Manhattan College

Department of Mathematics

MATG 630 Section 01 ***Probability and Statistics for Analytics*** Fall 2018

Class Time: MR 3-4:15 P.M. *Class Room*: RLC 102

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Office Hours: Monday 1:30-2:20 P.M., Wednesday 3-3:50 P.M., Thursday 11:00-11:50 A.M., or by appointment.

Required Textbook:
Mathematical Statistics and Data Analysis 3rd Edition (2007)
Author: John A. Rice, Publisher: Cengage Learning

Recommended Textbooks:
(For an introduction to R)
Introductory Statistics with R (Statistics and Computing) 2nd Edition
Author: Peter Dalgaard, Publisher: Springer
This text is available in PDF from O'Malley Library.

(For an undergraduate version of the material)
Modern Mathematical Statistics with Applications, 2nd. Ed.
Authors: Jay L. Devore and Kenneth N. Berk, Publisher: Springer
This text is available in PDF from O'Malley Library.

Catalog Course Description:
Basic theorems in probability, random variables, distribution functions, expected values; binomial, Poisson and normal distributions. Sampling distributions, point estimation, interval estimation, testing statistical hypotheses.

Prerequisite: Permission of the Graduate Director.

Learning Outcomes: Upon successful completion of this course, the student will be able to:

- Calculate probabilities and moments of discrete and continuous random variables.
- Calculate conditional probabilities and apply Bayes' rule.
- Obtain variance, covariance, and correlation measures of random variables.
- Understand, derive and apply the law of large numbers and the central limit theorem
- Calculate basic statistics for a sample of data.
- Compute probabilities associated with sample statistics, making inferences about population parameters from sample data using confidence intervals.
- Use and understand methods of parameter estimation (method of moments, maximum likelihood, Bayesian)
- Test claims about population parameters using hypothesis testing.

- Understand the connection between hypothesis testing and parameter estimation.
- Utilize statistical language R (using RStudio) to verify theory and solve data science problems

If time permits, material will be covered so that students will be able to:

- Use and understand methods of hypothesis testing (likelihood ratio, generalized likelihood ratio)
- Test the normality of data

Course Homepage (Moodle):
Here you will find four features that will be used in this course:

- *Email:* make sure that your email on Moodle is one that you check regularly. Homework assignments, announcements and other class related information will be sent via email.
- *Course Information and Documents:* material covered each week, assignments and solution keys.
- *Student Discussion Board:* this online forum allows for students and faculty to communicate about the course.
- *Grades:* students will be able to keep track of their grades online.

Assessment of Student Learning:
Homework (50 %)
There will be weekly assignments. Most of the learning will be in these weekly assignments.

Midterm Exam (20 %): Thursday October 4

Comprehensive Final Exam (30 %), Saturday Dec. 15, 11 am – 1 pm.
The final exam for this class will serve as a qualifying exam for the master's program in applied mathematics-data analytics and the master's program in mathematics.

Tentative Grading Scale

Percent	90-100	85-89	80-84	75-79	70-74	65-69	60-64	50-59	0-49
Grade	A	A-	B+	B	B-	C+	C	D	F

The exact grading scale will be determined after the final exam. The numerical scores in the tentative grading scale guarantee the associated letter grade but the instructor may change the scale to the student's benefit.

Dates to Remember:

August 31: Late Registration & Add/Drop Ends
September 3: Labor Day – No Classes
October 4: Midterm Exam
October 8: Fall Break – No Classes
October 9: Monday Schedule
October 15: Midterm Grades Due
November 16: Last Day to Withdraw from Courses
November 21-23: Thanksgiving Holiday – No Classes
December 7: Last Day of Classes
December 15: Final Exam

Class Policies

- Late homework will not be accepted after the solutions are distributed. In case the homework is handed in before the solutions are posted it will be marked 20% off for every day (or part thereof) it is late.
- The lowest HW grade will be dropped.

- No make-up exams will be given, unless you have a medical or family emergency. These emergencies require valid documentation. The grade for a missed exam is zero.
- Calculators are allowed in this class but most of the computation will be done using the R computing language using the RStudio graphical user interface.
- Attendance is expected. In the case of an absence, you should notify the instructor of the reason.
- Cell phones (or other technology not related to the class) in the classroom is only allowed with express permission of the instructor for special circumstances. In general cell phone or other potentially disruptive technology use is not allowed in class.

Suggestions for Success

- The course requires a time commitment of about 9 hours outside of class time per week (about 3 per class hour). The material builds on itself, so it is very important not to fall behind. Make sure to make enough space in your schedule to spend the time needed.
- I suggest you work in groups on your homework but hand in individual solutions, not copied from each other. Doing the homework is when most of the learning occurs.
- Treat your homework as a study guide for exams. Write solutions to problems in a neat and organized fashion.
- Review your notes from the previous lecture before each class.
- Read the textbook. It will complement the presentation in lecture and help give you the big picture of the material.
- I encourage you to come to office hours regularly. I will do my best to help you.

Academic Integrity:

Recall that as students of Manhattan College, you have each signed The Manhattan College Honor Pledge as a part of the Honor Code:

As a Manhattan College student, I will not lie, cheat, or steal in my academic endeavors, nor will I accept the actions of those who do. I will conduct myself responsibly and honorably in all my activities as a Manhattan College student. I am accountable to the Manhattan College community and dedicate myself to a life of honor.

Whenever you put your name on work to be handed in for grading in this class, you are reaffirming the above pledge. Violations of the Honor Code include, but are not limited to, cheating, plagiarism, fabrication, and other forms of academic misconduct. Please see the Manhattan College Code of Conduct and Academic Polices for a detailed description: https://inside.manhattan.edu/student-life/dean-of-students/code-conduct.php

Special Accommodations:

- Students with special needs should bring appropriate documentation to the Specialized Resource Center, Thomas Hall 3.15, https://inside.manhattan.edu/academic-resources/specialized-resource-center/, to obtain an Academic Adjustment/Auxiliary Aid form. Bring the completed form to me as soon as possible, and together we will decide on how best to fulfill the adjustments and/or aids listed on the form.
- Student athletes should bring their event schedules to me as soon as possible.

Tentative Course Outline:

- Chapter 1: Probability

1.1 Introduction
1.2 Sample Spaces
1.3 Probability Measures
1.4 Counting Methods
1.5 Conditional Probability
1.6 Independence

- Chapter 2: Random Variables

2.1 Discrete Random Variables
2.2 Continuous Random Variables
2.3 Functions of a Random Variable

- Chapter 3: Joint Distributions

3.1 Introduction
3.2 Discrete Random Variables
3.3 Continuous Random Variables
3.4 Independent Random Variables
3.5 Conditional Distributions
3.6 Functions of Jointly Distributed Random Variables
3.7 Extrema and Order Statistics

- Chapter 4: Expected Values

4.1 Expected Value of a Random Variable
4.2 Variance and Standard Deviation
4.3 Covariance and Correlation
4.4 Conditional Expectation and Prediction
4.5 Moment-Generating Function
4.6 Approximate Methods

- Chapter 5: Limit Theorems

5.1 Introduction
5.2 The Law of Large Numbers
5.3 Convergence in Distribution and the Central Limit Theorem

- Chapter 6: Distributions Derived from the Normal Distribution

6.1 Introduction
6.2 χ^2, t and F Distributions
6.3 The Sample Mean and the Sample Variance

- Chapter 7: Survey Sampling

7.1 Introduction
7.2 Population Parameters
7.3 Simple Random Sampling
7.4 Estimating a Ratio
7.5 Stratified Random Sampling

- Chapter 8: Estimating Parameters and Fitting of Probability Distributions

8.1 Introduction
8.2 Fitting the Poisson Distribution to Emissions of Alpha Particles
8.3 Parameter Estimation
8.4 The Method of Moments
8.5 The Method of Maximum Likelihood

8.6 The Bayesian Approach to Parameter Estimation
8.7 Efficiency and the Cramér-Rao Lower Bound
8.8 Sufficiency

- Chapter 9: Testing Hypotheses and Assessing Goodness of Fit

9.1 Introduction
9.2 The Neyman-Pearson Paradigm
9.3 The Duality of Confidence Intervals and Hypothesis Tests

(If time permits)
9.4 Generalized Likelihood Ratio Tests
9.5 Likelihood Ratio Tests for the Multinomial Distribution
9.8 Probability Plots
9.9 Tests for Normality

The material in this syllabus may be changed at the instructor's discretion. Any changes will be communicated to the students.