Preface

Scholars have tried for many years to find the meaning of Hamlet's last words "The Rest is Silence!" in Shakespeare's play. In a 2007 movie with the same title as Hamlet's famous quote, in the city of Bucharest of 1911, a 19-year old actor decides to become a film director (an utopian dream at the time), after realizing that cinema could save for eternity some of the magic captured in a theater performance. The present book has been born from the desire to give an answer to the very same question, that we face at the end of each term when we finish teaching a course. Could it be possible to save for the future generations of students some parts of the vibrant atmosphere in the classroom and make them share this incredible experience?

This manuscript has been developed from the authors' lecture notes for the course MAT 2379 "Introduction to Biostatistics" (and its former counterpart MAT 2378 "Probability and Statistics for the Natural Sciences"), that has been taught at University of Ottawa since 2003 to the present. During the years, these notes have constantly evolved and been enriched with more examples; this process will probably continue over the years to come. However, most of the examples that are included in the book are new and have not been used in the classroom before.

Unless a source of information is specified, all the examples in the book are using hypothetical data. The examples are usually based on a real-life situation, which is connected in a very simple way to the natural sciences. Computer-generated data sets have been avoided, and simulation results are not discussed.

The goal of the book is to introduce and explore the usefulness of various statistical or probabilistic methods, by means of simple and non-technical examples, allowing the reader to understand quickly the meaning of a newly
introduced concept, and apply it later in a more complex situation. Some
of the examples used in the book are drawing the attention to various
problems of today's world, related to environmental issues, climate change,
loss of biodiversity, and their impact on wildlife and humans.

The book has two parts. Part I introduces the basic concepts and rules
of probability theory, while Part II focuses on statistics. This order re-
fects the authors' philosophy that probability theory lies at the foundation
of statistics, and that it is important to understand the meaning of ran-
domness before doing any data analysis. This explains why the topic of
descriptive statistics is discussed only in Part II, and not at the beginning,
as it seems to be the common practice when teaching statistics.

In a 1914 address by Raymond Pearl to the American Statistical So-
ciety entitled “The Service and Importance of Statistics to Biology”, he
mentioned three important contributions of statistical methods to biology:
(i) to describe a group of individuals in terms of the group's own attributes
and qualities; (ii) to measure the precision of an estimate with high con-
fidence; (iii) to measure the degree of association between the variations in a
series of characters or events (see [46]). These three fundamental methods
are discussed at length in the present textbook.

Biostatistics is an interdisciplinary subject which lies at the intersec-
tion of biology and statistics, and consists in the study of quantitative or
statistical methods applied to biology. This subject has a recent history,
its origins dating back to Francis Galton, a cousin of Charles Darwin, who
was interested in the problem of heredity. He used quantitative techniques
(such as fitting a line to describe the association between two variables), to
answer biological questions.

The field of biostatistics (also known as biometrics) was born in the
late 19th century and early 20th century, mostly out of the work of Karl
Pearson (the founder of the world's first statistics department at University
College London) and Ronald Fisher (a pioneer in the field of experimental
design). Both Pearson and Fisher developed statistical methods to answer
questions from the biological sciences. In fact, the work of Gregor Mendel
went unnoticed for many years by biologists, since they were not used to
think in quantitative or statistical terms. It was Pearson and his peers that
rediscovered Mendel's work, and the laws of inheritance.

The purpose of this book is to introduce the biology students to sta-
tistical reasoning and modeling, which are of critical importance to the
foundations of modern biology.

Ottawa, February 15, 2011