

CE 5315 Probabilistic Methods for Civil Engineers

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PURPOSE

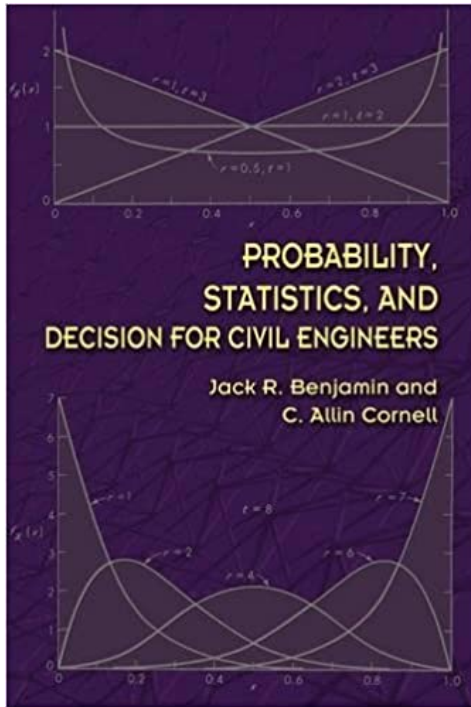
The purpose of this early graduate level class is to provide students with a strong background in probability and statistics and illustrate how concepts from these fields can be applied to solve civil engineering problems. Students will be exposed to many civil engineering datasets and a variety of probability based methods useful for civil engineers. Students will also achieve proficiency with the versatile R statistical and programming language for performing probabilistic analysis.

OBJECTIVES

Civil engineering students take an undergraduate level course in statistics but seldom use it extensively in other courses. The objective of this course is to take an in-depth look at probabilistic methods and illustrate their utility in civil engineering. A solid foundation in probabilistic methods is important to understand and properly apply newer machine learning methods and also imperative to evaluate risks and reliability, vulnerability and resilience of civil infrastructure, policies, practices and standard procedures

Assessment Methods

Assessment Method	Weightage	Remarks
Assignments	60%	5 -6 Assignments over a semester
Term Project	30%	Reproduce research from a journal paper
Journal Critique	10%	Review and critique of a recently published journal article



[Recommended Textbook:](#)

Benjamin JR, Cornell CA. Probability, statistics, and decision for civil engineers. (2014); Dover Publications Inc., Mineola, NY; ISBN: 978-0-486-78072-6

[Additional Resources:](#)

Lecture Notes (slides) and Videos will be provided as appropriate through TTU Blackboard LMS or other avenues as appropriate. These will be discussed by the instructor in the class.

[Additional Readings:](#)

Additional journal articles and computer software and data manuals will be required. Students are required to find this material online or in the library as necessary.

[Programming and Modeling Prerequisites:](#)

The course is mathematically-oriented and will require developing scripts (short computer programs) using R statistical and programming environment. No prior experience with R is necessary, some familiarity with programming concepts covered in CE 1315 - Introduction to Engineering is desirable.

[Technical Background:](#)

I expect you to have working knowledge of linear algebra and calculus (through ordinary differential equations), basic understanding and knowledge of the fundamental principles covered in university physics and undergraduate civil engineering classes is assumed to follow the illustrative applications presented in the class.

[Software and Hardware Requirements:](#)

A laptop capable of performing advanced data analysis. Please see - <https://www.depts.ttu.edu/coe/dean/engineeringitservices/buyingtherightcomputer.php> for some recommended guidelines from the WCOE. A high-speed internet connection suitable for connecting to the class online and ability to download videos and other materials posted online. R programming environment (R and R Studio); Office productivity software - MS EXCEL, MS Word, MS Power Point or equivalent. Please have sufficient hard-disk memory on your machine or on an external hard-drive. TTU provides cloud storage on one-drive which can be used to store and backup your class materials.

Tentative Outline

Week	Topic
Week 1	Course outline; Introduction to R programming Environment
Week 2	Random Events - Basic Concepts of Probability
Week 3	Random Events - Conditional, Joint and Marginal Probabilities
Week 4	Probability and Set Theory; PDF and CDF
Week 5	Exploratory Data Analysis; Empirical Models; Plotting Positions
Week 6	Kernel Density Estimation (KDE) for univariate random variables
Week 7	Multivariate Probability using KDE and Plotting Positions
Week 8	Common Univariate Discrete Probability Models
Week 9	Common Univariate Continuous Distribution Models
Week 10	Statistical Moments and Expectations
Week 11	Functions of Random Variables; Monte Carlo Simulations
Week 12	Parameter Estimation - Method of Moments; Quantile Matching
Week 13	Parameter Estimation - Maximum Likelihood Estimation
Week 14	Hypothesis Testing - Bootstrap Approaches
Week 15	Multivariate Models (Copula Theory)

The instructor reserves the right to change the outline based on his assessment of class performance; changes in material and extenuating factors. Both synchronous and asynchronous modes of instruction may be used as appropriate.

[Academic misconduct](#)

Please refer to the Texas Tech University Catalog and operating policies (OP 34.12) regarding academic integrity, cheating, and plagiarism. Academic dishonesty will not be tolerated.

[Religious holidays](#)

A student who intends to observe a religious holy day (as defined by OP 34.19) should make that intention known to the instructor prior to the absence in order to receive accommodations prescribed by OP 34.19.

[Disability policy](#)

Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructor's office hours. Please note instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, you may contact the Student Disability Services office at 335 West Hall or 806-742-2405.

[Laptops/PDAs/MP3 Players/Cell Phones/etc.](#)

As a matter of common courtesy to fellow students as well as your instructor, you shall not use any unauthorized electronic device during lectures, quizzes, or examinations. Unapproved electronic devices could include but are not limited to: cell phones, PDAs, MP3 players, laptops, and non-approved calculators. You will be asked to place your electronic devices in your bag during tests. If I find a student using an unapproved electronic device during a test, quiz, or the final examination, I will award that student a grade of zero on that test, quiz, or the final examination and the student will be referred to appropriate academic disciplinary committee.

[Classroom Civility and Professionalism](#)

Engineering practice requires professional demeanor, Examples of unprofessional behavior include but not limited to: talking on the cell phone, texting during class, being on websites not related to the class, working on homework or assignments not related to the class or talking and other disruptive behavior during the class lecture. Please keep your cell phones muted during the class hours. As the class is online, please only unmute your computer to ask questions. Otherwise please mute your computer to avoid background disturbances.

[Makeup Policy for Illness and University Excused Absences:](#)

Proper documentation from the university or medical professional must be submitted to request any consideration towards time lost due to illness and other university-approved absences. No consideration will be given for other absences. Please contact me as soon as you can, so reasonable accommodations can be made. The faculty determination of the nature and extent of makeup or additional time is final.