

Spring 2016

# MATH 218--Topics in Statistics

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# Math 218, Mathematical Statistics

Spring 2016

Course web page <http://aleph0.clarku.edu/~djoyce/ma218/>

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**Description of this course:** The emphasis of this course is to develop the fundamental statistical concepts of inference and hypothesis testing from a classical perspective using the tools of probability theory. Topics investigated include sampling and sample distributions, graphical data analysis, point and interval estimation, hypothesis testing and an introduction to Bayesian inference. Prerequisite: Math 217, or permission.

**Textbook:** *Statistics and Data Analysis* by Ajit C. Tamhane and Dorothy D. Dunlop, Prentice-Hall, 2000. ISBN 0-13-744426-5. Prentice-Hall's web site for the book.

## Course goals.

To provide students with a good understanding of the theory of statistics as described in the syllabus.

To show how statistical methods depend on the theoretical principles of probability.

To illustrate the use of statistics in science, both physical and social science

To examine the assumptions of statistical methods.

To make connections between statistics and other branches of mathematics, and to see some of the history of statistics.

## Syllabus

### Introduction

The basic goal of statistics: draw conclusions based on data. There are various aspects of statistics ranging from formulating the question, designing experiments to address the question, collecting the data, and analyzing the data, but we'll be stressing the role of probability and probability distributions in this process. We'll often begin with a random sample drawn from a parameterized family of distributions, and our job is to make conclusions about the parameter.

### Review of Probability

We'll quickly review the theory of probability. Sample spaces and events, Kolmogorov's axioms, principles of combinatorics including permutations and combinations, conditional probability and independence, Bayes' theorem,

random variables, probability mass functions for discrete random variables, probability density functions for continuous random variables, cumulative distribution functions, expected value, mean and variance of a distribution, selected discrete and continuous distributions.

### **Collecting Data**

Types of statistical studies, observational studies, basic sampling designs, experimental studies

### **Summarizing and Exploring Data**

Categorical data, numerical data, bivariate data, time-series data

### **Sampling Distributions of Statistics**

Sampling Distribution of the Sample Mean, Sampling Distribution of the Sample Variance, Student's t-distribution, Snedecor-Fisher's F-distribution

### **Basic Concepts of Inference**

Point Estimation, Maximum Likelihood Estimation, Confidence Interval Estimation, Hypothesis Testing, Likelihood Ratio Tests

### **Principles of Bayesian statistics.**

The Bernoulli process, the Poisson process, the normal process, conjugate prior families

### **Inferences for Single Samples**

Inferences on Mean (Large Samples), Inferences on Mean (Small Samples), Inferences on Variance (if time permits), Bayesian inference for samples

### **Inferences for Two Samples**

Independent Samples and Matched Pairs Designs, Graphical methods for comparing two samples, Comparing Means of Two Populations, independent samples and matched pairs

### **Inferences for Proportions and Count Data**

Inferences on Proportion, Inferences on Comparing Two Proportions

### **Simple linear regression and correlation**

The least squares method, The model for simple linear regression, Fitting a line, goodness of fit, Statistical inference with the simple linear regression model, prediction and confidence intervals, Regression diagnostics

### **Nonparametric statistics**

Inferences for single samples, sign tests  
Inferences for two independent samples

**Assignments, quizzes, tests, final**

There will be numerous short assignments, mostly from the text, occasional quizzes, two tests during the semester, and a two-hour final exam during finals week. Practice problems will be assigned daily from the text to help you master the concepts discussed in class. Periodically, problems will be assigned to be turned in and graded. Although not all practice problems will be submitted for a grade, it is expected that you will keep up to date on the problems. Collected homework is due in class on the assigned day. No late assignments will be accepted.

Tests are closed notebook, but you may bring one sheet of notes and a calculator. In the event that an emergency arises, you are responsible to contact me before the regularly scheduled exam to make alternative arrangements.

**Course grade.** The course grade will be determined as follows:

- 2/9 assignments and quizzes,
- 2/9 each of the two midterms, and
- 1/3 for the final exam.

**General policies.**

Class attendance and class participation are obligatory. During the class meetings the text will be supplemented with more rigorous theory and special topics. Turn off your cell phones during class. Laptops may only be used for class-related purposes—no texting, no browsing, no email.

**Time and study.** Besides the time for classes, you'll spend time on reading the text, doing the assignments, and studying of for quizzes and tests. That comes to about five to nine hours outside of class on average per week, the actual amount varying from week to week. Here's a summary of a typical semester's 180 hours

Regular class meetings, 14 weeks, 42 hours

Two evening midterms and final exam, 6 hours

Reading the text and preparing for class, 5 hours per week, 70 hours

Doing weekly homework assignments, 3 hours per week 42 hours

Meeting with tutors or in study groups, variable 4 to 12 hours

Reviewing for midterms and finals, 12 hours

**There is more information on the course web page**

<http://aleph0.clarku.edu/~djoyce/ma218/>