take: **Wrap Up**
- Watch: **A Big Deal!**
- Take: **Just Making Sure You're Hanging in There!**

Just One Moment?

Actually, we should understand four.

- Watch: **"Moments" Give Us a Language About the Shape of Our Distribution**
- Read: **Mean and Variance**
- Watch: **Skew Explained**
- Watch: **What is Kurtosis?**
- Watch: **"Moments" Give Us a Language About the Shape of Our Distribution C...**

Important Extensions (Teaser)

We don't want to overload you. We owe you at least a quick introduction.

- Read: **Extending the Exponential Distribution to Accommodate Multiple Obser...**
- Read: **Extending the Geometric Distribution to Accommodate Combinations o...**
- Read: **Poisson and its Connections to the Binomial Distribution**
- Watch: **The Normal Distribution ---> T-Distribution Family**
- Watch: **What Gives? Why Not Include More?**

Warnings As We Conclude

Pitfalls to Avoid

- Read: **Lying with Statistics (Split into Error in Collecting / Presenting / Interpre...**
- Read: **Errors in Decision Making**
- Read: **Indispensable Takeaways (and Why We Maybe Like to Go With Our Gut)**
- Read: **Error in Collecting Data**
- Read: **Error in Presenting Data**
- Read: **Error in Interpreting Data**

You Did It!

The Most Important Things That You Have Learned

Read: **The Most Important Ideas from this Class**

Take: **Scary Final Exam...**

Watch: **Video Congratulations and Wrap Up**

Read: **The Most Important Ideas from this Class Copy**