American University of Beirut

STAT 230: Introduction to Probability and Statistics

Course Summary & Objectives

Summary: Statistics is the science of extracting reliable information from empirical data. Probability Theory is the mathematics of reasoning about chance and randomness. Although these are two distinct disciplines, they are inherently intertwined. This course is an introduction to probability theory and statistics for students of engineering, computer science and natural sciences. It is calculus-based in that the students are assumed to be comfortable with the concepts and techniques of calculus such as limits, (partial) derivatives and (multiple) integration. It is also calculus-styled meaning that its emphasis is on modeling, conceptual understanding and problem solving rather than on mathematical rigor.

Tentative Course Outline:

- Basic descriptive statistics
- Mathematical language of probabilities
- Counting techniques and their applications in probability
- Dependence and conditional probabilities
- Discrete and continuous random variables; their individual and joint distributions
- Expected value and variance of random variables and their covariance and correlation
- Important classes or random variables
- Bernoulli and Poisson processes
- Law of large numbers
- Central limit theorem
- Point estimation
- Confidence intervals (classical interval estimation)
- Statistical hypothesis testing (classical significance tests)

Learning Objectives:

At the completion of the course, the students should be able to

- Correctly interpret basic summary statistics and plots;
- Correctly use and interpret the elements of probability models (e.g., sample space, outcome, event, probability, random variable, distribution, joint distribution, expected value, ...), including the correct use of terminology;
- Translate word description of random experiments/phenomena into precise mathematical models;
- Use mathematical tools (such as calculus and combinatorics) to correctly analyze mathematical models of probabilities in order to extract desired information;
- Correctly interpret the results of the analysis of the mathematical model in terms of the original random experiments/phenomena;
- Use the process of modeling, analysis, interpretation to quantitatively reason and argue about random experiments/phenomena;
- Recognize the applicability or inapplicability of the law of large numbers in real-world and mathematical settings;
- Correctly apply the central limit theorem to approximate probabilities of events when applicable;
- Distinguish between an estimator and an estimate;
- Choose appropriate point estimators for model parameters in simple cases, and identify their basic characteristics (consistency, bias, standard error, ...);
- Correctly interpret confidence intervals, and their margins of error and confidence levels;
- Find confidence intervals for parameter models in simple cases, and correctly recognize assumptions needed for their validity;
- Correctly identify the competing hypotheses in a significance test and express them in terms of the mathematical model;
- Use mathematical reasoning to quantitatively judge between competing hypotheses in a significance test in simple scenarios;
- Correctly interpret and state the result of a significance test;
- Correctly recognize different types of error in a significance test, and calculate their probabilities in simple scenarios.