PRESENTACIÓN / PREFACE

A new, extremely powerful paradigm to analyse the results of scientific experimentation, which is firmly based on axiomatic foundations, is gradually substituting the traditional recipe-based techniques which have been dominant in statistical inference for most of this century. The new paradigm, usually referred to as the *Bayesian* methodology, uses a probability concept which closely matches that used in ordinary language, directly solves the more relevant scientific questions on data analysis, and may be applied to complex, richly structured problems, fairly inaccesible to traditional statistical methods.

Conscious of the relevance of Bayesian statistical methods to modern analysis of scientific data, the Spanish Royal Academy of Sciences decided to devote a special issue of its journal, *Revista de la Real Academia de Ciencias*, entirely to *Bayesian Methods in the Sciences* and asked me to act as Invited Editor. The result is in your hands.

This volume contains thirteen invited papers from authors in seven countries. These papers include discussions on foundational issues, statistical methods, applications and software from a Bayesian perspective.

Foundational questions relating to scientific hypothesis testing are addressed by **Brewer**, who proposes an alternative to conventional Bayes factors, **De la Horra and Rodríguez-Bernal**, who discuss a Bayesian alternative to frequentist p-values, and by **Girón, Martínez and Parrado** who propose a predictive approach to hypothesis testing.

The choice of prior distributions is fundamental in Bayesian statistics; **D'Agostini** discusses options for the choice of the prior from the viewpoint of an experienced scientist.

Exponential families are known to include all probability models which admit a sufficient statistic of fixed dimension; **Gutiérrez-Peña and Mendoza** obtain new properties of the Bayes estimates within regular exponential families. The problem of data reduction when no such sufficient statistic exists is addressed by **Wolf and George** through the introduction of maximally informative statistics.

Several authors propose advances on Bayesian methods which may be specially suited to the analysis of experimental results. Motivated by the scientific need to replicate published experimental results, **Bayarri and Mayoral** show how graphical models can be used to simplify the analysis of hierarchical models. As a general method for prediction of future observations, **Bernardo** describes the construction of model-free objective predictive distributions. To address the problem posed by non-linear scale transformations, **Farrow** discusses an extension of Bayes linear networks. Data heterogeneity, either due to the presence of outliers or to the existence of different sources, is known to increase uncertainty; **Justel and Peña** propose a procedure to measure this effect.

Some contributions contain a Bayesian analysis of concrete scientific problems. To forecast floods, thus making possible preventive actions, **Sánchez-Manzano, Gómez-Villegas and Manzano** develop a specific linear dynamic model. Motivated by problems in infrared spectroscopy, **Fearn, Brown and Haque** address the problem of probabilistic classification using a Bayesian form of logistic regression.

Bayesian computation often requires sophisticated integration procedures. **Toivonen, Mannila, Heikki, Salmenkivi and Laakso** describe `Bassist`, a piece of computer software specially designed to implement the simulations required by the modern integration methods based on the use of Markov chain Monte Carlo techniques.

We would like to thank Leticia de las Heras for her work in the preparation of this volume, and we are most grateful to the Spanish *Real Academia de Ciencias* for this opportunity to provide information on Bayesian methodology to the scientific community.

Valencia, March 2000
José-Miguel Bernardo

REVISTA
DE LA
REAL ACADEMIA DE CIENCIAS
EXACTAS, FÍSICAS Y NATURALES
(ESPAÑA)

Volumen 93 · NÚMERO 3 · AÑO 1999

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MONOGRÁFICO: MÉTODOS BAYESIANOS EN LAS CIENCIAS
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