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STAT 452.01: Statistical Methods II

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Recommended Citation
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Syllabus

STAT 452, Statistical Methods II

Spring 2022, MWF 10:00-10:50am in Math 108

Course Information:

- **Instructor**: Jon Graham, Math 204, 243-2561, jgraham@mso.umt.edu.
- **Textbook:** *Statistical Methods & Data Analysis, 7th ed.,* by Ott & Longnecker
- **Office Hours**: To be announced, By appointment
- **Course Webpage**: Accessed through Moodle
- **Grading**: Homework: 30% Exams 1,2: 40% Final: 30%
- **Prerequisites:** STAT 451 or consent of instructor based on a previous statistics course.

Homework

Homework will typically be assigned every Friday, to be handed in at the beginning of class the following Friday. **NO LATE HOMEWORK WILL BE ACCEPTED FOR ANY REASON**, and the lowest homework grade will be dropped. Homework is not only a fairly substantial portion of your grade, but is vital to your success in this class. Working with other students on homework is encouraged, as long as you hand in your own work, and do not simply copy someone else's work. Solutions to all problems will be provided.

Exams

Exams 1 & 2 will be cumulative and closed book. More about the exams, including the exact dates of the exams will be given later. If you cannot make it to an exam, you must let me know **BEFORE** the exam is given. No make-up exams will be given without a documentable reason for missing the exam.

Final Exam

The **Final exam** is scheduled for 10:10am-12:10pm on Thursday, May 12. More will be said about the final at a later date.

Course Material and Objectives

This course is a continuation of an introduction to statistical methods for analyzing data. The course is intended primarily for students in disciplines outside of mathematics who are seeking statistical tools for data analysis. After discussing chi-square methods and simple linear regression, the course will concentrate on many areas of regression such as inference, multiple regression, logistic regression, etc., and on areas of analysis of variance (ANOVA) such as interpretation of ANOVA tables, experimental designs, and analysis of covariance among others. This course is taught in conjunction with STAT 458 which will use the software package **R** to illustrate statistical techniques and elucidate statistical concepts.

Questions are strongly encouraged, both during class and at office hours. If you are lost and confused, please let me know.

Important Dates

Wednesday, January 26: Last day to add courses by CyberBear

Monday, February 7: Last day to drop courses/change grading option in Cyberbear.

Monday, February 21: President's Day holiday

Monday, March 21 – Friday, March 25: Spring Break

Tuesday, March 29: Last day to drop courses. Paper form must be signed by advisor and instructor. A W will appear on your transcript. After this date, drops can only be done with the Dean's signature.

Friday, May 6: Last day to change grading option (letter grade to CR/NCR or vice-versa). Requires paper form signed by advisor and instructor.

Learning Outcomes: Upon successful completion of STAT 452, a student will:

1. Understand multiple linear regression, model building, and associated normal-based inference procedures.
2. Understand analysis of variance and to carry out analyses of variance for a variety of experimental designs, including completely randomized and randomized block designs.
3. Understand the assumptions behind standard statistical inference procedures for linear regression and analysis of variance.
4. Understand how statistical methods were used to answer specific scientific questions in a wide variety of applied problems.
5. Carry out analyses of real data sets and communicate the results in written form.

Disability Equity

The University of Montana assures equal access to instruction through collaboration be- tween students with disabilities, instructors, and the Office for Disability Equity (ODE). If you anticipate or experience barriers based on disability, please contact the ODE at: (406) 243-2243, ode@umontana.edu, or visit www.umt.edu/disability for more information. Retroactive accommodation requests will not be honored, so please, do not delay. As your instructor, I will work with you and the ODE to implement an effective accommodation, and you are welcome to contact me privately if you wish.

Academic Honesty

All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary action by the University. All students need to be familiar with the Student Conduct Code. You can find it in the A-Z index on the UM home page.

Classroom Safety Information due to COVID-19

1. Mask use is **REQUIRED** within the classroom. If you fail to bring a mask to class, I will have a few extras that I can give you.
2. You will also be required to wear a mask during class office hours.
3. If you feel sick and/or are exhibiting COVID-19 symptoms, please don't come to class and contact the Curry Health Center at (406) 243-4330. As a reminder, every lecture is videorecorded so you can watch any class you miss online.
4. If you are required to isolate or quarantine, you will receive support from me to ensure continued academic progress. Please contact me in such a situation and I will work with you to find a solution that allows you to remain in the course.
5. UM recommends that students get the COVID-19 vaccine or booster. Please direct your questions or concerns about vaccines and boosters to Curry Health Center.
6. Class attendance and seating will be recorded to support contact tracing efforts. You will be asked to write your name on a seating chart by the beginning of the 2nd week.
7. Drinking liquids and eating foods is discouraged within the classroom.
8. Please remain vigilant outside the classroom in mitigating the spread of COVID-19.
9. Up-to-date COVID-19 information from the University of Montana can be found here:
    - UM Coronavirus Website: https://www.umt.edu/coronavirus
    - UM COVID Operations Plan: https://www.umt.edu/coronavirus/campus-covid-plan/default.php

Other Important Course Information

1. **Video Recordings**: Because this class is primarily populated by students in the natural sciences who often have field work/conferences, all lectures will be video-recorded and posted in the VideoRecordings section of the main Moodle page.
2. **R Software**: As most of you know, the software package used in this course, **R**, is free for download at www.r-project.org/. Instructions for downloading and installing **R** and **R-Studio** can be found at the bottom of the course webpage. I have also included a brief **R** manual as a reference guide. My goal is not to teach you **R** in this course, but to simply use it as a tool for conducting the statistical analyses required. As a result, please feel free to ask me any and all **R** questions you have and when you have specific **R** coding questions, be sure to Email me the **ENTIRE** block of code you are using in "text" form so I can diagnose and help you solve any coding issues.
3. **Communication**: Whenever I forget to post something on the webpage, have information to pass along such as homework hints or corrections, or want to share another student's question and my response, I will send an Email to the entire class to let them know. As a result, please be sure to regularly check your university Email account for updates. Also, per university policy, I cannot communicate with you at your personal Email address, so please only send me Emails from your university address.

4. **My Role**: While I am the instructor for this course, it is not my intent to make your life miserable. I am here to help you. I try to be accessible and will do my best to help you when you have questions. It is NOT my role to do your homework for you, but I will try to walk you through the course content in an effort to answer whatever questions you have. Mostly, I want you to feel free to ask me anything.

Tentative Topic Outline

1. Categorical Data (Ch. 10)
    a. Review of inference for one or two proportions (10.1-10.3)
    b. Chi-square inferences for multiple proportions, goodness of fit (10.4)
    c. Chi-square tests for independence and homogeneity (10.5)
    d. Odds and odds ratios (10.7)
2. Linear Regression and Correlation (Ch. 11)
    a. Least Squares Concepts (11.1-11.2)
    b. Transformations to Linearize Relationships (11.1)
    c. Correlation Coefficients (11.6)
    d. Residual Analysis (11.2)
    e. Inference in Simple Linear Regression: CIs and tests for β_0 and β_1 (11.3)
    f. Inference on E(y), predictions of y (11.4)
    g. Examining Regression Lack of Fit (F tests) (11.5)
    h. Bootstrapping in Regression (not in book)
3. Multiple Linear Regression (Ch. 12)
    a. General Linear Models, Estimation, and Examples (12.1-12.3)
    b. Inference for Parameter Estimates, E(y), and predictions of y (12.4,12.6)
    c. Inference for Multiple Parameters Simultaneously (12.5)
    d. Comparing Slopes of Several Regression Lines (12.7)
    e. Nonlinear Regression (13.3)
    f. Logistic Regression (12.8)
4. More on Multiple Regression (Ch. 13)
    a. Model Formation and Variable Selection Techniques (13.1-13.3)
    b. Model Diagnostics: Residual Analysis (13.4), Influence Statistics (not in book)
5. Analysis of Variance (ANOVA) (Ch.8-9)
    a. Assumptions: Normality, Independence, Variance Homogeneity (8.3)
    b. Testing Equality of Two Population Means (8.1-8.2)
    c. 1-way ANOVA, 2-way ANOVA (8.2)
    d. Testing Homogeneity of Variance (Hartley's, Levene's Test) (7.4, 8.4)
    e. Variance Stabilizing Transformations (8.5)
    f. Kruskal-Wallis Test (nonparametric alternative) (8.6)

6. Multiple Comparisons of Means (Ch. 9)
    a. Linear and Orthogonal Contrasts (9.2)
    b. Procedures (Fisher's LSD, Tukey's W, SNK, Bonferoni, Scheffe's) (9.3-9.7)
    c. Controlling Type I error rates for Multiple Comparisons (9.3)
7. Experimental Design: The Completely Randomized Design (Ch. 14)
8. ANOVA for Experimental Designs (Ch. 15-19)
    a. Randomized Complete Block Design and Blocking Issues (15.2)
    b. Latin Square Design (15.3)
    c. Factorial Designs and Testing for Interactions (15.4-15.6)
    d. Analysis of Covariance (16)
    e. Fixed, Random, Mixed-effects Models (17)
    f. Other Designs (Split Plot, Nested, Repeated Measures, etc.) (18.2, 17.6, 18.3-18.5)