COURSE SYLLABUS

Course Title: **Computational Probability Theory**

Abbreviated Title As Appears on Transcript: `Comp Probability Theory`

Course Number: DMAT 311

Credit Hours: 3 credits [semester credit hours]

Course Description: A first course in calculus-based statistics and probability with emphasis on computational software techniques, geometrical analysis, and numerical processes applications. Topics include Monte-Carlo method, measurements of probability, distributions, applications to data analysis, discrete and random variables, conditional and joint probability concepts, Central Limit Theorem, correlation and regression, confidence intervals.

Prerequisite: Successful completion (C- or higher) of Calculus II or equivalent, or consent of instructor.

Course Workload: 3 semester credit hours • 3 student work hours per credit hour • 14 week Carnegie semester = 126 hours student course workload average

Examination Requirements: Proctored written final examination must be passed at 60% or higher to earn passing grade in course. "B" and "A" grade paths have additional examinations.
See https://www.distancecalculus.com/grades/ for more information.

Course Professor: Robert R. Curtis, Ph.D.<rcurtis@rwu.edu>, <robert@distancecalculus.com>

University Information: Roger Williams University, University College, 1 Empire Plaza, Providence, RI, USA 02903. Roger Williams University, 1 Old Ferry Road, Bristol, RI 02809.
Accredited by New England Commission of Higher Education (NECHE).
See https://www.rwu.edu/academics/accreditation/ for more information.

E-Textbook: *Probability, Statistics & Mathematica* by Davis/Porta/Uhl

Mathematical Software: Mathematica™ Computer Algebra & Graphing System

ADA ACCOMMODATIONS

Roger Williams University has a continuing commitment to providing reasonable accommodations for students with documented disabilities. Students with disabilities who need accommodations in order to fully participate in this class are urged to contact Student Accessibility Services, as soon as possible, to explore the arrangements needed to be made to assure access. Student Accessibility Services is open Monday

through Friday from 8:00AM to 5:00PM Eastern Time; Email: sas@rwu.edu or Voice: 401-254-3841. For more information about SAS, visit https://www.rwu.edu/undergraduate/academics/student-academic-success/student-accessibility-services-sas

Learning Outcomes for DMAT 311 - Computational Probability Theory

1. To understand the core concepts of Probability, Sampling, Distributions, and Density
2. To understand and compute Monte-Carlo method for integration
3. To understand and compute Expected Value, Variance, Mean, Mode, Median
4. To understand and compute Probability and Conditional Probability
5. To understand and compute Markov's and Chebyshev's Theorems
6. To understand and compute normally and exponentially distributions
7. To understand and compute calculus-based formulas and relationships between Cumulative Distribution Functions and Probability Density Functions
8. To understand and compute the Central Limit Theorem
9. To understand the core concepts of discrete and random variables
9. To understand and compute Joint Distributions, Correlations, and Covariance
10. To understand the Law of Total Probability
11. To understand and compute the classic statistics measures of Confidence Intervals and Hypothesis testing.

Syllabus Topics Outline for DMAT 311 - Computational Probability Theory

1. Getting Started
   - 1.1. Email and Chat
   - 1.2. Learning About the Course
   - 1.3. Required Hardware
   - 1.4. Software Fundamentals

2. Simulations
   - 2.1. Uniform Distributions
   - 2.2. Monte Carlo Methods
   - 2.3. Random Walks
   - 2.4. Shooting craps; Iterated Fractals.

3. Data Analysis
   - 3.1. Frequency
   - 3.2. Expected Value
   - 3.3. Cumulative Distributions
   - 3.4. Variance
   - 3.5. Histograms
   - 3.6. Related formulas for Expected Values and Variance

4. Probabilities
   - 4.1. Calculating Probability
   - 4.2. Union and Intersection and Probability
   - 4.3. Conditional Probability Formula

- 4.4. Independence
- 4.5. Indicator functions

5. More Data Analysis
   - 5.1. Markov's Inequality
   - 5.2. Chebyshev's Theorem
   - 5.3. Laws of Large Numbers
   - 5.4. One-Sided Chebyshev Theorem

6. Normal and Exponential Distributions
   - 6.1. Approximately Normally Distributed Sets
   - 6.2. Normal Distribution
   - 6.3. Approximately Exponentially Distributed Sets
   - 6.4. Exponential Distribution
   - 6.5. Memoryless Property of Exponential Distributions

7. Random Variables
   - 7.1. "Random Variables"
   - 7.2. Discrete Random Variables
   - 7.3. Continuous Random Variables
   - 7.4. Probability Density Functions
   - 7.5. Cumulative Distribution Functions
   - 7.6. Expected Values and Variance
   - 7.7. Markov, Chebyshev, and Law of Large Numbers Revisited
   - 7.8. Mean, Median, and Mode

8. Joint Distributions
   - 8.1. Joint Probability Calculations
   - 8.2. Discrete & Continuous
   - 8.3. Expected Values, Covariance, and Correlation.
   - 8.4. Conditional Probability Calculations
   - 8.5. Conditional Expectations
   - 8.6. The Law of Total Probability

9. Central Limit Theorem
   - 9.1. Generating Functions for Discrete Random Variables
   - 9.2. Generating Functions for Continuous Random Variables
   - 9.3. Generating Functions and Independence
   - 9.4. Central Limit Theorem
   - 9.5. Chi-squared and Gamma random variables

10. Classic Statistics
    - 10.1 Sampling
    - 10.2. Confidence Intervals

10.3. Hypothesis testing