# Advanced Psychological Statistics II

PSYX 521

Spring 2020

**Meeting Times**: Fridays, 12:30 – 3:20pm
**Location:** 246 Skaggs Building

**Instructor:** Daniel J. Denis, Ph.D.
**Office:** 369 Skaggs Building
**E-mail:** daniel.denis@umontana.edu
**Spring Office Hours:** M, 12-1; W, 12-2.

**Course Overview**

This course is a continuation of Psyx. 520 (Stat I). The goal is to learn and understand statistics, so that you can think about them **creatively** and **critically** when doing your own research, as well as when interpreting research in your field. The goal is for you to **understand** essential principles common to virtually all statistical techniques, understand to some extent what's going on "under the hood," so that you eventually can "own" the knowledge and have the concepts "down" to further your learning over the course of your career. The number of statistical and quantitative techniques in applied science is enormous, but many (at least in univariate and bivariate settings) are in one way or another related to principles of ANOVA, regression, and spin-offs of those techniques. So-called "advanced statistics" are built on fundamental core principles. If those fundamental principles are not understood, then tackling (and understanding) relatively complex techniques (such as might be later featured in a multivariate course, namely multivariate analysis of variance, discriminant analysis, principal components analysis, factor analysis, structural equation modeling, etc.) becomes very difficult to impossible. This course aims to give you a solid foundation, one you will have for the remainder of your careers, and will pay dividends as you learn new techniques and both conduct and digest novel research.

The course is designed for graduate students in psychology. Issues in measurement will also arise over the course, for example, in seminars. Performing statistical analyses on a measurement of one's anxiety is only as good as how well the given measure "taps" into the construct of anxiety. Similarly, issues of measurement also rear their head when contemplating how to best parameterize the statistical model of linear regression, which sometimes requires the use of special coding schemes to accommodate various types of data. Given the advance of specialized statistical tools such as structural equation models (SEM), we will also try to critically evaluate the use of regression methods and their failure to take measurement error in predictors into account. We will also discuss such elements as the intraclass correlation and coefficient alpha from the vantage point of classical test theory.

**Course Objectives**

By the end of the course, you should have a good understanding of the following topics (not necessarily covered in this order):

- A more solid understanding of the principles of Psyx. 520
- Random Effects Models
- Mixed Models, including Repeated Measures and Longitudinal Designs
- Randomized Block Designs

- A more broad understanding of Experimental Method (and alternatives)
- Simple Linear Regression, Correlation, and Bivariate Distributions
- Multiple Regression and the Nature of Multivariate Distributions
- Model Building with ANOVA or Regression
- Analysis of Covariance, Logistic Regression
- Generalized Linear Models

You will also be exposed to some or all of the following:

1. Bayesian Statistical Analysis (as an alternative to NHST)
2. Classical Measurement Theory in Test Construction.
3. Experimental vs. Non-Experimental Designs.
4. The Matrix Algebra of Multiple Regression Analysis.
5. Data Management Using SPSS.
6. Missing Data in Statistical Analyses.
7. Putting Statistics into Context: The Role of Statistics in Science.
8. Mediation Analysis.
9. Moderation Analysis.
10. An Introduction to R Statistical Software.
11. Path Analysis and Structural Equation Models
12. Advanced Repeated Measures & Longitudinal Designs
13. The Analysis of Categorical and Qualitative Data
14. Non-parametric Statistical Methods.

**Credits**: 4.0

#### Course Materials

**Required:** Moodle Instructor Notes & Other Article Postings

**Optional:** Fox, J. (2016). *Applied Regression Analysis & Generalized Linear Models*. Sage. (used primarily as a class reference and resource).

**Optional:** Montgomery, D. C. (2005). *Design and Analysis of Experiments*. Wiley. (used primarily as a class reference and resource)

#### Optional Texts

Hays, W. L. (1994). *Statistics*, 5th ed. Wadsworth Publishing Company, Belmont CA.

Howell, D. (2009). *Statistical methods for psychology*. Wadsworth Publishing.

Kirk, Roger E. (2007). *Statistics: An Introduction. 5th ed*. Thomson/Wadsworth.

**Software Texts** (depending on which software you prefer)
Morgan, G. A. (2012). *IBM SPSS for Intro Stats.* Routledge. 5th edition.
Leech, N. L. (2014). *IBM SPSS for Intermediate Stats*. Routledge. 5th edition.
Teetor, P. (2011). *R Cookbook.* O'Reilly.
VanderPlas, J. (2017). *Python Data Science Handbook.* O'Reilly.

### Office Hours

Office hours are held weekly. You are also strongly encouraged to e-mail questions to the instructor and/or TA, as they arise. Writing your question out in an e-mail, as clearly as you can,

is an excellent way to clarify what you do not understand, and often, you achieve a deeper understanding of the topic itself while writing out your e-mail. **Please be as detailed and specific as you can in your e-mail**, so we know how to frame our response to best suit your needs.

**Final Grade Assignment**
There are 4 components that will make up your final grade*:

1. Midterm Test (10%)
2. Assignments (20%)
3. Seminar (20%)
4. *Final Exam (50%)

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| 99 | |
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| 59 | D + |
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| 57 | |
| 56 | D |
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| 52 | D - |
| 51 | |
| 50 | |
| < 50 | F |

* If your final exam grade is better than your mid-term test grade, your final exam will be worth 60% instead of 50%. The final exam is cumulative over the entire course (including material already covered on the midterm). Assignments and evaluations will consist of multiple choice and short-answer.

**Student Seminars**

The student seminar component of the course comprises 20% of your final grade, and is an important component of this course. Details of the student seminar, and criteria on which it will be evaluated, will be discussed in class. **The primary criteria is that your seminar be a very strong presentation of a statistical topic.** It is expected that you will begin preparing for the seminar NOW, so that by the time you present, it represents something extremely well-prepared and advanced (and in depth; shallow, surface content will receive no points).

Seminars can be done on topics such as the following:

1. Bayesian Statistical Analysis (as an alternative to NHST)
2. Classical Measurement Theory in Test Construction.
3. Experimental vs. Non-Experimental Designs.
4. The Matrix Algebra of Multiple Regression Analysis.
5. Data Management Using SPSS.
6. Missing Data in Statistical Analyses.
7. Putting Statistics into Context: The Role of Statistics in Science.
8. Mediation Analysis.
9. Moderation Analysis.
10. An Introduction to R Statistical Software.
11. Path Analysis and Structural Equation Models
12. Advanced Repeated Measures & Longitudinal Designs
13. The Analysis of Categorical and Qualitative Data
14. Non-parametric Statistical Methods

In your seminar, you are encouraged to provide handouts, notes, etc., to the class. The instructor may also provide additional handouts on the day of each seminar, though these will form no part of your independent presentation.

**Accommodation of Students with Disabilities**

In accordance with the University of Montana's mission to provide equal educational opportunities for all students, the instructor is willing to provide necessary accommodations for students with disabilities. If you require any accommodations, please make these known to the instructor, who will work with the office of Disability Services in adapting this course to meet your needs.

**Attendance**

Past experience in this course suggests that students who miss classes, usually receive poor grades. This is a reflection of the difficulty of the subject, and the need to stay on pace with the class and course. Attending class lectures usually helps a great deal in understanding material.

**Incompletes**

Departmental and university policies regarding incompletes do not allow one to change "incomplete" grades after 1 year has passed since the "I" was granted.

**Mathematical Arguments Used in Statistics**

As was true of Stat I, Stat II will **not** be taught as if it were a mathematics course because **statistics is not equal to mathematics**. You will not be tested on whether you can prove or justify the equations that make up the discipline of statistics. Most test items, as was true of Stat I, will focus on your **understanding and grasp of the material**, both through applied questions and theoretical or conceptual questions. However, familiarity with the mathematics of statistics can sometimes (but not always) aid in your understanding of the fundamental concepts. For that reason, lectures, as well as handouts, will sometimes contain mathematical arguments to help in your understanding of statistics. However, as was the case in Stat I, knowing how to "work" a formula or follow a mathematical argument **may or may not** help you in understanding the underlying statistical concept. If you understand the concept however, the math often (but not always) makes much more sense, and may help to fill "gaps" in your conceptual knowledge. As well, learning the math might help you in understanding statistical concepts. It's generally a two-way street, but guard against knowing the math, without understanding the underlying conceptual meanings. Tests and exams will aim to evaluate your **understanding** of statistics – the do you "get it" part. In this course, mathematics is simply seen as a way of expressing this understanding. Do not memorize anything, but instead, seek to understand.

**A Note on the Use of Statistical Software**

SPSS and R will be used in this course and featured in assignments. Although SPSS and R will be featured, it is of **extreme importance** that you do not equate "SPSS and R knowledge" with statistical knowledge. The emphasis in this course will be on first understanding statistics, then applying them on the computer. Learning how to use SPSS and R effectively and efficiently is relatively easy **IF YOU FIRST UNDERSTAND THE STATISTICAL PROCEDURES** which they offer. It is much easier to know what a multiple regression is first, then learn how to do it on a computer, than to know how to do it on a computer, and be totally clueless as to what it is**. Further, you will rarely be asked at a thesis or dissertation defense to demonstrate your knowledge of SPSS or R, no more than you would be asked to demonstrate your ability to use your pocket calculator. However, you will likely be asked to defend the statistics you've used in your research, and what they mean.**

## "TENTATIVE" COURSE SCHEDULE

| DATE | TOPIC | READINGS | ASSIGNMENTS |
|---|---|---|---|
| **17 Jan.** | Course Syllabus, Course Policies<br>Research Articles | 1. depression study<br>2. death risk | - |
| **24 Jan.** | Review of Stat I Principles<br>Factorial ANOVA – Toward Complex Cases and Issues | TBA | #1 Assigned |
| **31 Jan.** | Random Effects and Mixed Models ANOVA | TBA | |
| **07 Feb.** | Random Effects and Mixed Models ANOVA | TBA | #1 is DUE<br>#2 Assigned |
| **14 Feb.** | Randomized Blocks and Repeated Measures | TBA | |
| **21 Feb.** | Randomized Blocks and Repeated Measures | TBA | #2 is DUE<br>#3 Assigned |
| **28 Feb.** | Simple Linear Regression | TBA | |
| **06 Mar.** | Multiple Linear Regression I | TBA | #3 is DUE<br>#4 Assigned |
| **13 Mar.** | **Midterm Test (10%)**<br>Multiple Linear Regression II | | |
| **20 Mar.** | **Spring Break (NO CLASS)** | | |
| **27 Mar.** | Multiple Linear Regression III | TBA | |
| **03 Mar.** | Multiple Linear Regression IV | TBA | #4 is DUE<br>#5 Assigned |
| **10 Apr.** | Interactions in Regression | TBA | |
| **17 Apr.** | Logistic Regression and the Generalized Linear Model | TBA | |
| **24 Apr.** | Student Seminars TBA | | #5 is DUE |
| **01 May.** | Student Seminars TBA | | |
| **05 May.<br>10:10 –<br>12:10** | **Final Exam (50%) – Skaggs 246.** | **All Course & Seminar Material is Testable** | |