Updated: 09/03/2014

Statistical Analysis of Psychological Experiments (Psych 610)
Fall 2014

Lecture: Tuesday and Thursday 9:30-10:45 am, Room 101
Labs: Friday 9:00 - 11:00 am (section 301) or 1:00 – 3:00 pm (section 302), Room 106 (Psychology)

Professors:

Markus Brauer
E-Mail: brauer2@wisc.edu
Office hours: Wed 9:45-10:45, or by appt
Room 417 (Psychology)

Bas Rokers
E-Mail : rokers@wisc.edu
Office hours : Mon 10:00-11:00, or by appt
Room 420 (Psychology)

Teaching Assistants:

Xiaoming Ma
E-mail: xma22@wisc.edu
Office hours: Thu 10:50-11:50, or by appt
Room: 638 (Psychology)

Kristina Kellett
E-mail: kellett@wisc.edu
Office Hours: Tue 12:00-1:00, or by appt
Room: 596 (Psychology)
Knock on locked 5th floor wing door to be let in

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 to assess conceptual knowledge. The first of these exams will be completed in class and the second during the final exam period. There will also be three open-book, take-home exams to evaluate application of concepts to brief statistical problems. These will be completed approximately every five weeks. Lab/homework assignments will comprise the remaining 20% of your grade. The homework assignments will involve hands-on application of the material, mostly involving computer exercises.

Final Exam Date/Time: Tuesday, Dec 16, 2:45 – 4:45 pm

Course Email List: psych610@lists.wisc.edu

Course Website: http://dionysus.psych.wisc.edu/GLM.htm

Course materials password: GLM

Required Text
Judd, C.M., McClelland, G. H., & Ryan, C. (2008). Data Analysis: A Model-Comparison Approach. 2nd Edition. New York, US: Routledge. ISBN: 9780805833881.

Additional Required Readings: Additional required readings will be provided as pdfs on the Lecture Outline and Materials page on the course website. These readings are password protected
password: GLM

Chapters 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 (Markus Brauer; 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 (Markus Brauer; 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) (Markus Brauer; 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 (Bas Rokers; 1 day)
- a) standard devation, standard error, degrees of freedom
- b) theory of null hypothesis significance testing

5) Inferences about a single continuous predictor (simple regression) (Bas Rokers, 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) (Markus Brauer, 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) (Bas Rokers; 3 days)
- a) the model : $Y = b_0 + b_1X1 + b_2X2$ [X1 is dichotomous, X2 is continuous]
- b) the model : $Y = b_0 + b_1X1 + b_2X2$ [X1 is continuous, X2 is 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 $r^2_{partial}$, interpretation of $r^2_{partial}$
- 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) (Markus Brauer, 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 (Bas Rokers; 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 (Bas Rokers; 1 day)
- a) data that have kurtosis problems: Fischer z transformation and other possible remedies

b) data that violate the homoscedasticity assumption: rank transformation, weighted least squares, White-corrected standard errors, and other remedies
c) Data exploration in R (visual displays: residual plots, normal quantile plots, etc.)

11) Dealing with messy data III – transformations (Bas Rokers; 1 day)
a) data that have skewed distributions: power transformations, root transformations, how to find the best transformations
b) how to analyze proportions and correlations as data

-) Review Session
-) In-class Exam 1

12) Inferences about two predictors and their interaction (= moderation) (Markus Brauer/Bas Rokers, 2 days)
a) centering variables: mean deviation form, contrast codes
b) the model: $Y = b_0 + b_1X1c + b_2X2c + b_3*(X1c*X2c) =$ [X1 is dichotomous, X2 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

13) Inferences about two continuous predictors and their interaction (Bas Rokers; 1 day)
a) the model: $Y = b_0 + b_1X1c + b_2X2c + b_3*(X1c*X2c) =$ [X1 and X2 are both continuous]
b) interpretation of an interaction between two continuous predictors
c) the pitfalls of dichotomization II: imaginary interaction effects

14) Inferences about two dichotomous predictors and their interaction (= 2 x 2 ANOVA) (Bas Rokers; 1 day)
a) the model: $Y = b_0 + b_1X1c + b_2X2c + b_3*(X1c*X2c) =$ [X1 and X2 are both dichotomous]
b) difference between main effects and simple effects
c) do variables have to be centered?
d) interpretation of interactions in 2 x 2 ANOVAs (Rosnow & Rosenthal)
e) comparison of the GLM terminology and the ANOVA terminology
f) the pitfalls of dichotomization I: loss of power, biased estimates
g) writing up the results of a 2 x 2 ANOVA

15) Mediation (Markus Brauer, 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, they are at best consistent with it, partial mediation)
e) multiple mediators
f) writing up the results of a mediation analysis
g) suppression

16) Inferences about three predictors and one interaction (= ANCOVA) (Markus Brauer, 1 day)
- a) the model Y: = $b_0 + b_1$X1c + b_2X2c + b_3*(X1c*X2c) + b_4*X3 [X1 and X2 are both dichotomous, X3 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

17) Inference about three-way interactions (Markus Brauer, 1 day)

-) Thanksgiving break

18) Polynomial regression (Bas Rokers, 2 days)

19) Advanced topics in Mediation (Markus Brauer, 1 day)

-) Review Session
-) Final exam

Recommended Texts for Data Analysis and Research Methodology:

Abelson, R. P. (1995). *Statistics as Principled Argument*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Aiken, L. S., & West, S. G. (1991). *Multiple Regression: Testing and Interpreting Interactions*. Newbury Park, CA.: Sage.

Chambers, J (2008). Software for Data Analysis: Programming with R. New York: Springer Science Business Media.

Cook, T. D., & Campbell, D. T. (1979). *Quasi-Experimentation - Design and Analysis Issues for Field Settings*. Boston, MA: Houghton Mifflin Company.

Cohen, J., Cohen, P., West, S. G., & Aiken,, L. S. (2003). *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences* (3rd. Ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Dalgaard, P. (2008) Introductory Statistics with R (2nd edition). New York: Springer Science Business Media.

Fox, J. (2008). Applied Regression, Generalized Linear Models, and Related Methods, Second Edition. Sage Publications.

Fox, J & Weisberg, S (2010). *An R Companion to Applied Regression* (2nd Edition). Sage Publications.

Hoyle, R. H., Harris, M. J., & Judd, C. M. (2006). *Research Methods in Social Relations*. Belmont, CA, US: Allyn & Bacon. (no need to buy this book)

Judd, C. M., & Kenny, D. A. (1981). *Estimating the Effects of Social Interventions*. New York, NY: Cambridge University Press.

Kutner, M., Nachtscheim, C., & Neter, J (2004). Applied Linear Regression Models, Fourth edition, McGraw-Hill.

Reis, H. T., & Judd, C. M. (2000). *Handbook of Research Methods in Social and Personality Social Psychology*. New York, NY: Cambridge University Press.

Tabachnick, B. G., & Fidell, L. S. (2006). *Using Multivariate Statistics* (5th edition). New York, NY: Harper Collins.

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 or published and/or online sources, acquiring previously written papers and submitting them (altered or unaltered) for course assignments, 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 you do not want to approach the instructor, 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 Benjamin Ball (bball@psych.wisc.edu), Psychology Department, Administrator, Room 281 Psychology (262-3168).

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).