Statistical Analysis of Psychological Experiments (Psych 610)
Fall 2016

Lecture: Tuesday and Thursday 9:30-10:45 am, Room 101 (Brogden)
Labs: Friday 9:00-11:00 am (section 301) or 1:00-3:00 pm (section 302), Room 228 (Psychology)

Professor:
Markus Brauer
E-Mail: markus.brauer@wisc.edu
Office hours: Wed 10:45-11:45
Room 417 (Psychology)

Teaching Assistants:
Mitchell Campbell
E-mail: mitchell.campbell@wisc.edu
Office hours: Mon 2:00-3:00, or by appt
Room: 438B (Psychology)
Adrienne Wood
E-Mail: adrienne.wood@wisc.edu
Office Hours: Tue 2:00-3:00, or by appt
Room: 392 (Psychology)

Martin Zettersten
E-mail: zettersten@wisc.edu
Office hours: Thu 11:00-12:00, or by appt
Room: 618 (Psychology)

Objectives: The goal of this class is to familiarize you with a statistical data analysis procedure called the general linear model. After a short introduction on reliability and validity, we will spend most of the semester on regression analysis as a tool for analyzing data from psychological experiments. We will give special attention to the interpretation of regression coefficients, regression models with continuous and categorical predictors, and the interpretation of interaction effects in regression analysis. We will be using the statistics software R (http://www.r-project.org/). Please know that extensive work outside the classroom is required in order to succeed in this class. We want to encourage you to participate actively in the class, both the lecture and the lab session.

Course Requirements and Grades: Course requirements include regular attendance, active participation in class discussion, and completion of all homework assignments and tests. Exams will compose 80% of your grade. There will be two closed book exams completed in class to assess conceptual knowledge. There will also be three open-book, take-home exams to evaluate application of concepts to brief statistical problems. Lab/homework assignments will comprise the remaining 20% of your grade. The homework assignments will involve hands-on application of the material.

In-class Exams Date/Time: (1) Tue, Oct. 25, 9:30-10:45 am
(2) Thu, Dec. 15, 9:30-10:45 pm

Take-home Exams Date/Time: (1) assigned Fri, Oct. 7, at 3:30 pm; due Wed, Oct. 12, at 8:00 am
(2) assigned Fri, Nov. 11, at 3:30 pm; due Wed, Nov. 16, at 8:00 am
(3) assigned Fri, Dec. 16, at 3:30 pm, due Wed, Dec. 21, at 8:00 am

Course Email List: psych610-1-f16@lists.wisc.edu

Course Website: https://learnuw.wisc.edu

**Additional Required Readings:** Additional required readings will be provided as pdfs on the course website. The readings are pulled from various texts and primary sources. Supplemental readings and recommended reference texts are also provided on the course website and the end of this document.

**Required Software:** This course will contain a significant applied component. As such, access to statistical analysis software is required. In the context of this course, we will rely heavily on R (http://www.r-project.org/). R is freely available and is rapidly become the standard for statistical analysis in many disciplines. Although the goal of this course is NOT to teach you how to use R, you will become quite familiar with this computational platform during the course.

**Course Schedule:** This schedule is provisional so that we may adjust our rate of progress as necessary to ensure maximal mastery of the material. See course website for the most up to date version of the assigned readings and topics.

1) Introduction to inferential statistics (1 day)
   a) introduction to the course
   b) the GLM framework
   c) data exploration in R (descriptive statistics, visual displays) (laboratory only)

2) Reliability and validity, experimental design (2 days)
   a) reliability (test-retest, split half, item-whole correlations, Cronbach's Alpha)
   b) construct validity (multitrait-multimethod matrix, nomological net, confounds)
   c) internal validity (random assignment, counterbalancing of order, threats to internal validity such as maturation, mortality, regression to the mean, etc.)
   d) external validity (sampling procedures, generalization to different settings)
   e) conclusion validity (= statistical validity; the concept of statistical power, number of participants, other factors affecting conclusion validity, including extreme level of the IV, within-subject designs, unit of measurement, outliers, etc.)

3) Inferences about a single mean (one-sample t test) (1 day)
   a) the null model \( Y = B_0 \)
   b) sum of squares, number of estimated parameters, residuals, etc.
   c) the basic model \( Y = b_0 \)
   d) statistical inference (comparison of basic model with null model, computation of \( t \), interpretation of \( p \))
   e) writing up the results (text, graphs, tables) of a one-sample t test

4) Sampling Distributions (1 day)
   a) standard deviation, standard error of the mean
   b) theory of null hypothesis significance testing

5) Inferences about a single continuous predictor (simple regression) (2 days)
   a) the model \( Y = b_0 + b_1X \) [\( X \) is continuous]
   b) computation of residuals, meaning of residuals
   c) graphic representation: intercept, slope, residuals
d) statistical inference (comparison of the new model with the basic model, computation of $t$ and $F$, interpretation of $p$)

e) proportion of variance explained, computation of $r^2$, interpretation of $r^2$, effect sizes

f) running a simple regression in R and interpreting the R output

g) writing up the results (text, graphs, tables) of a simple regression analysis

6) Inferences about a single dichotomous predictor (independent-samples t test) (1 day)
a) the model: $Y = b_0 + b_1X$ [X is dichotomous]
b) computation of residuals, meaning of residuals (= within-group variance)
c) graphic representation: intercept, slope, residuals; comparison with bar graph
d) statistical inference (comparison of the new model with the basic model, computation of $t$ and $F$, interpretation of $p$)
e) running an independent-samples t test in R (using the lm command in R) and interpreting the R output
f) writing up the results (text, graphs, tables) of an independent-samples t test

7) Inferences about two predictors (multiple regression without interaction) (3 days)
a) the model: $Y = b_0 + b_1X_1 + b_2X_2$ [X1 is dichotomous, X2 is continuous]
b) the model: $Y = b_0 + b_1X_1 + b_2X_2$ [X1 and X2 are both continuous]
c) computation of residuals, meaning of residuals
d) graphic representation: two lines, intercepts, slopes, residuals
e) statistical inference (model comparison, interpretation of the effect of one variable on DV while controlling for the effects of another variable)
f) computation of $r_{\text{partial}}^2$, interpretation of $r_{\text{partial}}^2$
g) different theoretical predictions that can be answered by multiple regression analyses that do not contain interactions
h) writing up the results of a multiple regression analysis

8) Inferences about 3 or more predictors (multiple regression without interactions) (1 day)
a) models with 3, 4, 5, etc. predictors
b) issues of colinearity, variance inflation, tolerance
c) data fishing (Steve Levitt), hierarchical vs. stepwise vs. simultaneous models
d) raw vs. standardized coefficients, partial $r$ vs. semipartial $r$

9) Dealing with messy data I – case analysis (1 day)
a) the different ways of being an outlier
b) outlier statistics: levers $h_{ij}$, studentized deleted residuals, Cook's D
c) dealing with outliers

10) Dealing with messy data II – model assumptions (1 day)
a) the 5 assumptions of the GLM: exact X, independence, normality, constant variance, and linearity
a) data exploration in R (visual displays: residual plots, normal quantile plots, density plots, spread-level plots, etc.)
b) statistical indicators: ncv test, gvlma test
c) first remedies: heteroscedasticity-corrected standard errors, weighted least squares

11) Dealing with messy data III – transformations (1 day)
a) How to address violations of GLM model assumptions: power transformations, root transformations, how to find the best transformations
b) how to analyze proportions and correlations as data
12) Mediation (2 days)
   a) goal of mediation analyses
   b) the four conditions to be tested
   c) the best way to test the fourth condition (the mediated effect = ab, Sobel test, bootstrapping)
   d) other issues related to mediation (data don't prove the mediation model, partial mediation)
   e) multiple mediators
   f) writing up the results of a mediation analysis
   g) suppression

13) Inferences about two predictors and their interaction (= moderation) (1 day)
   a) centering variables: mean deviation form, contrast codes
   b) the model: $Y = b_0 + b_1X_{1c} + b_2X_{2c} + b_3*(X_{1c}*X_{2c}) = [X_1$ is dichotomous, $X_2$ is continuous, both variables are centered]
   c) graphic representation: different slopes for different folks, $b_3$ tests the difference between the two slopes
   d) what happens if variables are not centered?
   e) interpretation of an interaction
   f) writing up the results of a multiple regression analysis with an interaction

14) Inferences about two continuous predictors and their interaction (1 day)
   a) the model: $Y = b_0 + b_1X_{1c} + b_2X_{2c} + b_3*(X_{1c}*X_{2c}) [X_1 and X_2 are both continuous]$
   b) interpretation of an interaction between two continuous predictors
   c) the pitfalls of dichotomization II: imaginary interaction effects

15) Inferences about two dichotomous predictors and their interaction (= 2 x 2 ANOVA) (1 day)
   a) the model: $Y = b_0 + b_1X_{1c} + b_2X_{2c} + b_3*(X_{1c}*X_{2c}) [X_1 and X_2 are both dichotomous]$
   b) difference between main effects and simple effects
   c) interpretation of interactions in 2 x 2 ANOVAs (Rosnow & Rosenthal)
   d) comparison of the GLM terminology and the ANOVA terminology
   e) the pitfalls of dichotomization I: loss of power, biased estimates
   f) writing up the results of a 2 x 2 ANOVA

16) Inferences about three predictors and one interaction (= ANCOVA) (1 day)
   a) the model $Y = b_0 + b_1X_{1c} + b_2X_{2c} + b_3*(X_{1c}*X_{2c}) + b_4*X_3 [X_1 and X_2 are both dichotomous, X_3 is continuous]$
   b) interpretation of $b_3$
   c) generalization to other models (e.g., the covariate is dichotomous, one of the predictors is continuous)
   d) appropriate and "inappropriate" uses of ANCOVA
   e) writing up the results of an ANCOVA

16) Inference about three-way interactions (1 day)
   a) the model $Y = b_0 + b_1X_{1c} + b_2X_{2c} + b_3X_3 + b_4*(X_{1c}*X_{2c}) + b_5*(X_{1c}*X_3c) + b_6*(X_{2c}*X_3c) + b_7*(X_{1c}*X_2c*X_3c)$
   b) interpretation of $b_7$
   d) appropriate and "inappropriate" uses of ANCOVA
   e) writing up the results of a model with a three-way interaction

18) Polynomial regression (2 days)
   a) the shape of the regression line with higher-order regressors
   b) polynomial regression vs. power transformations
c) a higher-order regressor is an interaction of a predictor with itself
d) testing simple effects in polynomial regression, the partial derivative
e) multiple regression with non-linear effects

19) Advanced topics in mediation (1 day)
a) moderated mediation
b) conditional process analysis
c) introduction to path analysis

c) a higher-order regressor is an interaction of a predictor with itself
d) testing simple effects in polynomial regression, the partial derivative
e) multiple regression with non-linear effects

Recommended Texts for Data Analysis and Research Methodology:


Ethics of Being a Student in the Department of Psychology:

The members of the faculty of the Department of Psychology at UW-Madison uphold the highest ethical standards of teaching and research. They expect their students to uphold the same standards of ethical conduct. By registering for this course, you are implicitly agreeing to conduct yourself with the utmost integrity throughout the semester.

In the Department of Psychology, acts of academic misconduct are taken very seriously. Such acts diminish the educational experience for all involved – students who commit the acts, classmates who would never consider engaging in such behaviors, and instructors. Academic misconduct includes, but is not limited to, cheating on assignments and exams, stealing exams, sabotaging the work of classmates, submitting fraudulent data, plagiarizing the work of classmates, collaborating with classmates when such collaboration is not authorized, and assisting fellow students in acts of misconduct. Students who have knowledge that classmates have engaged in academic misconduct should report this to the instructor.

Complaints:

Occasionally, a student may have a complaint about a TA or course instructor. If that happens, you should feel free to discuss the matter directly with the TA or instructor. If the complaint is about the TA and you do not feel comfortable discussing it with him or her, you should discuss it with the course instructor. If the complaint is about the instructor and you do not feel comfortable discussing it with him or her, make an appointment to speak to the Department Chair, Professor H. Hill Goldsmith (chair@psych.wisc.edu).

If your complaint has to do with sexual harassment, you may also take your complaint to Dr. Linnea Burk, Clinical Associate Professor and Director, Psychology Research and Training Clinic, Room 315 Psychology (262-9079; burk@wisc.edu).

If you believe the TA or course instructor has discriminated against you because of your religion, race, gender, sexual orientation, or ethnic background, you also may take your complaint to the Office of Equity and Diversity, Room 179-A Bascom Hall (www.oed.wisc.edu)

Accommodations Policy:

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations, as part of a student’s educational record is confidential and protected under FERPA.