Preface

The field of extremes, maxima and minima of random variables, has attracted the attention of engineers, scientists, probabilists, and statisticians for many years. The fact that engineering works need to be designed for extreme conditions forces one to pay special attention to singular values more than to regular (or mean) values. The statistical theory for dealing with mean values is very different from that required for extremes, so that one cannot solve the above indicated problems without a knowledge of statistical theory for extremes.

In 1988, the first author published the book *Extreme Value Theory in Engineering* (Academic Press), after spending a sabbatical year at Temple University with Prof. Janos Galambos. This book had an intentional practical orientation, though some lemmas, theorems, and corollaries made life a little difficult for practicing engineers, and a need arose to make the theoretical discoveries accessible to practitioners. Today, many years later, important new material have become available. Consequently, we decided to write a book which is more practically oriented than the previous one and intended for engineers, mathematicians, statisticians, and scientists in general who wish to learn about extreme values and use that knowledge to solve practical problems in their own fields.

The book is structured in five parts. Part I is an introduction to the problem of extremes and includes the description of a wide variety of engineering problems where extreme value theory is of direct importance. These applications include ocean, structural and hydraulics engineering, meteorology, and the study of material strength, traffic, corrosion, pollution, and so on. It also includes descriptions of the sets of data that are used as examples and/or exercises in the subsequent chapters of the book.

Part II is devoted to a description of the probabilistic models that are useful in extreme value problems. They include discrete, continuous, univariate, and multivariate models. Some examples relevant to extremes are given to illustrate the concepts and the presented models.

Part III is dedicated to model estimation, selection, and validation. Though this topic is valid to general statistics, some special methods are given for extremes. The main tools for model selection and validation are probability paper plots (P-P and Q-Q plots), which are described in detail and are illustrated with a wide selection of examples.

Part IV deals with models for order statistics and extremes. Important concepts such as order statistics, return period, exceedances, and shortfalls are

explained. Detailed derivations of the exact distributions of these statistics are presented and illustrated by many examples and graphs. One chapter is dedicated to point processes and exact models, where the reader can discover some important ways of modeling engineering problems. Applications of these models are also illustrated by some examples.

Part V is devoted to the important problem of asymptotic models, which are among the most common models in practice. The limit distributions of maxima, minima, and other order statistics of different types, for the cases of independent as well as dependent observations are presented. The important cases of exceedances and shortfalls are treated in a separate chapter, where the prominent generalized Pareto model is discussed. Finally, the multivariate case is analyzed in the last chapter of the book.

In addition to the theory and methods described in this book, we strongly feel that it is also important for readers to have access to a package of computer programs that will enable them to apply all these methods in practice. Though not part of this book, it is our intention to prepare such a package and make it available to the readers at: http://personales.unican.es/castie/extremes. This will assist the readers to (a) apply the methods presented in this book to problems in their own fields, (b) solve some of the exercises that require computations, and (c) reproduce and/or augment the examples included in this book, and possibly even correct some errors that may have occurred in our calculations for these examples. The computer programs will include a wide collection of univariate and multivariate methods such as:

1. Plots of all types (probability papers, P-P and Q-Q plots, plots of order statistics).
2. Determination of domains of attraction based on probability papers, the curvature method, the characterization theorem, etc.
3. Estimation of the parameters and quantiles of the generalized extreme value and generalized Pareto distributions by various methods such as the maximum likelihood, the elemental percentile method, the probability weighted moments, and the least squares.
4. Estimation and plot of multivariate models.
5. Tests of hypotheses.

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Enrique Castillo
Ali S. Hadi
N. Balakrishnan
Jose M. Sarabia

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