MTH 162 Statistics for the Social Sciences

Course Objectives

The purpose of this course is to introduce the student to Statistics in a way that will make the student aware of the techniques of Statistics as they apply to the solutions of practical problems in various fields. This introduction is presented with particular attention to statistical vocabulary; interpreting statistical formulas and graphs; and representing statistics symbolically, visually, numerically, and verbally.

Instructors will incorporate the use of technology and real data to perform calculations and to construct graphs. This course will focus on interpretation of results obtained from statistical software with minimal emphasis on manual computation. Since this is a course in Statistics, topics of basic probability are included only as needed.

Individual instructors are required to prepare and administer a comprehensive final exam.

1. Descriptive Statistics
   - 1.1 Define the terms population, sample, statistical experiment, variable (discrete and continuous), data (qualitative and quantitative), statistic, and parameter.
   - 1.2 Define various sampling techniques and potential bias.
   - 1.3 Use both formulas and statistical software to determine the following statistics and use them to describe and compare data sets: mean, median, mode, range, variance, standard deviation, percentiles, quartiles, and five-number summary.
   - 1.4 Produce and analyze frequency distributions.
   - 1.5 Produce and analyze histograms and box-and-whiskers displays. Graphs such as stem-and-leaf display, ogive, bar graph, dotplot, circle graph (pie chart), and Pareto diagram are optional.
   - 1.6 Identify the shape and describe the characteristics of the following distributions: normal, symmetrical, uniform (or rectangular), skewed, and bimodal.
   - 1.7 Use the shape and measures of central tendency and dispersion to describe and analyze distributions.

2. Correlation and Regression
   - 2.1 Define the terms bivariate data, data point, scatter diagram, correlation coefficient *r*, regression line, and regression coefficients, and explain the method of least-squares.
   - 2.2 Explain correlation and regression, including the uses and limitations of each.
   - 2.3 Given a set of bivariate data:
     - a. Produce and interpret a scatter diagram.
     - b. Determine and interpret the linear correlation coefficient *r*.
     - c. Determine and interpret the equation of the least-squares regression line.
     - d. Determine and interpret a predicted value of *y*.
     - e. Produce and interpret the graph of the least-squares regression line.
   - 2.4 Estimate a reasonable value for *r* given a scatter diagram.
   - 2.5 Complete inferences about ρ (rho), the population value of linear correlation.
   - 2.6 Interpret the results of a hypothesis test as it relates to the data set.

3. Probability (*Note*: It is recommended that the objectives in this section be incorporated within the coverage of the objectives for discrete, binomial, and normal probability distributions, to the extent possible.)
   - 3.1 Define the following terms: probability, simple probability experiment, sample space, simple event, compound event, complementary events, mutually exclusive events, dependent events, and independent events.
   - 3.2 Calculate probabilities using relative frequency.
   - 3.3 Apply the addition rule (for mutually exclusive events), multiplication rule (for independent events), and complement rule.

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4. Discrete Probability Distribution
   - 4.1 Describe both discrete and continuous random variables.
   - 4.2 Represent a discrete random variable by constructing a discrete probability distribution.
   - 4.3 Given a discrete probability distribution, calculate and interpret probabilities for the associated discrete random variable.
   - 4.4 Use the formula to calculate the mean (or expected value) of a discrete random variable.

5. Binomial Probability Distribution
   - 5.1 Describe the characteristics of a binomial probability experiment.
   - 5.2 Determine whether a variable is a binomial random variable.
   - 5.3 Calculate probabilities for a binomial random variable using at least one of the following: binomial formula, binomial probability table, or statistical software.
   - 5.4 Calculate and interpret probabilities for multiple values of a binomial random variable.
   - 5.5 Use the formulas to calculate the mean and standard deviation for a binomial probability distribution.

6. Normal Probability Distribution
   - 6.1 Explain why a normal random variable is an example of a continuous random variable.
   - 6.2 Describe the properties of the normal probability distribution and the relationship to the Empirical Rule.
   - 6.3 Use the Standard Normal Distribution table to:
     - a. Calculate and interpret the area under the standard normal curve for given values of *z*.
     - b. Determine *z* for a given area under the standard normal curve.
   - 6.4 Given μ and σ for a normal random variable, represent associated probabilities by using:
     - a. a sketch of the normal curve and shading the appropriate area
     - b. appropriate mathematical notation; e.g. P($x > 115$)
     - c. a written statement
   - 6.5 Use the Standard Normal Distribution table to:
     - a. Calculate and interpret probabilities for given values of a normal random variable.
     - b. Determine values of a normal random variable for given probabilities.

7. Sampling Distribution
   - 7.1 Explain what a sampling distribution is and the method used to create one for any sample statistic.
   - 7.2 Explain the Central Limit Theorem and use it to describe the properties of the sampling distribution of the sample mean, $\overline{x}$.
   - 7.3 Use the Standard Normal Distribution table to calculate and interpret probabilities for values of a sample mean, $\overline{x}$.

8. Statistical Inference - Estimation and Hypothesis Testing
   - 8.1 Describe the relationship between a sample statistic and its corresponding population parameter.
   - 8.2 Explain how to estimate a parameter and define the following terms: point estimate, level of confidence, maximum error of estimate, and confidence interval.
   - 8.3 Explain how to perform a hypothesis test and define the following terms: null hypothesis, alternative hypothesis, level of significance, Type I and Type II errors and their associated probabilities, test statistic, *p*-value, decision, and conclusion.
   - 8.4 Describe the Student's *t*-distribution and compare it with the normal distribution.
   - 8.5 Use formulas and statistical software to determine and interpret confidence intervals that estimate μ and p for any level of confidence. Recognize the limitations of the methods used to construct these estimates.
   - 8.6 Generate the following hypothesis tests and interpret the decisions with appropriate conclusions that incorporate the limits of these tests.

a. One population
   i. test μ using both the z and t statistic
   ii. test p
b. Two populations
   i. test two independent means
   ii. test two dependent means
   iii. test two proportions

8.7 Perform the calculations for effect size (standardizing the mean differences). Describe, interpret, and compare the values of effect size for different samples.

8.8 Use of Chi-Square to complete hypothesis tests for independence using data in a contingency table and interpret the results as it relates to the data set.

9. Analysis of Variance
   9.1 Articulate the basic concepts of Analysis of Variance.
   9.2 Recognize when to apply ANOVA technique.
   9.3 Complete one-factor ANOVA (hypothesis test for the factor)

10. Statistical Software
   10.1 Use statistical software to generate output corresponding to the following topics.
      a. Graphs, including histograms, box-and-whiskers displays, and scatter diagrams.
      b. Descriptive measures, including mean, median, mode, range, variance, standard deviation, and quartiles.
      c. Linear correlation coefficient.
      d. Linear regression equation and its graph.
      e. Confidence intervals.
      f. Hypothesis tests and ANOVA.
   10.2 Analyze and interpret software-generated output

11. Statistical Project
   11.1 Obtain real data from a Web site, publication, survey, experiment, or class collected data.
   11.2 Collect, organize, analyze, interpret, and represent numerical data for at least one project, taking advantage of computer software to facilitate calculations and graphing while minimizing labor-intensive work done manually.

Optional Topics:

12. Power Calculations
   12.1 Calculate the power of a statistical test
   12.2 Articulate the basic concept of the power of a statistical test with relationship to β, the probability of committing a Type II error.

13. Complete an ANOVA solution for problems involving:
      a. two-factors without replication (hypothesis test for each factor)
      b. two-factors with replication (hypothesis test for interaction and each factor)