Preface

The main intended audience for this book is undergraduate students in pure and applied sciences, especially those in engineering. Chapters 2 to 4 cover the probability theory they generally need in their training. Although the treatment of the subject is surely sufficient for non-mathematicians, I intentionally avoided getting too much into detail. For instance, topics such as mixed type random variables and the Dirac delta function are only briefly mentioned.

Courses on probability theory are often considered difficult. However, after having taught this subject for many years, I have come to the conclusion that one of the biggest problems that the students face when they try to learn probability theory, particularly nowadays, is their deficiencies in basic differential and integral calculus. Integration by parts, for example, is often already forgotten by the students when they take a course on probability. For this reason, I have decided to write a chapter reviewing the basic elements of differential calculus. Even though this chapter might not be covered in class, the students can refer to it when needed. In this chapter, an effort was made to give the readers a good idea of the use in probability theory of the concepts they should already know.

Chapter 2 presents the main results of what is known as *elementary probability*, including Bayes' rule and elements of combinatorial analysis. Although these notions are not mathematically complicated, it is often a chapter that the students find hard to master. There is no trick other than doing a lot of exercises to become comfortable with this material.

Chapter 3 is devoted to the more technical subject of random variables. All the important models for the applications, such as the binomial and normal distributions, are introduced. In general, the students do better when examined on this subject and feel that their work is more rewarded than in the case of combinatorial analysis, in particular.

Random vectors, including the all-important central limit theorem, constitute the subject of Chapter 4. I have endeavored to present the material as simply as possible. Nevertheless, it is obvious that double integrals cannot be simpler than single integrals.

Applications of Chapters 2 to 4 are presented in Chapters 5 to 7. First, Chapter 5 is devoted to the important subject of reliability theory, which is used in most engineering disciplines, in particular in mechanical engineering. Next, the basic queueing models are studied in Chapter 6. Queueing theory is needed for many computer science engineering students, as well as for those in industrial engineering. Finally, the last application considered, in Chapter 7, is the concept of time series. Civil engineers, notably those specialized in hydrology, make use of stochastic processes of this type when they want to model various phenomena and forecast the future values of a given variable, such as the flow of a river. Time series are also widely used in economy and finance to represent the variations of certain indices.

No matter the level and the background of the students taking a course on probability theory, one thing is always true: as mentioned above, they must try to solve many exercises before they can feel that they have mastered the theory. To this end, the book contains more than 400 exercises, many of which are multiple part questions. At the end of each chapter, the reader will find some solved exercises, whose solutions can be found in Appendix C, followed by a large number of unsolved exercises. Answers to the even-numbered questions are provided in Appendix D at the end of the book. There are also many multiple choice questions, whose answers are given in Appendix E.

It is my pleasure to thank all the people I worked with over the years at the École Polytechnique de Montréal and who provided me with interesting exercises that were included in this work.

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