

## STA 291 Statistical Method

### STA 291 Course Competencies

- A. Knowledge of human cultures and the physical and natural worlds through study in the sciences and mathematics, social sciences, humanities, histories, languages, and the arts.
- B. Intellectual and practical skills, including
  - inquiry and analysis
  - critical and creative thinking
  - written and oral communication
  - quantitative literacy
  - information literacy
  - teamwork and problem solving
- C. Personal and social responsibility, including
  - civic knowledge and engagement (local and global)
  - intercultural knowledge and competence
  - ethical reasoning and action
  - foundations and skills for lifelong learning
- D. Integrative and applied learning, including synthesis and advanced accomplishment across general and specialized skills.

### Student Learning Outcomes for Quantitative Reasoning

In STA 291, students will learn to:

1. Interpret information presented in mathematical and/or statistical forms by:
  - Understanding basic statistical concepts, including sampling and measurement.
  - Computing and interpreting measures of central tendency, dispersion, and position.
2. Illustrate and communicate mathematical and/or statistical information symbolically, visually, and/or numerically by:
  - Constructing various types of statistical graphs.
3. Determine when computations are needed and execute the appropriate computations by:
  - Applying the basic principles of probability.
  - Identifying discrete probability distributions, including the binomial distribution, and calculate probabilities, means, variances, and standard deviations for them.
  - Calculating probabilities, means, variances, and standard deviations for the uniform probability distribution using methods including integration.
  - Calculating z-scores and determining probabilities for the normal probability distribution.
4. Apply an appropriate model to the problem to be solved by:
  - Computing and interpreting Pearson's correlation coefficient and testing the significance of relationships.

- Computing linear regression equations and using the model to make predictions.
5. Make inferences, evaluate assumptions, and assess limitations in estimation modeling and/or statistical analysis by:
- Understanding concepts of sampling distributions and applications of the Central Limit Theorem.
  - Calculating one-sample confidence intervals for population means and proportions, based on the standard normal distribution and t distribution.
  - Performing one-sample hypothesis tests for population means and proportions, based on the standard normal distribution and t distribution.
  - Calculating two-sample confidence intervals for population means and proportions, based on the standard normal distribution and t distribution.
  - Performing two-sample hypothesis tests for population means and proportions, based on the standard normal distribution and t distribution.

### **STA 291 Course Outline**

- I. Understanding Statistics
  - A. Define statistics
  - B. Understand that statistics is used to make relevant decisions
  - C. Understand the distinction between statistical science and the reporting of numerical facts
  
- II. Experiments & Observational Studies
  - A. Random Variables
    1. Determine categorical and measurement variables
    2. Determine continuous and discrete variables
    3. Identify experimental variables
      - a. Response
      - b. Explanatory
      - c. Confounding
      - d. Interacting
      - e. Extraneous factors
  - B. Experiments – Understand and identify use of the following elements:
    1. Treatments
    2. Control groups, placebo and placebo effect
    3. Experimental Design
      - a. Block design
      - b. Randomized comparative design
      - c. Matched-pair design
    4. Randomization
    5. Causation
  - C. Observational Studies – Understand and identify use of the following elements:
    1. Types of observational studies
      - a. Case-control study
      - b. Retrospective study
      - c. Prospective study
    2. Efficacy

- III. Sampling – Indicate knowledge of purpose and importance of random sampling, demonstrate various sampling methods
  - A. Terminology
    - 1. Population
    - 2. Sampling frame
    - 3. Sample
  - B. Margin of Error
  - C. Sampling methods
    - 1. Simple Random Sampling
    - 2. Stratified Random Sampling
    - 3. Other Sampling Methods
  - D. Sampling variability
    - 1. Behavior of sample proportions
    - 2. Behavior of sample means
  
- IV. Descriptive Statistics
  - A. Statistic vs. Parameter – Define and understand statistic and parameter
  - B. Measures of central tendency – Determine when use is appropriate and compute
    - 1. Mean
    - 2. Median
    - 3. Mode
  - C. Measures of variability – Understand relationship and purpose, and compute using technology after achieving understanding
    - 1. Variance
    - 2. Standard deviation
    - 3. Quartiles
  - D. Graphical Displays
    - 1. Displays for Measurement Data – Understand and determine appropriateness, draw graphs, and make conclusions
      - a. Histogram
      - b. Stemplot
      - c. Boxplot
      - d. Scatterplot
      - e. Line Graph
    - 2. Displays for Categorical Data – Understand and determine appropriateness, draw graphs, and make conclusions
      - a. Frequency distributions
      - b. Bar graph
      - c. Pie chart
  
- V. Inferential Statistics
  - A. Confidence Intervals – Demonstrate understanding of confidence interval and purpose, compute confidence intervals, draw conclusions and interpret results
    - 1. Types of intervals – means, proportions, differences of means, differences of proportions
    - 2. Margin of Error
    - 3. Standard error
    - 4. Confidence level
    - 5. Interval interpretation

- B. Hypothesis Testing - Demonstrate understanding of hypothesis test and purpose, compute hypothesis tests, draw conclusions and interpret results
  - 1. Types of tests: z-test, t-test, paired t-test, tests for proportions, tests for differences
  - 2. Null & Alternative hypotheses
  - 3. Test statistic
  - 4. Significance level
  - 5. Type I and Type II errors
  - 6. Statistical significance
  - 7. Test interpretation
  
- VI. Normal Distribution – Understand and determine normality, compute normal probabilities
  - A. Standard Score
  - B. Percentile
  - C. Empirical Rule
  - D. Relation to sampling variability
  
- VII. Relationships – Indicate knowledge and understanding in determining types of relationships for bivariate data and their implications, perform simple linear regression using technology, interpret results
  - A. Scatterplots
  - B. Correlation
  - C. Regression
  - D. Least squares equation
  - E. Coefficient interpretation
  
- VIII. Probability and probability distributions – Knowledge and understanding of basic probability rules, perform probability calculations, determine various probability distributions and calculate probabilities
  - A. Relative frequency
  - B. Expected Value
  - C. Probability rules
    - 1. Multiplication rule
    - 2. Addition rule
    - 3. Conditional probability
    - 4. Independence
  - D. Probability distributions
    - 1. Discrete distributions
      - a. Binomial distribution
      - b. Geometric distribution
      - c. Poisson distribution (optional)
    - 2. Continuous distributions
      - a. Normal distribution
      - b. Gamma distribution (optional)
      - c. Beta distribution (optional)