

# STA 371G Outline

## Fall 2017

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Office Hours: Monday & Wednesday 5:00-6:15 PM. You are welcome to come by my office at other times.

### Wednesday, August 30

#### Topics:

- Introduction
- Probability
- Random variables

#### Reading Assignments:

You are recommended to read:

Chapter 1 of OpenIntro Statistics, 3rd edition

### Wednesday, September 6

#### Topics:

- Probability distributions
- Mean, variance and standard deviation of a random variable

#### Reading Assignments:

If you are not familiar with the topics discussed in class, you are recommended to read:

pp. 156-168, 189-195, of Data analysis and decision making, 4th edition

or

pp. 196-206, 225-231 of Data analysis and decision making, 3rd edition

You are also recommended to read:

pp. 1-14 of “1TopicSummary\_ProbabilityConceptsAndNormalDistributions.pdf” (available in Canvas/files)

To learn more about these topics, you may further read:

Chapters 2.1, 2.2, 2.4, and 2.5 of OpenIntro Statistics, 3rd edition

## Monday, September 11

- Add a constant to a random variable
- Multiply a random variable by a constant
- Independent random variables, sum of independent random variables
- Continuous random variables
- Probability density function: area under the curve represents probability
- Standard normal distribution  $Z \sim \mathcal{N}(0, 1)$
- Normal distribution  $X \sim \mathcal{N}(\mu, \sigma^2)$

### Reading Assignments:

To get familiar with the normal distribution, you are recommended to read:  
pp. 211-215, 217-225 of Data analysis and decision making, 4th edition  
or  
pp. 247-250, 253-260 of Data analysis and decision making, 3rd edition

You are also recommended to read:  
pp. 15-30 of “1TopicSummary\_ProbabilityConceptsAndNormalDistributions.pdf” (available in Canvas/files)

You may further read:  
Chapters 3.1.1, 3.1.2, 3.1.4 and 3.1.5 of OpenIntro Statistics, 3rd edition

## Wednesday, September 13

- If  $X \sim \mathcal{N}(\mu, \sigma^2)$ , then  $P(X < x) = P(\frac{X-\mu}{\sigma} < \frac{x-\mu}{\sigma}) = P(Z < \frac{x-\mu}{\sigma})$ .
- Standard normal calculations in Excel: NORMSDIST,  
or in R: pnorm (type “?pnorm” in R for help).
- Understand the meaning of the standard deviation  $\sigma$  in a normal distribution:  $P(\mu - \sigma < X < \mu + \sigma) = ?$  and  $P(\mu - 2\sigma < X < \mu + 2\sigma) = ?$
- Normal calculations in Excel:  
NORMSDIST, NORMDIST  
NORMSINV, NORMINV  
or in R:  
pnorm, qnorm (type “?pnorm” and “?qnorm” in R for help).
- Standardizing a normal random variable  $Z = \frac{X-\mu}{\sigma} \sim \mathcal{N}(0, 1)$   
Interpretation: the value of  $Z$  is the number of standard deviations that  $X$  deviates towards the left (if  $Z < 0$ ) or the right (if  $Z > 0$ ) of the mean.
- Plot a normal distribution in Excel and R

## Monday, September 18

- Example: Testing at ZTel, we will make an Excel spreadsheet for calculations
- Case study, Texas BBA Salary Statistics
- Expectation of a continuous random variable
- Population mean, variance, standard deviation
- Sample mean, sample variance, standard error of the sample mean
- Sampling distribution of the sample mean

### Reading Assignments:

To learn more about estimation and sampling distribution, please read:

pp. 352-353, 366-371, 374, 388-395 of Data analysis and decision making, 4th edition  
or

pp. 378-379, 393-398, 400-401, 422-430 of Data analysis and decision making, 3rd edition

You are also recommended to read:

“2TopicSummary\_EstimationAndSamplingDistributions.pdf” (available in Canvas/files)

For this topic, you may further read:

Chapters 4.1, 4.2, 4.4 and 5.3 of OpenIntro Statistics, 3rd edition

## Wednesday, September 20

- Sampling distribution of the sample mean
- Confidence interval
- Simple linear regression
- Linear prediction:  $Y = b_0 + b_1X$

### Reading Assignments:

Chapters 7.1 and 7.2 of OpenIntro Statistics, 3rd edition

pp. 531-551 of Data analysis and decision making, 4th edition  
or

pp. 562-584 of Data analysis and decision making, 3rd edition

## Monday, September 25

- Least squares estimation of  $b_0$  and  $b_1$
- Examples: predict house price, baseball runs per game

- Using Excel and R to do the calculation
- Excel add-in: [Palisade Decision Tools \(including StatTools\)](#) for Windows, [StatPlus:mac LE](#) for Mac.
- Sample mean, variance, and standard deviation
- Sample covariance, sample correlation

### Reading Assignments:

PDF “Simple Linear Regression” posted in Canvas/files

## Wednesday, September 27

- Linear relationship between  $X$  and  $Y$
- $b_0 = \bar{y} - b_1\bar{x}$ ,  $b_1 = r_{xy} \times \frac{s_y}{s_x}$
- $\text{mean}(e)=0$ ,  $\text{Corr}(e, X)=0$ ,  $\text{Corr}(e, \hat{Y})=0$ ,  $\text{Corr}(\hat{Y}, X)=1$
- SST, SSR, SSE
- Coefficient of determination:  $R^2 = \frac{SSR}{SST} = 1 - \frac{SSE}{SST}$
- $R^2 = r_{xy}^2$  measures the proportion of variation in  $Y$  explained by  $X$ .
- Statistical model for simple linear regression
- Statistical model for simple linear regression:  
 $Y = \beta_0 + \beta_1 X + \epsilon$ ,  $\epsilon \sim \mathcal{N}(0, \sigma^2)$   
 $Y \sim \mathcal{N}(\beta_0 + \beta_1 X, \sigma^2)$
- Conditional distribution of  $Y$  given  $X$
- 95% prediction interval of  $Y$  given  $X$ :  $\beta_0 + \beta_1 X \pm 2\sigma$

### Reading Assignments:

“3TopicSummary\_RegressionModelAndEstimation.pdf” (available in Canvas/files)  
 “5TopicSummary\_CorrelationAndCovariance.pdf” (available in Canvas/files)  
 “6TopicSummary\_ComputingAndInterpretingRSquare.pdf” (available in Canvas/files)  
 “7TopicSummary\_InterpretingAndEstimatingVarianceOfEpsilon.pdf” (available in Canvas/files)

## Monday, October 2

- Conditional and marginal distributions of  $Y$
- Interpretation of  $\epsilon$  and  $\sigma$

- The error terms  $\epsilon_i$  are independent, and identically distributed
- Least squares estimation and Gaussian maximum likelihood (optional)
- True line  $\beta_0 + \beta_1 X$  and least squares line  $b_0 + b_1 X$
- Case study: A stock's beta coefficient

### Wednesday, October 4

- Case study: Milk and Money
- Degrees of freedom
- In SLR,  $\sigma^2$  is estimated with  $s^2 = \frac{\sum_{i=1}^n e_i^2}{n-2} = \frac{SSE}{n-2}$ .
- SLR regression standard error:  $s = \sqrt{SSE/(n-2)}$
- Sampling distributions of regression parameters
- Confidence intervals of regression parameters

### Monday, October 9

- Hypothesis testing in SLR:  $t$ -statistic and  $p$ -value
- Discuss Practice Exam #1
- Common problems in homework assignments
- Topic summary for Midterm #1

### Wednesday, October 11

- Midterm Exam #1, 7:00-9:30 pm

### Monday October 16

- Multiple regression
- T-test
- Examples: Auto MPG, Baseball

### Wednesday, October 18

- Example: Supervisor performance data

- F-test
- Understanding multiple regression
- Correlation and causation
- Multicollinearity
- Example: Number of beer and weight & height

### **Monday, October 23**

- Multicollinearity
- Dummy variables and interactions
- Example: Gender Discrimination in Salary at Fifth National Bank
- Case study: Orion Bus Industries—Contract Bidding Strategy

### **Wednesday, October 25**

- Example: MidCity House Price
- Diagnostics
- Polynomial regression

### **Reading Assignments:**

Chapters 10, 11.1-11.5, and 11.8-11.11 of Data analysis and decision making, 4th edition  
or  
Chapters 11, 12.1-12.5, and 12.8-12.11 of Data analysis and decision making, 3rd edition

“4TopicSummary\_NonlinearRelationships.pdf ” (available in Canvas/files)

### **Monday, October 30**

- Slides 3.3 pages 25-46
- Variable interaction
- Log transformation
- Case Study, Oakland A's (A)
- Case Study, Oakland A's (B)

**Reading Assignments:**

“9TopicSummary\_MeasuringTheQualityOfTheEstimateOfBeta.pdf” (available in Canvas/files)

“10TopicSummary\_HypothesisTestingInRegression.pdf” (available in Canvas/files)

**Wednesday, November 1**

- Slides 4.1, Slides 4.2 pages 1-15
- Time series: fitting a trend
- Autocorrelation
- Time series regression, Hotel Occupancy Case

**Reading Assignments:**

Chapter 12 of Data analysis and decision making, 4th edition  
or

Chapter 13 of Data analysis and decision making, 3rd edition

**Monday, November 6**

- Slides 4.2 pages 16-end, Slides 4.3 pages 1-15
- Random walk models
- Autoregressive models
- Example: Monthly stock closing prices
- Example: Daily/Monthly temperature
- Example: Monthly Boston Armed Robberies Jan.1966-Oct.1975
- Seasonal models
- Example: Fisher river daily temperatures

**Reading Assignments:**

“8TopicSummary\_ForecastingModelForSPSSSales.pdf” (available in Canvas/files)

**Wednesday, November 8**

- Slides 4.3 pages 16-end
- Example: Monthly airline passengers
- Case study: Northern Napa Valley Winery, Inc.
- Example: Monthly liquor sales

## **Monday, November 13**

- Slides 5, Slides 6.1 pages 1-3
- Outliers
- Moving averages, exponential smoothing and ARMA
- Hypothesis testing: Type I Error, Type II Error, significant level, and power
- Understanding prediction errors in linear regression
- Model selection
- Measure uncertainty with probability
- Frequency probability and subjective probability

## **Wednesday, November 15**

- Midterm Exam #2

## **Monday, November 20**

- Slides 6.1 pages 1-16, Slides 6.2 pages 1-21
- Frequency probability and subjective probability
- Probability, lotteries and betting odds
- Payoff tables
- Payoffs and Losses
- Nonprobabilistic criteria for decision making: maximin, maximax, and minimax loss
- Review for Midterm Exam #2

## **Monday, November 27**

- Slides 6.2 pages 22-end, Slides 6.1 pages 17-end, Slides 1.1 pages 26-35
- Probabilistic criteria for decision making: expected payoff, expected loss
- Utility functions
- Conditional probability and conditional bets or conditional reference contracts
- Conditional, joint and marginal probabilities



- Bayes' theorem

**Reading Assignments:**

Chapter 6 of Data analysis and decision making, 4th edition  
or  
Chapter 7 of Data analysis and decision making, 3rd edition

**Wednesday, November 29**

- Slides 6.3 pages 1-14, Slides 6.4 pages 1-14
- Decision trees, risk profile, sensitivity analysis
- Risk profile, sensitivity analysis
- The value of information
- Expected value of perfect information (EVPI)
- Expected value of sample information (EVSI)

**Reading Assignments:**

Chapter 6 of Data analysis and decision making, 4th edition  
or  
Chapter 7 of Data analysis and decision making, 3rd edition

**Monday, December 4**

- Expected value of sample information (EVSI)
- Case study: Freemark Abbey Winery

**Wednesday, December 6**

- Please install R and Rstudio on your laptop and bring it to class
- Simulation using Excel and R
- Simulate random numbers from a discrete distribution
- Find the sample mean and variance, compare them with the true mean and variance
- Simulate the sampling distribution of the sample mean
- Uniform random numbers, flip a coin, toss a die, flip two coins, toss two dice, law of large numbers
- Estimate  $\pi$  with Monte Carlo simulation

- Simulate normal random numbers  $X \sim \mathcal{N}(\mu, \sigma^2)$ .
- Find  $P(X < x)$  and  $P(X < ?) = p$  using simulation
- Demonstrate Central Limit Theorem using simulation
- Simulation of weekly demand

**Reading Assignments:**

Chapters 4.4–4.8 of Data analysis and decision making, 4th edition  
or  
Chapters 5.4–5.8 of Data analysis and decision making, 3rd edition

**Monday, December 11**

- Simulation and decision
- Multivariate distributions, covariance and correlation
- Sum of correlated random variables
- Simulate portfolio return
- Sample from a finite population (with/without replacement)
- Simulate binomial random variables
- Simulate student t random variables
- Simulate a random walk model
- Simulate an AR+Trend model
- Simulate prediction intervals for an AR model

**Final Exam**

- Final Exam: GEA 105, Friday, 12/15/2017, 7:00-10:00 pm