Computing and Data Analysis for Environmental Applications

Syllabus

Course Meeting Times

Lectures: 2 sessions / week, 1.5 hours / session

Lecturer

Prof. Dennis Mc Laughlin

Prerequisites

18.01, 18.02

Description

Class periods will generally be divided into 40 minutes of lecture and 40 minutes of related hands-on computer work using laptops available in the classroom. In the beginning of the semester recitations will provide computer programming background for students without previous programming experience. Later, these recitations will be used for more in-depth virtual experiments and data analysis exercises and for discussion of homework problems.

Assignments

The class includes several homework sets and three quizzes held during the two hour recitation periods. The grade will be based 40% on homework and in-class exercises and 20% on each of the three quizzes. The lowest homework grade will not be counted. There will be no final exam.

References

The primary text is Devore, Jay L. *Probability and Statistics for Scientists and Engineers.* Duxbury Press, 2000. (Noted by D in the readings section.) Students not familiar with MATLAB® should also consider purchasing one of the many introductory texts on this programming package. A reasonable choice that is easy to read and moderately priced is Etter, D. *Introduction to MATLAB® for Engineers and Scientists.* Prentice-Hall, 1996. (Noted by E in the readings section.)

Calendar

LEC/REC #	TOPICS	KEY DATES

L1	Course Introduction Course Logistics Repeated Trials, Virtual Experiments, Probability, Statistics	
R1	Programming in MATLAB® Downloading Data, Accessing MATLAB®, MATLAB® Environment, Variables, Arrays, Scripts Plotting Data	
L2	Descriptive Statistics Histograms, Percentiles, Mean, Median, Variance, etc. Characterizing Streamflow Data	
L3	Probability Experiments, Outcomes, Sample Spaces, Events, Probability, Axioms of Probability Methods for Assigning Probabilities	PS1 Issued
R2	MATLAB® Operations Internal MATLAB® Functions. Common MATLAB® Operations, Element-wise Computations, Loops Translating Equations to Programs	
L4	Joint Probability, Independence, Repeated Trials Joint Probability, Independent Events, Repeated Trials	
L5	Combinatorial Methods Counting Rules, Combinatorial Techniques for Evaluating Probabilities. Examples	PS1 Due PS2 Issued

R3	MATLAB® Tests and Loops Relational and Logical Operations, User-defined Functions, if Tests. Virtual Experiments	
L6	Conditional Probability and Bayes Theorem Joint Probability, Conditional Probability, Prior & Posterior Probabilities, Bayes Theorem Engineering Applications	
L7	Random Variables and Probability Distributions Definition of a Random Variable Cumulative Distribution Functions, Mass and Density Functions Using Distributions to Assign Probabilities	PS2 Due PS3 Issued
R4	Virtual Experiments	
L8	Expectation, Functions of a Random Variable Expectation, Population Mean and Variance Defining and Functions of a Single Random Variable Solving Derived Distribution Problems with Stochastic Simulation	
L9	Risk Defining and Evaluating Risk Engineering Applications	PS3 Due
R5	Recitation 5 — Quiz Review	
	Quiz 1	

L10	Some Common Probability Distributions Uniform, Exponential, Normal, and Lognormal Distributions Special Properties of Normal Random Variables Fitting Distributions to Data	PS4 Issued
L11	Multivariate Probability Multiple Random Variables, Joint and Conditional Distributions, Independence, Covariance and Correlation Computing Conditional Probabilities in MATLAB®	
L12	Functions of Many Random Variables Derived distributions for multivariate problems, moments of linear functions of several random variables. Central Limit Theorem	
R6	Time Series and Central Limit Theorem	
L13	Populations and Samples Populations, random samples. Sample statistics, moments of the sample mean and variance.	PS4 Due PS5 Issued
L14	Estimation Estimating Distributional Properties, Assessing Estimation Error Comparing Alternative Estimators	
L15	Confidence Intervals Basic Concepts, Large Sample Confidence Intervals for the Population Mean Computing Large Sample Confidence Intervals	PS5 Due PS6 Issued
R7	Review	

L16	Testing Hypotheses about a Single Population Formulating Hypothesis Testing Problems, Definitions Large Sample Tests of Hypotheses about a Single Population Applications Using MATLAB®	
L17	Testing Hypotheses about Two Populations Large Sample Tests of Hypotheses about Two Populations Controlled Experiments Applications Using MATLAB®	PS6 Due
R8	Quiz Review	
	Quiz 2	
L18	Small Samples t, chi-squared and F statistics. Small sample confidence intervals and hypothesis tests. Applications using MATLAB®.	PS7 Issued
L19-L20	Analysis of Variance (ANOVA) Testing the Significance of a Single Factor, the F Test Review of Quiz 2, ANOVA examples	PS7 Due PS8 Issued
L21	Multifactor Analysis of Variance Extension of the Single-Factor Model, Significance Testing Applications on MATLAB® Examples	PS8 Due PS9 Issued

	Linear Regression	
L22	Objectives and Assumptions of Linear Regression, Estimating Regression Coefficients, Normal Equations	
	Some Typical Environmental Applications	
R11	Quiz Review	
	Analyzing Regression Results	
L23	Accuracy of Regression Estimates and Predictions, Prediction Confidence Intervals, Testing Significance	PS9 Due
	Continuation of Environmental Examples	
	Quiz 3	
	Some Practical Applications	