Stat 202: Probability **2017**
Probability and Statistics, Wackerly, Chapters 1-4,5-9

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Course Objectives: *Continue to learn how to do mathematics!* Mathematics is a problem-solving discipline, and we all have room to improve. To develop as problem-solvers, we must focus on technique and not on memorization. In this course, we focus on the basics of the fields of probability and statistics, mathematical areas that are increasingly important in our digital world. A common complaint about probability and statistics is that there are too many formulas and the formulas are confusing. The way to avoid this problem is to not memorize formulas! If you spend time learning the thought process and concepts behind the formulas, they will make sense and be "obvious" enough that no memorization is needed. Like all math courses, thinking is the key!

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

- Apply techniques for discrete and continuous distributions to solve problems of interest
- Understand the role of randomness in decision-making processes
- Distinguish among different statistical tests, and know which to use in a given situation
- Distinguish among different distributions, and know which to use in a given situation
- Use integration and sums as appropriate to determine probabilities

Attendance Policy: Regular attendance is expected. You are responsible for everything done in class, through your attendance and sharing class notes with classmates. If you miss a class, you must e-mail or call me before class is over and explain why. **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.

Study Problems: You should attempt as many of the exercises in the book as you can. In general, practical computation questions are more likely to appear on tests than theoretical questions, so focus on those questions. Ask questions about any problems you do not understand completely. I may delay answering a question until after class, but I will always get you an answer.

Homework: Every other week, problems will be assigned to hand in with due dates specified. Work these problems neatly and completely. You will be graded on accuracy and ability to communicate your ideas. At least one problem will require Mathematica – once you get comfortable with its syntax, you will find it to be a wonderful resource. Some of the problems will be theme based. You should choose the theme that interests you the most: options are actuarial science, games, sports, and medical. The problems will be of the same mathematical difficulty; if you choose your theme wisely, your interest in the topic will make your problems easier. Each assignment will include a challenge problem. Two (out of six) will count in your test grade, but try all of them! They will be graded on a mastery basis; the bar is high but reachable. Start early on these and ask questions!

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

Co-Curricular: During the course of the semester, you must attend at least two 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 a week of the talk.

Daily Grades: On many occasions, we will spend some time in or out of class collecting data for analysis. There will typically be a worksheet for you to turn in. Doing so shows your commitment to the class, as the more good data is collected the more we can learn from our analysis.

Tests: There will be six full test days, six partial test days, and a final exam. Each test will cover all topics covered to that date. Full test dates are W 9/13, W 9/27, W 10/11, F 11/3, F 11/17 and W 12/6. The exam is Tuesday, 12/12, 2-5. Grading is mastery based, meaning that there is no partial credit. For this reason, there are six partial test days where you can attempt one or two problems. Once you have mastered a topic, you do not need to test on it further. The intent of this system is to encourage deeper understanding of topics, and perseverance at mastering topics from earlier in the semester. We will talk about strategy and status in the course at various times during the semester – the most important message is to keep studying!

Make-ups: In case of sickness or scheduling conflicts, get in touch with me ASAP.

Academic Integrity: The college policy is fully supported. Tests are closed notes, closed book unless noted. Electronic devices other than computers are not allowed in test situations, and computers may only be used for computation purposes in Mathematica.

Extra Credit: You may earn extra credit in a number of ways. My intent is to encourage you to have fun with mathematics, and that is the grading criterion that I will use – so have fun learning! You may check out from the Roanoke College library and report on "popular" statistics or probability books. You may report on mathematical web sites that have good stat demonstrations or extra material. You may do one of the extra credit options posted on Inquire during the semester. The main rule here is to do this now; waiting until the end of the semester will annoy me and (more importantly) distract you from the end-of-semester studying that you need to do.

Grading: The tests and exam count 60% of the final average.
The grading scale is given below the list of mastery topics.
Homework counts 30% of the final grade.
The remaining 10% comes from: (1) daily grades, (2) co-curricular and (3) class participation.
Grades may be curved up based on extenuating circumstances.

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

Stat 202 Schedule

Date	Sections	Topics	Due
W 8/30	intro	Probability Puzzles	
F 9/1	1.1-1.3	What is Statistics?	
M 9/4	2.4-2.5	Sample-Point Method	
W 9/6	2.6	Counting: Permutations	HW 1 due
F 9/8	2.6-7	Combinations	pre-test
M 9/11	2.7	Conditional Probability	
W 9/13	TEST 1		TEST
F 9/15	2.8	Laws of Probability	
M 9/18	2.9	Event-Composition Method	
W 9/20	2.10	Bayes' Rule	HW 2 due
F 9/22	3.1-2	Probability Distributions	re-test
M 9/25	3.3	Expected Value	
W 9/27	TEST 2		TEST
F 9/29	3.4	Binomial Distribution	
M 10/2	3.5	Geometric Distribution	
W 10/4	3.8	Poisson Distribution	HW 3 due
F 10/6	3.9	Moment-Generating Functions	re-test
M 10/9	4.2	Continuous Distributions	
W 10/11	TEST 3		TEST
F 10/13	4.3	Expected Value	

FALL BREAK

Stat 202 Schedule

Date	Sections	Topics	Due
M 10/23	4.4	Uniform Distribution	
W 10/25	4.5	Normal Distribution	
F 10/27	4.6-7	Gamma and Beta	HW 4 due
M 10/30	5.2	Bivariate Distributions	re-test
W 11/1	5.3	Marginal Distributions	
F 11/3	TEST 4		TEST
M 11/6	5.4	Independence	
W 11/8	5.7	Covariance, Correlation	re-test
F 11/10	10.2	Statistical Tests	HW 5 due
M 11/13	7.2-3	Central Limit Theorem	
W 11/15	10.3	Large-Sample Tests	
F 11/17	TEST 5		TEST
M 11/20	8.5-6	Confidence Intervals	
Thanksgiving Week			
M 11/27	10.6	Significance Levels	re-test
W 11/29	10.8	Small-Sample Tests	HW 6 due
F 12/1	10.9	Tests of Variance	
M 12/4	10.10	Power of Tests	
W 12/6	TEST 6		TEST
F 12/8	review		
T 12/12	EXAM 2:00-5:00		

Mastery Topics Stat 202

1. Apply the empirical rule
2. Compute probabilities with the sample-point method
3. Compute combinations and permutations
4. Compute conditional probabilities
5. Compute probabilities with the event-composition method
6. Compute probabilities with Bayes' Rule
7. Compute and give graphical displays of probability distributions
8. Compute expected values for discrete distributions
9. Solve problems with binomial distributions
10. Solve problems with geometric distributions
11. Solve problems with Poisson distributions
12. Solve problems with moment-generating functions
13. Compute expected values for continuous distributions
14. Compute probabilities with uniform and normal distributions
15. Compute probabilities with various distributions
16. Compute probabilities with bivariate distributions
17. Compute marginal distributions
18. Determine independence
19. Compute and interpret correlations
20. Use the Central Limit Theorem to apply statistical tests
21. Complete statistical tests for large samples
22. Complete statistical tests for small samples
23. Complete statistical tests on variances
24. Solve problems with power of tests
25. Solve a challenge problem
26. Solve a second challenge problem
27. Exam problem #1: identify distributions
28. Exam problem #2: interpret definitions and theorems
29. Exam problem #3: comprehensive problem
30. Exam problem #4: comprehensive problem

Grading scale

30 mastered: 100
29 mastered: 98
28 mastered: 96
27 mastered: 94
26 mastered: 92
25 mastered: 90
24 mastered: 87
23 mastered: 85
22 mastered: 83
21 mastered: 80
20 mastered: 77
19 mastered: 75
18 mastered: 73
17 mastered: 70
16 mastered: 67
15 mastered: 65
14 mastered: 63
13: 60 **12**: 55, **11**: 50, **10**: 45, **9**: 40, **8**:35, **7**: 30, **6**: 25, **5**: 20, **4**: 15, **3**: 10, **2**: 5, **1**: 0

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?

Stat 202 Information Sheet

Name: **Theme:**

Email:

Cell phone:

Intended Major:

Hometown:

List any other statistics courses you have taken.

What are your expectations and goals for this course?

What are some of the co-curricular or other campus activities you would like to participate in this year?

Pick a (random) integer between 1 and 9 (inclusive):

Pick a random 3-digit integer:

List a sequence of 20 random H's and T's that would model coin-flipping: