

# MATH 2112: Probability and Statistics

Bullet points without links are works-in-progress.

## Chapter 1: Sampling Data (Week 1)

### 1.1 DEFINITIONS OF STATISTICS, PROBABILITY AND KEY TERMS

- What is Statistics
- Types of statistical studies

### 1.2 DATA, SAMPLING, AND VARIATION IN DATA SAMPLING

- Census and Sampling
- Samples and Surveys
- Inferring population mean from sample mean
- Reasonable samples

### 1.3 FREQUENCY, FREQUENCY TABLES, AND LEVELS OF MEASUREMENT

- Frequency tables & dot plots

### 1.4 EXPERIMENTAL DESIGN AND ETHICS

- Designing Experiments
- Appropriate statistical study example

## Chapter 2: Descriptive Statistics (Week 2)

### 2.1 STEM-AND-LEAF GRAPHS (STEMPLOTS), LINE GRAPHS AND BAR GRAPHS

- Stemplots
- Reading stem and leaf plots
- Reading bar graphs

- Creating a bar graph
- Reading bar charts: comparing two sets of data
- Reading line graphs

## 2.2 HISTOGRAMS, FREQUENCY POLYGONS, AND TIME SERIES GRAPHS

- Histograms

## 2.3 MEASURES OF THE LOCATION OF THE DATA

- Measures of Center
- Statistics intro: Mean, median, & mode
- Mean, median, & mode example
- Comparing means of distributions
- Means and medians of different distributions

## 2.4 BOX PLOTS

- Box plots
- Reading box plots
- Constructing a box plot

## 2.5 MEASURES OF THE CENTER OF THE DATA

- Measures of Center
- Statistics intro: Mean, median, & mode
- Mean, median, & mode example
- Comparing means of distributions
- Means and medians of different distributions

## 2.6 SKEWNESS AND THE MEAN, MEDIAN, AND MODE

- Comparing means of distributions
- Means and medians of different distributions

## 2.7 MEASURES OF THE SPREAD OF THE DATA

- Standard Deviation
- Measures of spread: range, variance, & standard deviation
- Variance of a population
- Sample variance
- Review and intuition why we divide by  $n-1$  for the unbiased sample variance
- Simulation showing bias in sample variance
- Why we divide by  $n-1$  in variance
- Simulation providing evidence that  $(n-1)$  gives unbiased estimate.
- Population standard deviation
- Sample standard deviation and bias
- Statistics: Standard deviation

## Chapter 3: Probability Topics (Week 4)

### 3.1 TERMINOLOGY

- Introduction to Probability
- Subsets of sample spaces
- Simple probability: yellow marble
- Simple probability: non-blue marble

### 3.2 INDEPENDENT AND MUTUALLY EXCLUSIVE EVENTS

- Compound probability of independent events
- Coin flipping probability
- Die rolling probability
- Free throwing probability
- Three pointer vs free throw probability
- Probability with equally likely events
- Independent events example: test taking
- Die rolling with independent events

### 3.3 TWO BASIC RULES OF PROBABILITY

- Addition rule for probability
- Dependent probability introduction
- Dependent probability: coins
- Dependent probability example
- Independent and dependent probability
- Analyzing event probability for independence
- Dependent probability
- Calculating conditional probability
- The Monty Hall problem

### 3.4 CONTINGENCY TABLES

- Filling out contingency table for independent events

### 3.5 TREE AND VENN DIAGRAMS

- Probability with Venn diagrams
- Count outcomes using a tree diagram

## **Chapter 4: Discrete Random Variables (Week 6)**

### 4.1 PROBABILITY DISTRIBUTIONS FUNCTION (PDF) FOR A DISCRETE RANDOM VARIABLE

- Random Variables
- Discrete and continuous random variables
- Constructing a probability distribution for random variable

### 4.2 MEAN OR EXPECTED VALUE AND STANDARD DEVIATION

- Term life insurance and death probability
- Getting data from expected value
- Expected profit from lottery ticket
- Expected value while fishing

- Comparing insurance with expected value

### 4.3 BINOMIAL DISTRIBUTION

- Binomial Distributions
- Visualizing a binomial distribution
- Binomial probability example
- Generalizing k scores in n attempts
- Free throw binomial probability distribution
- Graphing basketball binomial distribution
- Expected value of binomial distribution

### 4.4 GEOMETRIC DISTRIBUTION

### 4.5 HYPERGEOMETRIC DISTRIBUTION

### 4.6 POISSON DISTRIBUTION

## **Chapter 5: Continuous Random Variables (Week 7)**

### 5.1 CONTINUOUS PROBABILITY FUNCTIONS

### 5.2 THE UNIFORM DISTRIBUTION

### 5.3 THE EXPONENTIAL DISTRIBUTION

## **Chapter 6: The Normal Distribution (Week 8)**

### 6.1 THE STANDARD NORMAL DISTRIBUTION

- Normal Curves
- [ck12.org](http://ck12.org) normal distribution problems: Qualitative sense of normal distributions

### 6.2 USING THE NORMAL DISTRIBUTION

- Normal Calculations
- [ck12.org](http://ck12.org) normal distribution problems: Empirical rule

- [ck12.org normal distribution problems: z-score](https://www.ck12.org/normal-distribution-problems-z-score/)
- [ck12.org exercise: Standard normal distribution and the empirical rule](https://www.ck12.org/exercise-standard-normal-distribution-and-the-empirical-rule/)
- [ck12.org: More empirical rule and z-score practice](https://www.ck12.org/more-empirical-rule-and-z-score-practice/)

## **Chapter 7: The Central Limit Theorem (Week 10)**

### 7.1 THE CENTRAL LIMIT THEOREM FOR SAMPLE MEANS (AVERAGES)

- Sampling Distributions
- Central limit theorem
- Sampling distribution of the sample mean
- Sampling distribution of the sample mean 2

### 7.2 THE CENTRAL LIMIT THEOREM FOR SUMS

### 7.3 USING THE CENTRAL LIMIT THEOREM

- Standard error of the mean
- Sampling distribution example problem

## **Chapter 8: Confidence Intervals (Week 11)**

### 8.1 A SINGLE POPULATION MEAN USING THE NORMAL DISTRIBUTION

- Confidence Intervals
- Confidence interval 1

### 8.2 A SINGLE POPULATION MEAN USING THE STUDENT T DISTRIBUTION

- Small Sample Inference for One Mean

### 8.3 A POPULATION PROPORTION

- Confidence interval example
- Mean and variance of Bernoulli distribution example
- Bernoulli distribution mean and variance formulas
- Margin of error 1
- Margin of error 2

## **Chapter 9: Hypothesis Testing with One Sample (Week 12)**

### 9.1 NULL AND ALTERNATIVE HYPOTHESES

- Test of Significance
- Hypothesis testing and p-values
- One-tailed and two-tailed tests

### 9.2 OUTCOMES AND THE TYPE I AND TYPE II ERRORS

- Type I errors

### 9.3 DISTRIBUTION NEEDED FOR HYPOTHESIS TESTING

- Z-statistics vs. T-statistics
- Small Sample hypothesis test

### 9.4 RARE EVENTS, THE SAMPLE, DECISION AND CONCLUSION

### 9.5 ADDITIONAL INFORMATION AND FULL HYPOTHESIS TEST EXAMPLES

## **Chapter 12: Linear Regression and Correlation (Week 3)**

### 12.1 LINEAR EQUATIONS

- See Section 2.2 in the College Algebra material above.

## 12.2 SCATTER PLOTS

- Scatter plots
- Scatter plots: studying, shoe size, and test scores
- Scatter plot: smokers
- Constructing a scatter plot

## 12.3 THE REGRESSION EQUATION

- Fitting Lines to Data
- Correlation
- Correlation and causality
- Fitting a line to data
- Estimating the line of best fit exercise
- Squared error of the regression line
- Example: Correlation coefficient intuition

## 12.4 TESTING THE SIGNIFICANCE OF THE CORRELATION COEFFICIENT

- Inference for Regression