Syllabus
Statistics
Dr. M. P. M. M. M^{c}Loughlin
Spring 2022

Prerequisite: Math 105 (College Algebra) with a "C" or better or two years of high school level algebra.

Text (required): M^{c}Loughlin , M. P. M. M. (2022) *Class Notes.*

Resources (required):
My web-site materials (http://faculty.kutztown.edu/mcloughl/Math140.html).
SPSS or Minitab.

Software (required for the second half of the semestre): SPSS 18.0 or higher or Minitab 12.0 or higher (installed on all computers in the Lytle (Lytle Hall 215) and Old Main (the ITS lab in Old Main Wing I - Old Print Shop 006) computer labs on campus whilst Minitab is available for on-line use).

Course Description (catalogue): An introduction to quantitative methods in the biological sciences. Techniques for obtaining, analysing and presenting data in numerical form; measures of central tendency and dispersion; normal distribution curve; standard scores; applicability of probability and sampling theory to research in the health sciences; interpretation of confidence intervals; hypothesis testing; correlation; linear regression. Prerequisites: MAT 105 or two years of high school algebra.

Course Rationale (catalogue): This course prepares students who major in the social sciences, hard sciences, business, or mathematics with the statistical background they need to analyse the data that arise in those majors. It can be counted in Category C-2 of General Education.[1]

Course Objective: This course is designed to provide the student a intense foundational introduction to the fundamental concepts in Mathematical Statistics.

(1) the student is able to think logically
(2) the student is able to reason and recognise patterns and be able to make conjectures
(3) the student is able to create, read, and interpret graphs, charts, histogrammes, and diagrammes
(4) the student is able to collect, organise, and represent data, and be able to recognise and describe relationships
(5) the student is able to understand and use the basic measure of central tendency
(6) the student is able to understand and use the language of probability
(7) the student is able to compute the probabilities of composite events using the basic rules of probability
(8) the student is able to understand the significance of statistics and probability in the real world
(9) the student is able to understand the significance of the connection between logic, sets, and probability and their applicability to the real world
(10) the student is able to understand the significance of the connection between statistics and probability and their applicability to the real world
(11) the student is able to understand the concept of approximation, quantities, estimation, error, precision, and accuracy in understanding the results of such measurements

[1] Except for Mathematics majors (don't ask).

(12) the student is able to understand the role of numbers as a logical, predictable system for expressing and relating quantities in analyzing and solving problems in the real world
(13) the student is able to demonstrate several approaches to basic problem solving and implement those strategies
(14) the student is able to acquire, organise, and synthesise information and creatively use that information
(15) the student is able to understand and appreciate the significance of the interconnection between areas of mathematics (especially applied finite mathematics) and their applicability to the real world

Course Outline:

I. Preliminaries
For the first day of the course, the student will be reminded of basic mathematical material he should know from Algebra and Geometry.

II. Logic & Set Theory
For the remainder of the first two and one-half weeks of the course, the student will be familiarised with definitions and major results of Aristotelian Logic and Set Theory: basic connectives; universe; elements; sets; and diagrammes.

III. Probability For the next five and one-half weeks we will focus on an introduction to or review of basic probability. After completing this section of the course, the student should be familiar with sample spaces, experiments, events, the rules of probability, probability functions, conditional probability, independence or dependence, Tree Diagrams, Bayes' Theorem, odds and the fundamental probability principles. Further, the student will have mastered the use of the Fundamental Principle of Counting; combinatorics; &, Pascal's Triangle, as well as the material from this section, to solve problems. We focus on the Bernoulli; Binomial; and, Normal distributions (plus a few more – Poisson; Student; and, Fisher-Snedecor).

IV. Introductory Statistics
After completing this section of the course, the student should be familiar with the populations, samples, what and why experimentation, and statistics. Furthermore he should understand and be able to define how to summarise data, compute measures of central tendency, measure of variation, and measures of position. We concentrate also on the nature of data, the uses (and abuses by policy makers or consumers of statistics) of statistics, methods of sampling, and other descriptive statistics.

V. Descriptive Methods
We discuss measurement scales (nominal, ordinal, interval, and ratio scales) and statistics that are meaningful to each type of scale; we discuss binomial experiments, mean, variance, and standard deviation for the binomial distribution, the normal Probability distribution, the standard normal distribution, and the law of large numbers and central limit theorem. The student should be familiar with the concepts of: the different types of data, stem-and-leaf displays, frequency distributions, histogrammes, and interpretation of results.

VI. Numerical Summary Methods
After completing this section of the course, the student should be familiar with central tendencies and the computation thereof, with variability and the computation thereof, summarisation of a data set and interpretations.

VII. Sampling Distributions
After completing this section of the course, the student should be familiar with statistics and random samples, sampling experiments, the sampling distribution for a sample mean, and the sampling distribution of a sample proportion.

VIII. Estimation and Hypothesis Testing Using A Single Sample

After completing this section of the course, the student should be familiar with point estimation, large sample confidence intervals for population means, for population proportions, estimating a population mean, estimating a population proportion, estimating a population variance, small sample confidence intervals for means from normal distributions, and description and reports of the results.

IX. Estimation and Hypothesis Testing Using Two Samples

After completing this section of the course, the student should be familiar with inferences about two means, comparing two variances, and inferences about two proportions.

X. Hypothesis Testing Using A Multi-sample Sample

After completing this section of the course, the student should be familiar with estimation, hypothesis tests and errors, large sample hypothesis tests for a single mean, p-values, large sample hypothesis tests for a population proportion, interpretation, ANOVA, MANOVA, and conclusions.

XI. Correlation and Regression Theory

After completing this section of the course, the student should be familiar with Person product-moment correlation for a continuous random variable, a sample correlation, and basic linear regression analysis.

XII. In Depth Application (if time)

An in depth analysis of application using the subjects studied in the previous part of the course. This section changes from semester to semester and is based on a survey of the interests and needs of the students taking the course. It can be, but is not limited to, more hypothesis testing, ANOVA, or categorical data analysis, Person product-moment correlation for a non-continuous random variable (Spearman rank correlation, etc.), and the chi-squared test.

In addition some other optional instructional resources may be of use to the student[2]:

References

[1] Blair, C & Taylor, R. (2008) *Biostatistics for the Health Sciences* (1^{st} edition). Upper Saddle River, NJ: Pearson Publishing Co.

[2] Bartz (2009). *Basic Statistical Concepts* 4^{th} Edition, ISBN 978-0-13-737180-8

[3] Larson and Farber (2005). *Elementary Statistics – Picturing the World (3^{rd} edition).* Upper Saddle River, NJ: Pearson Education Inc.

[4] Brase and Brase (1999). *Understanding Statistics – Concepts and Methods (6^{th} edition).* Boston, MA: Houghton Mifflin.

[5] Field, Andrew (2009). *Discovering Statistics Using SPSS (Introducing Statistical Methods) (3^{rd} Edition).* New York: Sage Publications Ltd.

[6] Freund, J. E., Miller, and Miller (2007). *Mathematical Statistics (8^{th} edition).* Englewood Cliffs, NJ: Prentice-Hall, Inc.

[7] Freund, John E.(2000). *Modern Elementary Statistics (10^{th} edition).* Upper Saddle River, NJ: Prentice Hall, Inc.

[8] Johnson, Richard A. and Bhattacharyya, Gouri K. (2001). *Statistics – Principles and Methods (4^{th} edition).* New York, NY: John Wiley & Sons, Inc.

[9] Johnson, Robert and Kuby, Patricia (2000). *Elementary Statistics (8^{th} edition).* Belmont, CA: Duxbury Press.

[10] Mann, Prem S. (2004) *Introductory Statistics (5^{th} edition).* Hoboken, NJ: John Wiley & Sons, Inc.

[11] McClave, James T. and Sincich, Terry (2000). *A First Course in Statistics* (7^{th} edition). Upper Saddle River, NJ: Prentice Hall.

[12] Moore, David S. and McCabe, George P (2003). *Introduction to the Practice of Statistics (4^{th} edition).* New York, NY: W. H. Freeman and Co.

[13] Peck, Olsen, and Devore (2005). *Introduction to Statistics and Data Analysis (2^{nd} edition).* Belmont, CA: Brooks/Cole-Thomson Learning.

[2]Warning: I do not endorse any of these, I merely mention them. Many that have been rewritten in the 21^{st} century are not correct logically or mathematically. So, I advise the older the edition, the better.