Preface

This is an introductory course on loss data analysis. By that we mean the determination of the density of the probability of cumulative losses. Even though the main motivations come from applications to the insurance, banking and financial industries, the mathematical problem that we shall deal with appears in many application in engineering and natural sciences, where the appropriate name would be accumulated damage data analysis or systems reliability data analysis. Our presentation will be carried out as if the focus of our attention is operational risk analysis in the banking industry.

Introductory does not mean simple: because the nature of the problems to be treated is complicated, some sophisticated tools may be required to deal with it.

Even though the main interest, which explains the title of the book, is to develop a methodology to determine probability densities of loss distributions, the final numerical problem consists of the determination of the probability density of a positive random variable. As such, the problem appears in a large variety of fields.

For example, for the risk management of a financial institution, the nature of the problem is complicated because of the very large variety of risks present. This makes it hard to properly quantify the risks as well as to establish the cause-effect relationships that may allow preventive control of the risk or the damage the risk events may cause. For risk analysts, the complication comes from the fact that the precise attribution of losses to risk events is complicated, due to the variety and nature of the risk events.

Historically speaking, in the engineering sciences there has been a large effort directed to developing methods that can identify and manage risks and quantify the damage in risk events. In parallel, in the insurance business, a similar effort has led to a collection of techniques developed to quantify damages (or losses) for the purpose of the determination of risk premia.

In the banking and financial industries, during the last few decades, there has been a collective effort to develop a precise conceptual framework in which to characterize and quantify risk, and in particular, operational risk, which basically describes losses due to the way in which business is carried out. This was done so that banks would put money aside to cover possible operational risk losses. This has resulted in a typification of risks according to a list of business types. Such typification has resulted in systematic procedures to aggregate losses in order to compute their distribution.

Similar mathematical problems also appear in systems reliability and operations research in the insurance industries; in the problem of finding the distribution of a positive random variable describing some threshold in structural engineering; and in describing the statistics of the escape time from some domain when modeling reaction rates in physical chemistry.

In all of these problems, one eventually ends up with the need to determine a probability density from the knowledge of its Laplace transform, which may be known either analytically, as the solution of some (partial) differential equation, or numerically, as the result of some simulation process or calculated from empirical data.
The problem of inverting the Laplace transform can be transformed into a fractional moments problem on the unit interval, and we shall see that the method of maximum entropy provides an efficient and robust technique to deal with these problems. This is what this book is really about.

This volume is written with several possible classes of readers in mind. First and foremost, it is written for applied mathematicians that need to address the problem of inverting the Laplace transform of probability density (or of a positive function). The methodology that we present is rather effective. Additionally, with the banking and insurance industries in mind, risk managers should be aware of the potential and effectiveness of this methodology for the determination of risk capital and the computation of premia.

To conclude, we mention that all numerical examples were produced using R.

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