



A First Course in Probability

William J. Stewart

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The primary purpose of this book is to provide an introductory text for a one semester undergraduate course in probability. The only assumed background knowledge is that of calculus, which makes it suitable, not only for those following curricula in the mathematical sciences, but also for students whose future careers lie in diverse engineering fields, biological sciences, management science, among many others. The text covers all the probability concepts that are necessary for study in these areas and does so in a clear and methodical manner. Furthermore, the pedagogic approach that is adopted in this text, together with the more than 200 examples and worked exercises that are omnipresent and whose solutions are provided in great detail, enable students returning to school, after perhaps a brief period of time in industry, to master probability theory in a relatively short period of time. In chapter 1, trails, sample spaces, events, and the three probability axioms on which all of probability is based are introduced. From these concepts, conditional probability, independent events, the law of total probability and Bayes' rule are studied. Chapter 2 introduces combinatorics --- the art of counting. Permutations, with and without replacement, are studied as are combinations, again with and without replacement. The chapter concludes with an examination of sequences of Bernoulli trials. Random variables, both discrete and continuous, are studied in Chapter 3. Probability mass, probability density and cumulative distribution functions are introduced. We also study functions of a random variable and conditioned random variables. In Chapter 4, joint probability mass functions and joint cumulative distributions are introduced This is followed by an examination of conditional distributions for both discrete and continuous random variables. The chapter ends with the introduction of convolutions and sums of random variables. Expectations and higher moments are covered in Chapter 5. After introducing the basic definitions, we consider expectations of a random variable and then the expectation of jointly distributed random variables. This leads to the concept of covariance and correlation and to conditional expectation and variance. Probability generating functions and moment generating functions are examined as are maxima and minima of sets of independent random variables. Chapter 6 deals with probability distributions for discrete random variables. It includes the discrete uniform distribution, the Bernoulli, binomial, geometric, modified geometric, and negative binomial distribution, among others. In this chapter we also introduce the Poisson process and study its relationship with other distributions and its application to arrival and departure processes. Chapter 7 is perhaps the longest chapter in the book because of the great number of continuous distributions that are studied. These include wedge and triangular distributions, the exponential, normal, gamma and beta distributions. The Weibull distribution is studied in the context of reliability modeling. And finally, particular attention is paid to phase-type distributions due to the important role they play in systems modeling. The Markov and Chebychev inequalities and the Chernoff bound are introduced and compared in Chapter 8. The weak and strong laws of large numbers and the central limit theorem, perhaps one of the most important theorems in all of probability, are also examined in this chapter. The final chapter of the book deals with the theory of Markov chains. The basic concepts of discrete and continuous-time Markov chains and their underlying equations and properties are discussed. This chapter may be omitted from undergraduate courses since it requires some minimal knowledge of linear algebra. A PDF file containing detailed solutions to all the chapter-ending exercises is available from the author (billy@ncsu.edu).

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