PROBABILITY AND STATISTICS

Ma 527

Course Description

Prefaced by a study of the foundations of probability and statistics, this course is an extension of the elements of probability and statistics introduced in an undergraduate course. Topics include: unlimited sequences, random variables, expectation, law of large numbers and generating functions. 3 credits.

Goals of the Course

1. To teach a knowledge of combinatorial reasoning.
2. To increase the student's appreciation of how combinatorial reasoning differs from other approaches to proof and problem solving.
3. To teach a knowledge of random variables that forms a basis for studying the most useful distributions.
4. To increase the student's ability to prove theorems.
5. To improve the student's ability to apply the calculus.
6. To introduce the student to common notations for summations and products.
7. To increase the student's ability to use calculators and computers.
8. To encourage the student to attack interesting problems not presented in class.
9. To encourage the student to use criteria of consistency and reasonableness in evaluating his solutions to problems.
10. To apply the knowledge of probability and random variables to sampling distributions, estimation theory, and hypothesis testing.
11. To understand the mathematical model and assumptions which underlie regression and correlation and the analysis of variance.
12. To solve problems using commonly available statistical packages.

Instructional Procedures

A. Lecture/Discussion

B. Step-by-step problem calculations with calculators or computers.
C. Cooperative assignments.
D. Student critiques of erroneous solutions.
E. Daily homework assignments

Course Content

A. Combinatorics
    1. Combinatorial methods
    2. Binomial coefficients

B. Probability
    1. Sample spaces
    2. Events
    3. Probability of an event
    4. Some rules of probability
    5. Conditional probability
    6. Independent events
    7. Bayer' Theorem

C. Probability Distributions & Probability Densities
    1. Discrete random variables and probability distributions
    2. Continuous random variables and probability density functions
    3. Multivariate distributions
    4. Marginal distributions
    5. Conditional distributions

D. Mathematical Expectation
    1. Expected value of a random variable
    2. Moments
    3. Chebyshev's Theorem
    4. Moment-generating functions
    5. Product moments
    6. Moments of linear combinations of random variables
    7. Conditional expectations

E. Special Probability Distributions
    1. Discrete uniform distribution
    2. Bernoulli distribution
    3. Binomial distribution
    4. Negative binomial & geometric distributions
    5. Multinomial distribution

F. Special Probability Densities
    1. Uniform density

2. Normal distribution
3. Normal approximation to the binomial distribution

G. Functions of Random Variables
    1. Distribution function techniques
    2. Transformation technique: one variable
    3. Transformation technique: two variables
    4. Moment-generation function technique

H. Sampling Distributions
    1. Distribution of the mean
    2. The Chi-square distribution
    3. The t distribution
    4. The F distribution
    5. The Poisson distribution

I. Point Estimation
    1. Point estimation
    2. Unbiased estimators
    3. The Method of moments
    4. The Method of maximum likelihood

J. Interval Estimations
    1. Confidence intervals for means
    2. Confidence intervals for difference in means
    3. Confidence intervals for proportions
    4. Confidence intervals for differences in proportions
    5. Confidence intervals for variances
    6. Confidence intervals for ratios of two variances

K. Hypothesis Testing Theory
    1. Testing a statistical hypothesis
    2. Losses and risks
    3. Power function of a test

L. Hypothesis Testing: Applications
    1. Tests concerning means
    2. Differences between means
    3. Tests concerning variances
    4. Tests concerning proportions
    5. Differences among K proportions
    6. r x c tables
    7. Goodness of fit

M. Regression and Correlation
    1. Linear Regression
    2. Method of least squares
    3. Normal regression analysis
    4. Normal correlation analysis
    5. Multiple Linear regression (opt)
    6. Multiple Linear regression (Matrix notation)

N. Analysis of Variance
    1. One-way anova; uses of variance
    2. Two-way analysis of variance

Evaluations methods

1. Daily homework assignments. Students are expected to do their assignments and be prepared to discuss the problems in class.
2. Special take-home problems. Problems will be counted collectively as an additional test.
3. Quizzes. Quizzes will be counted collectively as an additional test. Quizzes will be given when necessary.
4. Tests. Tests will be given every three to four weeks. The results will be discussed in class.
5. Comprehensive final exam. This will test whether the student has finally learned to do the problems which are representative of the course and to what extent he possesses these skills at the conclusion of the course.

Tests	2/3
Final Exam	1/3

* Grading procedures vary with Instructor.

Bibliography

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Weisberg, S., Applied Linear Regression, 2nd Ed., New York, N.Y., John Wiley & Sons, 1985.

Software

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