Statistics II

Spring 2021

Jindal School of Government and Public Policy
O.P. Jindal Global University

Course Synopsis

This is the second part of the two part course on statistical methods for undergraduate economics students. It begins with a discussion on sampling techniques used to collect survey data. The course introduces the concept of sampling distributions that act as a linkage between statistical inference and probability theory. It then covers topics in inference which include point estimation, interval estimation and hypothesis testing.

Course Goals

At the end of the course, students will be able to understand the necessity of sampling in order to gather information regarding population, the methods of sampling, estimation of a population parameter using sample data and use statistical hypotheses to test hypothesis regarding population parameters using sample data.

Class Timing

Monday 1:00 PM - 2:30 PM
Wednesday 3:00 PM - 4:30 PM

Pre-requisites

Statistics I

Instructors and Office Hours

Instructor	Nikhil Damodaran
Prefered Contact	ndamodaran@jgu.edu.in
Office Hours	Wednesday 2:30 pm – 3:30 pm or by appointment
	Cabin #6, T4, Academic Block, OP Jindal Global University

Readings

Required Textbook	Anderson, D. R., Sweeney, D. J., Williams, T. A., Camm, J. D., & Cochran, J. J. (2015). Statistics for business and economics (12th ed.). Delhi: Cengage Learning. [ASW]
	Gupta, S. C. (2019). Fundamentals of statistics (7th ed.). Delhi: Himalaya Publishing House. [SCG]
	Mittelhammer, R. C. (2013). Mathematical Statistics for Economics and Business. Springer, 2nd edition edition.

Assessment

Assessments include internal evaluations and an external end term exam.

Examinations	Quiz/Assignment/Viva/Presentation	45%
	Participation	5%
	End Semester Examination	50%

Missed excusable reasons: Require prior or immediate email communication with the instructor, cc-ed to the academic dean and the vice dean of the school. The percentage grade would be proxied with the percentage grade obtained in the remainder of the course, only to be assessed at the *end of the semester*

Course Contents

This syllabus is intended to give the student guidance in what may be covered during the semester and will be followed as closely as possible. However, the instructor reserves the right to modify, supplement and make changes as the course needs arise.

Topic 1: Sampling and Sampling Distributions

- ASW, Chapter 7: Sampling and Sampling Distributions
- 7.1 Introduction
  - Example of Voter Patterns
- 7.2 Selecting a Sample
  - Sampling from a Finite Population
    - With and Without Replacement
  - Sampling from an Infinite Population
  - Example: McDonald's Randomization Efforts
- 7.3 Point Estimation
  - Example: EAI Managers Problem
  - Exercises
- 7.4 Introduction to Sampling Distributions

- 7.5 Sampling Distribution of Sample Averages, $\bar{x}$
  - Expected value of $\bar{x}$
    - Unbiased Estimator
  - Standard Deviation of $\bar{x}$
  - Form of the Sampling Distribution of $\bar{x}$
    - Central Limit Theorem
  - Example: Sampling Distribution of $\bar{x}$ for the EAI Problem
    - Z-table look up
  - Relationship Between the Sample Size and the Sampling Distribution of $\bar{x}$
- 7.6 Sampling Distribution of $\bar{p}$
  - Expected value, Standard Deviation of $\bar{p}$
  - Form of the sampling distribution of $\bar{p}$
  - Example: Sampling Distribution of $\bar{p}$ for the EAI Problem
- 7.7 Properties of Point Estimators
  - Unbiasedness
  - Efficiency
  - Consistency
- 7.8 Other Sampling Methods
- 7.9 Maximum Likelihood Estimation
- 7.10 Method of Moments Estimation

Topic 2: Interval Estimation

- Chapter 8 Interval Estimation, (ASW)
- 8.1 Intervals for population mean, μ under known population standard deviations, σ
  - Example: Lloyd's Departmental Store
  - Standard Normal Variable and Margin for Error
  - Confidence Intervals constructed using $z_{\alpha/2}$
- 8.2 Intervals for population mean, μ under unknown population standard deviations, σ
  - t-distribution and its degrees of freedom
  - Reading the t-table
  - Confidence Intervals constructed using $t_{\alpha/2}$
  - Example: Average Credit Card Debt
  - Using a Small sample
    - Example: Sheer Industries Automated Training Program

- 8.3 Determining the Sample size
  - Optimal Error and sample size
  - Example: Renting a Mid-Size
- 8.4 Population Proportion
  - Normal approximation of a binomial distribution
  - Example: Women's Tee Times and Discrimination in Golf
  - Determining the Sample Size
  - Planning Value
  - Example: Using planning value for Women's Tee Times

Topic 3: Introduction to Hypothesis Testing

AWS: Chapter 9: Hypothesis Tests

- 9.1 Developing Null and Alternative Hypothesis
  - Types of Null Hypothesis, One tailed and Two Tailed Tests
  - Exercises
- 9.2 Type I Error: reject H_0, when its true
  and Type II Errors: accept H_0 when its false
  - Honda Jazz Mileage example
  - Statement about 'Not Rejecting the null'
  - Exercise
- 9.3 Population Mean with Known σ
  - Hilltop Coffee and Federal Trade Commission Example
  - Step 1: Specifying a null hypothesis
  - Step 2: Deciding a level of significance, α
  - Step 3: Constructing a test statistic, z under population normality
  - Step 4: Compare p-value with α and reject/fail to reject null
  - Step 4A: Examine critical value of the test-statistic, and reject/fail to reject null
  - Two Tailed Tests using Kookaboora cricket ball
    - p-Value
    - Critical Value approach
  - Interval estimation and Hypothesis testing
- 9.4 Population Mean with Un-Known σ
  - t-distribution to capture sample variability
  - Skytrax Delhi Airport Example
  - Step 1: Specifying a null hypothesis

  - Step 2: Deciding a level of significance, α
  - Step 3: Constructing a test statistic, t using $\bar{x}, s$ from sample
  - Step 4: Compare p-value with α and reject/fail to reject null
  - Step 4A: Examine critical value of the test-statistic, and reject/fail to reject null
  - Two Tailed Tests using Holiday Toys
    * p-Value
    * Critical Value approach

- 9.5 Population proportion, p
  - Proportion of female candidates in BPP party
    * p-Value
    * Critical Value approach

- 9.6 Hypothesis testing with both Type I and Type II error
  - Introducing Lot acceptance sample

- 9.7 Calculating Type II error
  - Power of Test and the Power Curve

- 9.8 Determining the Sample Size for a Hypothesis Test About a Population Mean
  - Optimal sample size accounting for α and β
  - Relation between α, β and n

Topic 4: Inference about Means and Proportions with Two Populations

- 10.1 Inference about the Difference between Two Population Means,
  - Example: Big Bazar in GK versus Badli
  - Interval estimation
  - Example: Training quality of Two GRE Coching Centers
  - Hypothesis Tests

- 10.2 Inferences About Difference between Means based on Unknown
  - State Bank of India Example
  - Interval Estimates
  - Matlab vs. Python
  - Hypothesis testing

- 10.3 Inference About The Difference Between Two Population Means: Matched Samples
  - Uber Example of Matched Samples
  - Interval Estimates

- 10.4 Inference About Difference Between Two Population Proportions

  - Jindal Tax Center example
    * Interval Estimate
    * Hypothesis Testing
    * Pooled Point Estimates
    * Test Statistic and Standard Error under the Null

Topic 5: Population Variance Inference

AWS Chapter 11: Inferences about population variances

- 11.1 One estimator with one population
- 11.2 Estimating variances from two populations

Topic 6: Goodness of Fit

AWS Chapter 12: Comparing Multiple Proportions, Tests of Independence and Goodness of Fit (*Tentative*)

- 12.2 Testing independence
- 12.3 Goodness of Fit Test

Tentative Weekly Plan

** This is contingent upon class participation, evaluations and other tutorials

- Week 1: Sampling Methods
- Week 2: Point Estimation and Sampling Distributions
- Week 3: Properties of Estimator
- Week 4: Interval Estimation
- Week 5: Interval Estimators
- Week 6: Maximum Likelihood and Method of Moments Estimators
- Week 7: Recap Week (Assignment submissions)
- Week 8: Introduction to Hypothesis Testing and Error Types
- Week 9: Hypothesis Testing with Known and Unknown σ
- Week 10: Hypothesis Testing Population Proportion and Type II Errors
- Week 11: Inference about Difference of Means
- Week 12: Inference about Difference of Proportions and Matched Samples
- Week 13: Inference on Population Variance / Review