Advanced Psychological Statistics I

PSYX 520 – Autumn 2020 - REMOTE

Course Location and Time

McGill Hall 210 - REMOTE
Friday 12:00 – 2:50 PM

Instructor Information

Instructor: Daniel J. Denis, Ph.D.
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Office Hours: M, 9:30-10:30; 11:30-12:30, T, 9:30-11:30; W, 9:30-10:30.

Course Overview & Expectations

Although the course is self-contained, it is assumed that you have taken **at least one undergraduate statistics course and preferably a research methods course.** The scope of the course is generally applied, however select theoretical details and results will be emphasized insomuch as they facilitate the understanding of statistical concepts. It is imperative to gain an **understanding** of statistics, and a sense of its logical **foundation**, before knowing **how** and **when** to apply them (and in some cases, whether they should be applied at all). It's only through studying principles in sufficient depth can you appreciate what can vs. cannot be concluded from the application of statistics to data.

Credits

3.0

Learning Outcomes

1. By completion, you should have a reasonable understanding of the nature of statistics, learn to think statistically and probabilistically, as well as its common applications and its benefits and limitations within scientific practice. You should be able to critically evaluate select scientific statements based on statistical evidence in journal articles. You should also have beginner facility with software computing packages featured in the course, which you can then extend on independently later as needed in your work, and be able to apply what you have learned in class to the computer to carry out select statistical tests as well as other statistical computations.

2. Understanding the wealth of statistical procedures used in psychology begins with an understanding of the **key fundamental foundations** that are a component of virtually every statistical method or procedure, and that lie at the very heart of statistical science. Unifying concepts and principles will be emphasized in this course as to encourage a general understanding. **The goal is to strike a balance between showing you HOW to apply statistics and providing an appreciation for WHAT you are doing, so that you may generalize your skills to new domains and new quantitative approaches throughout your career.** In addition to providing the initial skills of data analysis, the goal is to provide you with the foundation required to permit independent study of statistical topics in psychological research and possibly beyond into **psychometrics** and **mathematical psychology** as initial preparation for reading papers in journals such as **Psychometrika** and **British Journal of Mathematical and Statistical Psychology**. Psychology and related sciences have literally seen an explosion of statistical methods in the past couple of decades, and unless you have a foundation for understanding them, you will quickly get lost in the "cookbook" approach, and not really understand what you are doing. To avoid this, you need some understanding of what unites virtually all statistical methods. Seek to understand **unifying principles**, and statistics will make much more sense to you. **Do not memorize. Rather, strive to understand. Strive to "demystify" the complexity and you'll start to look at a statistics book in a different way (as a unifying theme rather than a collection of unrelated topics). And as you study further into the future (via coursework or self-study), you'll better appreciate how essential having that foundation is to learning new things.**

3. This course will cover topics which include: functions, essentials of set theory, probability, conditional probability and distributions, independence, association, random sampling and randomization, measurement scales, probability and sampling distributions, discrete and continuous random variables, expectation, the binomial distribution, measures of central tendency, measures of variability, confidence intervals, normal distribution, hypothesis testing, the nature of the null vs. alternative hypotheses, power, inferences about population means, chi-square distribution, *F* distribution, linear contrasts and post-hoc comparison procedures, general linear model, experimental design, simple analysis of variance, factorial analysis of variance, correlation, linear regression and linear multiple regression, elements of psychometrics such as reliability and validity, as well as featuring select applications and computations using SPSS, R and Python.

Required Text

Montgomery, D. C. (2005). **Design and analysis of experiments**.[*We will not be covering every element of this book, and will be expanding greatly on certain other elements in the book in lecture – it is suggested that you use the book for elaboration/clarification on topics brought up in class and focus on those topics emphasized in class and needed for assignments*]

Software Texts

Morgan, G. A. (2012). **IBM SPSS for Intro Stats**. Routledge. 5th edition.
Teetor, P. (2011). **R Cookbook**. O'Reilly.
VanderPlas, J. (2017). **Python Data Science Handbook**. O'Reilly.

Optional Texts & Resources

Howell, D. (2010). *Statistical methods for psychology*. Wadsworth, Cengage Learning: NY.

Zar, J. H. (2009). *Biostatistical analysis*. Pearson: New York.

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

Dowdy, S., Wearden, S. & Chilko, D. (2004). *Statistics for research*. Wiley: New Jersey.

Morgan, G.A., Leech, N. L., Gloeckner, G. W. & Barrett, K. C. (2011). IBM SPSS for Introductory Statistics: Use and Interpretation, 4th ed. Routledge: New York.

Leech, N. L., Barrett, K. C. & Morgan, G. A. (2011). IBM SPSS for Intermediate Statistics: Use and Interpretation, 4th ed. Routledge: New York.

Barnett, R.A., Ziegler, M. R., & Byleen, K. E. (2011). College Mathematics for Business, Economics, Life Sciences, and Social Sciences. Prentice Hall: MA.

Field, A. (2009). *Discovering statistics using SPSS*. Sage Publications: California.

Kirk, R. E. (2008). *Statistics: An introduction*. Thomson/Wadsworth: Belmont, CA.

Upton, G., & Cook, I. (2006). *Oxford Dictionary of Statistics*. Oxford University Press. New York.

A Note about Texts & Resources

Statistics and data analysis books can be categorized across a wide spectrum from in-depth analytical thought-provoking books, to very surface data-analytic "how to" and "procedural" books. What one kind of text will give you makes up for what another kind will not. One kind of book is no better than the other so long as you understand that they were written with different purposes in mind. ***In this course, all definitions and fundamental concepts will be drawn from our primary text and lecture notes, and you will be expected to be familiar with these fundamental concepts. Do not learn definitions from (most) software manuals!***

Office Hours (ZOOM)

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

is an **excellent** way to clarify what you do not understand, and often, you achieve a deeper understanding of the topic itself. **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. There will be a class e-mail listserv which I will use ocassionally to communicate with the class. **Be sure you are receiving messages from this list**.

Evaluation

There are 3 components that will make up your final grade (see table below):

1. Assignments (30%) Approx. 1/2 theory, 1/2 computation (Binary grading, 0, 1)
2. Mid-Term Exam (20%)
3. Final Exam (50%) *

* **Final Exam = 70% if higher than Midterm.**

Percentage	Grade	Percentage	Grade	Percentage	Grade
100	A	79	B +	59	D +
99	A	78	B +	58	D +
98	A	77	B +	57	D +
97	A	76	B	56	D
96	A	75	B	55	D
95	A	74	B	54	D
94	A	73	B	53	D
93	A	72	B -	52	D -
92	A	71	B -	51	D -
91	A	70	B -	50	D -
90	A	69	C +	< 50	F
89	A -	68	C +		
88	A -	67	C +		
87	A -	66	C		
86	A -	65	C		
85	A -	64	C		
84	A -	63	C		
83	A -	62	C -		
82	A -	61	C -		
81	A -	60	C -		
80	A -				

Policies regarding Tests & Exams

All tests and exams will be written in-class. Be on time for all evaluations, as you will not have additional time if you arrive late.

All material in lecture/book is testable. However, usually, tests (and the final exam) will consist of a subset of material from each chapter. By attending lectures and keeping up with the class, you should get a good idea of what this subset will consist of.

Assignments

Work turned in that does not show sufficient detail or thought process will receive a grade of **zero**. If you are unsure of how much explanation or work to include in your solutions, **include more than not**.

Course Guidelines & Policies

Disability Modifications

The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. If you have a disability adversely affecting your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or call 406-243-2243. I will work with you and Disability Services to provide an appropriate modification.

Attendance

If you absolutely must miss a class, please note that it is your responsibility to catch up on missed work. *Instructor notes will **not** be made available on an individual basis at any time, nor can the time of the TA be used to provide catch-up lectures.* Attending class lectures usually helps a great deal in understanding material, and consequently doing well on tests and exams.

Academic Misconduct

You are expected to adhere to the university's Student Conduct Code with regard to academic integrity. Academic misconduct in this course will not be tolerated and will result in an academic penalty. **If you are suspected of cheating on a test or exam, you will receive zero on that test or exam and be asked to leave the class permanently**. In short, even if you do not know the answer to a question, you're much better off guessing than risking the chance of getting caught cheating.

Policy on Class Disruptions

The expectations for this course are such that you remain respectfully silent while either the instructor is speaking or a colleague in the class is asking or responding to a question. In accordance with **policies set by the University, disruptions in class will not be tolerated**. This policy is set very strict so that **every student has the opportunity to learn in a quiet and constructive environment**. **A failure to meet this expectation ($p < .05$) will result in you being dismissed permanently from the class.** This policy is extremely strict as to protect the rights of students who have invested time, money and energy into this course and deserve nothing less than an optimal learning environment. **The instructor will make every effort to make sure you have an ideal learning environment**. Please speak to the instructor privately if you are being disturbed in class.

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.

Questions during Class

Although you are welcome and often encouraged to ask questions during lecture, class questions to some extent will have to be limited if they become too numerous, as to allow us to make our way through all the material we need to wade through by the end of the course. **Be sure to recognize that only once in a "blue moon" will you understand EVERYTHING from the beginning to end of a given lecture, which is why studying between lectures is necessary. This is normal**. Approximating that which you are trying to learn is key. If you understand the main themes of lectures, and can more or less "stay with us" as we progress through the lecture, that's a good guidepost to evaluate your in-class progress. Many of the questions you have during class will be answered by post-class study (or sometimes while waiting at a red light on the way home). Such is the nature of learning - do your best to "get it now," but if you can't, then sit or sleep on it for a little bit and return to *experience* the concept again from scratch

once more. It might just "take" this time! Even the best of the best learners are always learning. As soon as you declare a concept "mastered," you possibly close the door to new learning and deepening of that very concept. If you would like to discuss learning strategies further, feel free to contact myself or the TA.

Mathematical Arguments Used in Statistics

Stat I will not be taught as if it were a mathematics course because **statistics (applied) 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 will focus on your **understanding and grasp of the material** rather than on your ability to manipulate equations (though it would be nice if both went hand-in-hand). Familiarity with the mathematics of statistics can sometimes (but not always) aid in your understanding of the fundamental concepts. For that reason, lectures will sometimes contain mathematical arguments to help in your understanding of statistics. However, be aware that 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, or at minimum, **provide you with a means to express your statistical knowledge**. The opposite is also true - 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; it will get you nowhere fast. Tests and exams will aim to evaluate your **understanding** of statistics – the "Do you get it?" part, and not weather you were able to memorize a formula you don't truly understand yet. In this course, **mathematics is simply seen as a vehicle or means to express statistical understanding**. **Focus on the concepts** (even the most technical of mathematics are but expressions of underlying concepts).

A Note on the Use of Statistical Software

It is of extreme importance that you do not equate "SPSS or R or Python 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 software effectively and efficiently is relatively easy **IF YOU FIRST UNDERSTAND THE STATISTICAL PROCEDURES** which it offers. Using software texts as a guide now and into the future will help you in using SPSS or R or SAS, or STATA, Python, etc. **It is much easier to know what an ANOVA is first, and 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 and then try to learn it. Further, you will never be asked at a thesis or dissertation defense to demonstrate your knowledge of SPSS or R or Python, 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. To do that, you must UNDERSTAND what you are doing, and not simply HOW to generate output.** Software used in this course will include **SPSS**, **R**, and **Python**. Assignments will feature the use of all three programs, so you will be required to have access to each one. **Computing is a part of statistics and research**, and it is good practice to introduce yourself to several software packages and be able to use them to some degree. In Python, we will be using the **Spyder** environment. Though direction will be provided on assignments, you will be expected to consult your software manuals for ideas on how to complete the assigned questions. This is meant to simulate what researchers (from beginning to advanced) do when coding programs and running statistical software and otherwise "figuring things out." The key is to learn how to access software resources so that you can execute the task at hand. There are numerous software packages, and at times as a researcher you may need to use more than one, depending on the given analysis.

Recommendations for Studying Statistics

In learning and/or expanding your knowledge of statistics, always try to see the "parts" within the "whole." In other words, take the elements that you learn, and try to situate them within the "bigger picture." You need a certain amount of small pieces before you can build the bigger picture, but **always make the effort to see the larger frame**. Once you do, the smaller pieces fall into place, and even new things that you learn can be more easily situated within the larger framework. For instance, if you are familiar with the general linear model (big picture), you can more easily situate and understand ANOVA and regression (smaller pieces). Similarly, if you understand what an F-distribution is (small piece), you can link this concept to better understanding ANOVA and regression (larger pieces).

Tentative Course Timetable

Date	Topic	Howell	Assignments (Binary Grading)
21 Aug.	Syllabus, Introductions, Course Policies, Transition to Remote	1	Install R
28 Aug.	Describing and Exploring Data	1, 2	A#1 ASSIGNED
04 Sept.	The Normal Distribution	3	A#1 DUE A#2 ASSIGNED
11 Sept.	Sampling Distributions and Hypothesis Testing	4	A#2 DUE A#3 ASSIGNED
18 Sept.	Basic Concepts of Probability	5	A#3 DUE A#4 ASSIGNED
25 Sept.	Categorical Data and Chi-Square	6	A#4 DUE A#5 ASSIGNED
02 Oct.	Hypothesis Tests Applied to Means	7	A#5 DUE
09 Oct.	**MID-TERM EXAM (20%)**	**MID-TERM EXAM DUE @ 3:00PM. E-mail to daniel.denis@umontana.edu**	
16 Oct.	Power	8	A#6 ASSIGNED
23 Oct.	Correlation and Regression/ Alternative Correlational Techniques	9, 10	A#6 DUE A#7 ASSIGNED
30 Oct.	Simple Analysis of Variance	11	A#7 DUE A#8 ASSIGNED
06 Nov.	Multiple Comparisons Among Treatment Means	12	A#8 DUE A#9 ASSIGNED
13 Nov.	Factorial Analysis of Variance	13	A#9 DUE
23 Nov. Final Exam	**FINAL EXAM (50%)**	**FINAL EXAM DUE @ 3:00PM. E-mail to daniel.denis@umontana.edu**	