STA 371G Outline
Spring 2016

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Office Hours: Tuesday & Thursday 5:00-6:30 PM. You are welcome to come by my office at other times.

Tuesday, January 19

Topics:

- Introduction
- Probability
- Random variables

Reading Assignments:
You are recommended to read:
Chapter 1 of OpenIntro Statistics, 3rd edition

Thursday, January 21

Topics:

- Probability distributions
- Mean, variance and standard deviation of a random variable
- Add a constant to a random variable
- Multiply a random variable by a constant

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

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

Tuesday, January 26

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

Thursday, January 28

- 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 may further read:

  Chapters 3.1.1, 3.1.2, 3.1.4 and 3.1.5 of OpenIntro Statistics, 3rd edition

Tuesday, February 2

- 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).
- If $X \sim \mathcal{N}(\mu, \sigma^2)$, then $P(X < x) = P(\frac{X-u}{\sigma} < \frac{x-u}{\sigma}) = P(Z < \frac{x-u}{\sigma})$.
- 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.

Thursday, February 4

- Plot a normal distribution in Excel and R
- Normal calculations in Excel:
  NORMSDIST, NORMDIST
  NORMSINV, NORMINV
  or in R:
  pnorm, qnorm (type "?pnorm" and "?qnorm" in R for help).
- Example: Testing at ZTel, we will make an Excel spreadsheet for calculations
- Case study, Texas BBA Salary Statistics
- Expectation of a continuous random variable
- Binomial distribution and its normal approximation

Reading Assignments:
Lecture notes 3 and 4 posted on the course website.

To learn more about the binomial distribution, its normal approximation, and the sampling distribution of a sample proportion, please read:
pp. 233-239, 403-404 of Data analysis and decision making, 4th edition
or
pp. 268-273, 438-439 of Data analysis and decision making, 3rd edition

For this topic, you may further read:
Chapters 3.4.1, 3.4.2 and 6.1 of OpenIntro Statistics, 3rd edition

Tuesday, February 9

- Binomial distribution and its normal approximation
- Case study: Texas BBA Demographics
- Binomial distribution $X \sim \text{Binomial}(n, p)$. Examples: the number of "Heads" in 100 coin flips, the number of votes for Republican in 1000 voters
- The normal approximation to the binomial $X \sim \mathcal{N}\left(np, np(1-p)\right)$
- Important concepts: Population and Sample
- Sampling distribution of a sample proportion
- Case study: A national poll of 803 adults by Anzalone Liszt Grove Research

Thursday, February 11

- 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

For this topic, you may further read:
Chapters 4.1, 4.2, 4.4 and 5.3 of OpenIntro Statistics, 3rd edition

Tuesday, February 16

- Confidence interval
- Simple linear regression
- Linear prediction: $Y = b_0 + b_1 X$
- 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
- Linear relationship between X and Y
- $b_0 = \bar{y} - b_1 \bar{x}$, $b_1 = r_{xy} \times \frac{s_y}{s_x}$

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

Thursday, February 18

- mean(e)=0, Corr(e, X)=0, Corr($e, \hat{Y}$)=0, 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

Reading Assignments:
PDF "Simple Linear Regression" posted in Canvas/files

Tuesday, February 23

- 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 $b_0 + b_1 X$
- Case study: Waite First Securities, Milk and Money

Thursday, February 25

- Topic summary for Midterm #1
- Discuss Practice Exam #1
- Common problems in homework assignments

Tuesday, March 1

- Midterm Exam #1, UTC 2.102A, 7:00-10:00 pm

Thursday, March 3

- 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

Tuesday, March 8

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

Thursday, March 10

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

Tuesday, March 22

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

Thursday March 24

- 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

Tuesday, March 29

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

Thursday, March 31

- 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

Tuesday, April 5

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

Thursday, April 7

- Review for Midterm Exam #2
- Case study: Northern Napa Valley Winery, Inc.
- Example: Monthly liquor sales

Tuesday, April 12

- Midterm Exam #2

Thursday, April 14

- 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

Tuesday, April 19

- 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

Thursday, April 21

- 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

Tuesday, April 26

- 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

Thursday, April 28

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

Tuesday, 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

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

Thursday, May 5

- Simulation
- Review for the Final Exam

Final Exam

- Time: 7:00-10:00 pm, Wednesday, 05/11/2016
- Location: JES A121A
- Make-up Exam: RLM 7.124, 7:00-10:00 pm, Thursday, 05/12/2016