

Preface to the Second Edition

This edition adds a considerable amount of new information on recent change point research results. In light of numerous book reviews of the first edition of this monograph and favorable comments that we have received from researchers during the last ten years, we have added many new results and applications of change point analysis throughout this new edition.

The main additions consist of (i) two new sections of applications of the underlying change point models in analyzing the array Comparative Genomic Hybridization (aCGH) data for DNA copy number changes in Chapter 2, (ii) a new Chapter 7 (the original Chapter 7 becomes Chapter 8 in this edition) on change points in hazard functions, (iii) a new Chapter 9 on other practical change point models such as the epidemic change point model and a smooth-and-abrupt change point model, and (iv) a number of examples of applications throughout the other chapters.

Change point analysis has been an active research area since its inauguration in the early 1950s. The authors acknowledge that there are many other works and several approaches in change point analysis that are important but not included in this monograph due to the approaches that the authors have chosen to present here. One of the primary goals of this edition is to present readers and practitioners with a systematic way of detecting change points in the particular models demonstrated in this book.

The first author started to branch out her statistical research to the analysis of high throughput data resulting from biomedical and life science research in 2003. Since then, she has actively collaborated with many scientists on modeling gene expression data, for example, resulting from blood stem-cell study and somitogenesis study. She and her collaborators envisioned the problem of modeling array data resulting from DNA copy number studies as a change point problem in the mean and variance parameters of a sequence of normal random variables, and started modeling such DNA copy number experimental data with her medical collaborators in 2006. After her many years of experience in modeling biomedical data, she is keen to add such exciting applications of change point analysis to the DNA copy number data

to this volume. Meanwhile, the second author and his collaborators have studied several other change point models, especially the epidemic change point model, and this work is also added to this volume. In the context of the above-mentioned new work, the two authors were thus motivated to write this new edition, emphasizing those change point models that have major applications in modeling biomedical research data.

Every attempt was made to correct various misprints and errors from the first edition. The authors are indebted to the many readers who communicated their findings of some of these errata. Special thanks are due to Mr. Paul Plummer, one of the doctoral students of the first author, for carefully reading the first edition and noting many of the misprints and errors; to Miss Xue Bai, one of the graduate research assistants of the first author, for obtaining the computational and graphical results using the R-package called DNACopy on the example presented in Section 2.1 of Chapter 2 and in Chapter 9; and to Dr. Fanglong Dong for proofreading this volume. The authors would like to thank Richard Scheines and Changwon Yoo for noting some misprints in Chapter 4 of the first edition, as well as Dr. Asoka Ramanayake for her help with Chapter 9 of this edition. Finally, the authors would also like to thank Professor Jiahua Chen for many conversations on various occasions regarding change point analysis and its applications.

The first author would like to especially thank her husband, Dr. Ke Xia, for his encouragement and support during the process of writing this second edition, and she would also like to thank her two daughters, Rowena and Gracelynn, who were patient and cooperative when their mother was busy writing this book and unable to play with them during their spare time. The second author would like to thank his wife Meera and his daughters, Alka, Mita, and Nisha for their support.

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Preface to the First Edition

Recently there has been a keen interest in the statistical analysis of change point detection and estimation. Mainly, it is because change point problems can be encountered in many disciplines such as economics, finance, medicine, psychology, geology, literature, and so on, and even in our daily lives. From the statistical point of view, a change point is a place or time point such that the observations follow one distribution up to that point and follow another distribution after that point. Multiple change points problems can also be defined similarly. So, the change point(s) problem is twofold: one is to decide if there is any change (often viewed as an hypothesis testing problem), and another is to locate the change point when there is a change present (often viewed as an estimation problem).

The earliest change point study can be traced back to the 1950s. During the following period of forty-some years, numerous articles have been published in various journals and proceedings. Many of them cover the topic of single change point in the means of a sequence of independently normally distributed random variables. Another popularly covered topic is a change point in regression models such as linear regression and autoregression. The methods used are mainly likelihood ratio, nonparametric, and Bayesian. A few authors also considered the change point problem in other model settings such as gamma and exponential.

It is impossible to discuss and include all relevant change point(s) problems in a one-volume work. In this monograph, therefore, only the most important results in change point(s) analysis have been collected and new interesting results have been added. In other words, this volume is an in-depth study of the change point problem in general, and is also a detailed exposure of change point analysis of the most commonly used statistical models. There are seven chapters devoted to different aspects/models. Multivariate normal models and univariate normal models are discussed in much detail about change point(s) in mean vectors (means), covariance matrices (variances), or in mean vectors and covariance matrices (means and variances). Regression, gamma, exponential, and discrete models are also discussed for change

point(s) analysis. The methodologies involved are mainly (classical) likelihood ratio, Bayesian, and information criterion approaches. Some other methods are also discussed. An annotated bibliography is given at the end of this volume.

This research monograph should appeal to theoretical as well as applied statisticians. It should also appeal to economists, quality control managers, or graduate students who are interested in change point(s), or any other investigators who might encounter the change point problem. It can be used as a reference book concerning different aspects of change point problems.

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