Stat 301: Mathematical Statistics **2022**
Mathematical Statistics with Application *7th Edition,* by Wackerly, Mendenhall, and Scheaffer.
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office hours by appointment at calendly.com/minton/15min

Course Objectives: The overall objective of this course is to expand our understanding of statistical theory in order to clearly understand the role that it plays in solving problems. We will investigate probability through functions of random variables in order to define point estimators and understand their properties. While the focus is on developing a strong understanding of the theoretical/mathematical aspects of statistical methods, we will concurrently work on applied problems and handle real data sets.

Intended Learning Outcomes: At the end of the course, successful students will be able to

- understand and interpret multivariate probability distributions.
- identify relationships between random variables.
- articulate the connections between probability theory and statistics.
- describe the role the central limit theorem plays in probability and statistics.
- understand the properties of point estimators and their connection with point estimates.
- identify appropriate tests to solve a variety of problems

Attendance Policy: Attendance and attention in class is essential! Work hard in class and you will have little need for studying the night before a test. You are responsible for everything done in class, through attendance and sharing class notes with classmates. If you miss a class, e-mail or call me before class is over and explain why. With the first unexplained absence, you and your advisor and the registrar will be warned that another unexplained absence will result in removal from the course. **If you have two unexplained absences, you will be dropped from the course.**

Equipment: We will use Mathematica in class, on homework assignments and on tests. You are encouraged to get a copy installed on a laptop or desktop. This is free! Take advantage of this great offer. We will practice using Mathematica in class. There will be homework problems and test questions that will be very hard to work without Mathematica! Please note that Mathematica is used extensively in other upper-level mathematics courses. Although we will not use it in this class, you are encouraged to download a (free) copy of R, am open source statistical package that is widely used in industries.

Study Problems: In each section of the book that we cover, I will give you a list of problems to study. Work as many of these problems as you can! There are some topics in the book that you are not responsible for learning; the study problems indicate what topics you will see on tests.

Co-Curricular: During the course of the semester, you must attend at least three approved co-curricular events offered by the MCSP department. For each, write a two-paragraph reflection paper, giving a brief summary of the talk and expanding on some aspect of particular interest to you. Reports are due within two weeks of the talk. One report must be turned in by 10/14.

I expect you to spend at least 12 hours of work each week inside and outside of class.

Academic Integrity: The college policy is fully supported. Projects are to be your own work though you may ask me for help. No other outside sources are allowed beyond your group partners. Tests are closed notes, closed book, no electronic devices allowed. Anything that requires Mathematica will be given as take-home work. For that, no sources other than Mathematica files posted on Inquire are allowed.

Tests: There will be four tests and a final exam. Each test will cover all material since the previous test, and the final exam will be comprehensive. Anticipated test dates are Friday 9/23, Wednesday 10/12, Friday 11/11, and Wednesday 12/7.
The exam is Wednesday, December 14, 8:30-11:30.

Projects: You will have two extended projects to be done in groups of two. Partners are your choice, but must be different for the two projects. For each project, the group will produce a written report and a class presentation (5 minutes, PowerPoint or equivalent).

Grading:
Tests and Exam: 60%
Projects: 30%
Worksheets/Participation: 10%

Grades may be curved up based on extenuating circumstances, such as one unusually bad score, and including improvement as the semester goes on.

A: 93-100	A-: 90-92	
B+: 87-89	B : 83-86	B-: 80-82
C+: 77-79	C: 73-76	C-: 70-72
D+: 67-69	D: 63-67	D-: 60-62
F: 59 and below		

Subject Tutoring, located on the lower level of Fintel Library (Room 5), is open 4-9 PM, Sunday-Thursday. Subject Tutors are highly trained, current students who offer free, one-on-one (and small group) tutorials in over 80 courses taught at Roanoke College, including: Business, Economics, Mathematics, INQ 240, Modern Languages, Lab Sciences, and Social Sciences. Check out all available subjects and schedule 30- or 60-minute appointments at www.roanoke.edu/tutoring. If you have a question, feel free to stop by, or contact us at subject_tutoring@roanoke.edu or 540-375-2590. See you soon!

Accessible Education Services (AES) is located in the Goode-Pasfield Center for Learning and Teaching in **Fintel Library**. AES provides reasonable accommodations to students with documented disabilities. To register for services, students must self-identify to AES, complete the registration process, and provide current documentation of a disability along with recommendations from the qualified specialist. Please contact Becky Harman, Assistant Director of Academic Services for Accessible Education, at 540-375-2247 or by e-mail at aes@roanoke.edu to schedule an appointment. If you have registered with AES in the past and would like to receive academic accommodations for this semester, please contact Becky Harman at your earliest convenience to schedule an appointment and/or obtain your accommodation letter for the current semester.

Student Health & Counseling Services supports students through in-person health appointments, in-person counseling, 24/7 telehealth (TimelyCare), Therapy Assistance Online, as well as resources related to general wellness, LGBTQ+, sexual assault, substance abuse, and suicide prevention. Unmet health needs can negatively impact your performance in this course. Student Health & Counseling Services can help. Please see https://www.roanoke.edu/shcs for more information and to access services.

Date	Sections Topics	Study Problems
W 8/31	4.2-3 Continuous Dist.	4.8,9ab,12-16; 4.20,22,25,28-30
F 9/2	4.4-6 Distributions	4.39-40,43-44; 72-76; 88,90,97-98
M 9/5	Mathematica	
W 9/7	5.2 Bivariate Dist.	5.5-9.11-12
F 9/9	5.3 Marginal, Conditional	5.23-27,31-32
M 9/12	5.5 Expected Value	5.76-79,82
W 9/14	5.7 Covariance, Correlation	5.89,91-93
F 9/16	6.4 Transformations	6.23-26,29-30
M 9/19	6.5 Moment-Generating	6.39-40,42,45,48
W 9/21	review	
F 9/23	Test #1	
M 9/26	8.2 Bias, MSE	8.2-3,6,8,14-15
W 9/28	8.3-4 Unbiased Estimators	8.23-25,27-28,31,36-37
F 9/30	8.6 Large Sample CI	8.56-60
M 10/3	8.6 continued	8.63-66
W 10/5	8.8 Small Sample CI	8.82-83,85-87
F 10/7	8.9 Variance CI	8.95-96,100-101
M 10/10	review	
W 10/12	Test #2	
F 10/14	Presentations	
Fall Break 10/17-21		
M 10/24	9.2-3 Efficiency, Consistency	9.1-4,15,17,19
W 10/26	9.5 MVUE	9.59-60,63
F 10/28	9.6 Method of Moments	9.69-72
M 10/31	9.7 Max Likelihood	9.80-84
W 11/2	10.6-7 p-values	10.50-55,57
F 11/4	10.8 Small Sample Mean	10.67,69,72-75
M 11/7	10.9 Testing Variance	10.78,82-84
W 11/9	review	
F 11/11	Test #3	
M 11/14	10.10 Power, N-P Test	10.88-89,91-93,96
W 11/16	10.11 Likelihood Test	10.106-108,111
F 11/18	14.2 Chi Square Test	14.1-5
M 11/21	14.4 Contingency Tables	14.14,16-19
Thanksgiving		
M 11/28	16.2 Bayesian Priors	16.7,9,11
W 11/30	16.3 Credible Intervals	worksheet
F 12/2	Information (AIC)	worksheet
M 12/5	review	
W 12/7	Test #4	
F 12/9	Presentations	
W 12/14	EXAM 8:30-11:30	

Model Reflection Paper

(This is made up, but shows what I'd like to get from you. The two main elements are (1) brief summary of talk and (2) some original thought on the subject.)

The talk on September 7th was by Dr. Sue Dokoo of Pseudo Duke University. Her research is in the game of Sudoku and discussed different aspects of this game. I have seen other people playing it, but did not know the rules or any of the mathematics behind it.

In this game, a 9x9 playing space is provided. An example given was:

		6	2			5	8	
4		2	5					7
				7	8	6		3
5		1		6	7			8
	3						6	
6			8	2		9		1
7		4	3	9				
9					5	2		6
	5	3			1	4		

To "solve" the puzzle, one could just enter numbers in a brute-force kind of way to see if they could get a working configuration. However, sitting in a room full of mathematicians, taking a more analytical approach seemed to be the dominant strategy. Treating this as a constraint-satisfaction problem, you can identify that certain cells must contain specific values. This leads to the conclusion that there is exactly one solution to a "well-formed" Sudoku.

This got me thinking about well-formed Sudoku, and how they are generated in the first place. It seems unlikely that the seeds are randomly assigned, you run the risk of violating set-up rules. A bigger problem is that the seeds may not constrain the possibilities enough to make a unique solution. Another naïve approach might be to take a completed grid and start taking away numbers, but I suspect that you might have a similar issue in terms of necessary constraints.

One that I want to think about is: In forming a viable Sudoku, is it the number of seeds or the placement of seeds that is more critical? I suspect the latter. Also,

- What is the maximum number of seed numbers that can be provided and still result in an ambiguous (unsolvable) puzzle?
- What is the minimum number of seed numbers that can be provided to generate a (uniquely) solvable puzzle?

We were provided two puzzles – one was rated "Easy" the other "Difficult".

- What goes into the rating system?
- Does a difficult puzzle necessarily have fewer seed numbers?
- Is the rating of the complexity somehow determined by the deductive skills required?