

## Outline of Lessons for ISyE 6739 Probability/Statistics – 200114

### 0. Course Introduction + Bootcamps

- Lesson 0.1: Syllabus
- Lesson 0.2: Introduction to Probability and Statistics
- Lesson 0.3: The Joy of Sets Bootcamp
- Lesson 0.4: Calculus Bootcamp: Introduction + Derivatives
- Lesson 0.5: Calculus Bootcamp: Integration and Beyond

### 1. Getting Started with Probability

- Lesson 1.1: Experiments, Sample Spaces, and Events
- Lesson 1.2: What is Probability?
- Lesson 1.3: Basic Probability Results
- Lesson 1.4: Finite Sample Spaces
- Lesson 1.5: Counting Techniques: Baby Examples
- Lesson 1.6: Counting Techniques: Permutations
- Lesson 1.7: Counting Techniques: Combinations
- Lesson 1.8: Hypergeometric, Binomial, and Multinomial Problems
- Lesson 1.9: Permutations vs. Combinations
- Lesson 1.10: The Birthday Problem
- Lesson 1.12: The Envelope Problem
- Lesson 1.12: Poker Problems
- Lesson 1.13: Conditional Probability
- Lesson 1.14: Independence Day
- Lesson 1.15: Partitions and the Law of Total Probability
- Lesson 1.16: Bayes Theorem

### 2. Random Variables

- Lesson 2.1: Introduction
- Lesson 2.2: Discrete Random Variables
- Lesson 2.3: Continuous Random Variables
- Lesson 2.4: Cumulative Distribution Functions
- Lesson 2.5: Great Expectations
- Lesson 2.6: LOTUS, Moments, and Variance
- Lesson 2.7: Approximations to  $E[h(X)]$  and  $\text{Var}(h(X))$
- Lesson 2.8: Moment Generating Functions
- Lesson 2.9: Some Probability Inequalities
- Lesson 2.10: Functions of a Random Variable
- Lesson 2.11: Inverse Transform Theorem
- Lesson 2.12: Honors Bonus Results

### 3. Bivariate Random Variables

- Lesson 3.1: Introduction
- Lesson 3.2: Marginal Distributions
- Lesson 3.3: Conditional Distributions

- Lesson 3.4: Independent Random Variables
- Lesson 3.5: Consequences of Independence
- Lesson 3.6: Random Samples
- Lesson 3.7: Conditional Expectation
- Lesson 3.8: Double Expectation
- Lesson 3.9: First-Step Analysis
- Lesson 3.10: Random Sums of Random Variables
- Lesson 3.11: Standard Conditioning Argument
- Lesson 3.12: Covariance and Correlation
- Lesson 3.13: Correlation and Causation
- Lesson 3.14: A Couple of Worked Correlation Examples
- Lesson 3.15: Some Useful Covariance / Correlation Theorems
- Lesson 3.16: Moment Generating Functions, Revisited
- Lesson 3.17: Honors Bivariate Functions of Random Variables

#### 4. Distributions

- Lesson 4.1: Bernoulli and Binomial Distributions
- Lesson 4.2: Hypergeometric Distribution
- Lesson 4.3: Geometric and Negative Binomial Distributions
- Lesson 4.4: Discrete Distributions: Poisson Distributions
- Lesson 4.5: Uniform, Exponential, and Friends
- Lesson 4.6: Other Continuous Distributions
- Lesson 4.7: Normal Distribution: Basics
- Lesson 4.8: Standard Normal Distribution
- Lesson 4.9: Sample Mean of Normals
- Lesson 4.10: The Central Limit Theorem + Proof
- Lesson 4.11: Central Limit Theorem Examples
- Lesson 4.12: Extensions – Multivariate Normal Distribution
- Lesson 4.13: Extensions – Lognormal Distribution
- Lesson 4.14: Computer Stuff

#### 5. Getting Started with Statistics

- Lesson 5.1: Introduction to Descriptive Statistics
- Lesson 5.2: Summarizing Data
- Lesson 5.3: Candidate Distributions
- Lesson 5.4: Introduction to Estimation
- Lesson 5.5: Unbiased Estimation
- Lesson 5.6: Mean Squared Error
- Lesson 5.7: Maximum Likelihood Estimation
- Lesson 5.8: Trickier MLE Examples
- Lesson 5.9: Invariance Property of MLEs
- Lesson 5.10: Method of Moments Estimation
- Lesson 5.11: Sampling Distributions

#### 6. Confidence Intervals

- Lesson 6.1: Introduction to Confidence Intervals

- Lesson 6.2: Normal Mean (variance known)
- Lesson 6.3: Difference of Two Normal Means (variances known)
- Lesson 6.4: Normal Mean (variance unknown)
- Lesson 6.5: Difference of Two Normal Means (unknown *equal* variances)
- Lesson 6.6: Difference of Two Normal Means (variances known)
- Lesson 6.7: Difference of Paired Normal Means (variances known)
- Lesson 6.8: Normal Variance
- Lesson 6.9: Ratio of Variances of Two Normals
- Lesson 6.10: Bernoulli Proportion

## 7. Hypothesis Testing

- Lesson 7.1: Introduction to Hypothesis Testing
- Lesson 7.2: The Errors of Our Ways
- Lesson 7.3: Normal Mean Test with Known Variance
- Lesson 7.4: Normal Mean Test with Known Variance: Design
- Lesson 7.5: Two-Sample Normal Means Test with Known Variances
- Lesson 7.6: Normal Mean Test with Unknown Variance
- Lesson 7.7: Two-Sample Normal Means Tests with Unknown Variances
- Lesson 7.8: Two-Sample Normal Means Test with Paired Observations
- Lesson 7.9: Normal Variance Test
- Lesson 7.10: Two-Sample Normal Variances Test
- Lesson 7.11: Bernoulli Proportion Test
- Lesson 7.12: Two-Sample Bernoulli Proportions Test
- Lesson 7.13: Goodness-of-Fit Tests: Introduction
- Lesson 7.14: Goodness-of-Fit Tests: Examples
- Lesson 7.15: Goodness-of-Fit Tests: Honors Example