

STA 371G Outline

Spring 2017

Instructor: Mingyuan Zhou, Ph.D., Assistant Professor of Statistics

Office: CBA 6.458

Phone: 512-232-6763

Email: mingyuan.zhou@mcombs.utexas.edu

Website: <http://mingyuanzhou.github.io/>

Office Hours: Monday & Wednesday 3:30-5:00 PM. You are welcome to come by my office at other times.

Wednesday, January 18

Topics:

- Introduction
- Probability
- Random variables

Reading Assignments:

You are recommended to read:

Chapter 1 of OpenIntro Statistics, 3rd edition

Monday, January 23

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

Wednesday, January 25

- Mean, variance and standard deviation of a random variable
- Add a constant to a random variable
- Multiply a random variable by a constant
- Conditional, joint and marginal probabilities

Monday, January 30

- Conditional, joint and marginal probabilities
- Independent random variables, sum of independent random variables

Wednesday, February 1

- Continuous random variables
- Probability density function: area under the curve represents probability
- Standard normal distribution $Z \sim \mathcal{N}(0, 1)$
- Normal distribution $X \sim \mathcal{N}(\mu, \sigma^2)$
- If $X \sim \mathcal{N}(\mu, \sigma^2)$, then $P(X < x) = P(\frac{X-\mu}{\sigma} < \frac{x-\mu}{\sigma}) = P(Z < \frac{x-\mu}{\sigma})$.

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

Monday, February 6

- Standard normal calculations in Excel: NORMSDIST, or in R: pnorm (type “?pnorm” in R for help).
- Understand the meaning of the standard deviation σ 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

Wednesday, February 8

- 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

Monday, February 13

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

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

Wednesday, February 15

- Sample mean, variance, and standard deviation
- Sample covariance, sample correlation
- 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 .

Reading Assignments:

PDF “Simple Linear Regression” posted in Canvas/files

Monday, February 20

- 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 : $\beta_0 + \beta_1 X \pm 2\sigma$
- Conditional and marginal distributions of Y

- Interpretation of ϵ and σ
- The error terms ϵ_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 $b_0 + b_1 X$

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)

Wednesday, February 22

- Case study: Waite First Securities, Milk and Money
- Discuss Practice Exam #1
- Common problems in homework assignments
- Topic summary for Midterm #1

Monday, February 27

- Midterm Exam #1, FAC 21, 7:00-10:00 pm

Wednesday, March 1

- Degrees of freedom
- In SLR, σ^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
- Hypothesis testing in SLR: t -statistic and p -value

Monday, March 6

- Multiple regression
- T-test

- Example: Supervisor performance data
- Understanding multiple regression
- Examples: Auto MPG, Baseball

Wednesday March 8

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

Monday, March 20

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

Wednesday March 22

- Example: MidCity House Price
- Diagnostics
- Polynomial regression
- Variable interaction
- Log transformation

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, March 27

- Log transformation
- Outliers
- Case Study, Oakland A's (A)
- Case Study, Oakland A's (B)
- Time series: fitting a trend

Reading Assignments:

“9TopicSummary_MeasuringTheQualityOfTheEstimateOfBeta.pdf” (available in Canvas/files)

“10TopicSummary_HypothesisTestingInRegression.pdf” (available in Canvas/files)

Wednesday, March 29

- Autocorrelation
- Time series regression, Hotel Occupancy Case
- Random walk models
- Autoregressive models
- Example: Monthly stock closing prices
- Example: Daily/Monthly temperature
- Example: Monthly Boston Armed Robberies Jan.1966-Oct.1975

Reading Assignments:

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

or

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

Monday, April 3

- Seasonal models
- Example: Fisher river daily temperatures
- Example: Monthly airline passengers

Reading Assignments:

“8TopicSummary_ForecastingModelForSPSSSales.pdf” (available in Canvas/files)

Wednesday, April 5

- Review for Midterm Exam #2

- Case study: Northern Napa Valley Winery, Inc.
- Example: Monthly liquor sales

Monday, April 10

- Midterm Exam #2

Wednesday, April 12

- 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
- Probability, lotteries and betting odds

Monday, April 17

- Probability, lotteries and betting odds
- Payoff tables
- Payoffs and Losses
- Nonprobabilistic criteria for decision making: maximin, maximax, and maximin loss
- Probabilistic criteria for decision making: expected payoff, expected loss
- Utility functions

Wednesday, April 19

- Utility functions
- Conditional probability and conditional bets or conditional reference contracts
- 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

Monday, April 24

- Simpson's paradox
- 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

Wednesday, April 26

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

Monday, May 1

- 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 π 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

Wednesday, May 3

- 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
- Review for the Final Exam

Final Exam

- Final Exam: WCH 1.120, 7:00-10:00 PM, Friday, 05/12/2017
- Makeup Final Exam: BEN 1.104, 9:00-11:59 am, Monday, 05/15/2017