INTRODUCTION

With the rapid advancement in modern technology, more and more data are being collected over time on the same individual (i.e., subject, animal, sample), and there is a greater need for statisticians to analyze such data. While this type of data are common in nearly all fields, they are termed differently, with *longitudinal data* being the preferred term in health and social sciences and *functional data* being the preferred term in engineering and physical sciences. Longitudinal data analysis (LDA) and functional data analysis (FDA) techniques are also intrinsically different.

Longitudinal data, as observed in biomedical follow-up studies or panel studies in the social sciences, often involve small numbers of repeated measurements per subject taken intermittently at different time points for different subjects. Functional data, in contrast, are often recorded by an instrument, and tend to involve a large number of repeated measurements per subject. Furthermore, these measurements may be recorded at the same time points and with the same frequencies.

Perhaps due to these structural differences, the approaches to analyze those data are also traditionally quite distinct. Longitudinal data observed for a subject are often viewed as a random vector (with possibly varying dimensions across subjects) in a parametric model, where random effects are often used to represent the within subject correlations. Functional data, in contrast, are usually treated as observations of a smooth random process observed at discrete time points with few model structural assumptions, leading to nonparametric or semiparametric modeling approaches. Moreover, LDA often involves quite a number of covariates, whereas this is not the case in traditional FDA. Another difference, corresponding to differences in the nature of the questions that are being addressed, is that LDA approaches focus usually on means, and the covariance structure is treated as a nuisance parameter, while FDA approaches focus on the covariance structure.

A 2002 Joint Summer Research Conference, co-sponsored by the American Mathematical Society (AMS), the Institute of Mathematical Statistics (IMS) and the Society of Industrial and Applied Mathematics (SIAM), on "Emerging Issues in Longitudinal Analysis" successfully provided a platform for researchers from both fields to merge ideas and to learn from each other. This special issue is inspired by that experience, and summarizes some of the results presented at the conference, or related results. We felt that it is timely to publish such a special issue to explore some of the emerging issues in longitudinal analysis. Overall, it is hoped that this issue, like the conference itself, will provide a unique

opportunity for researchers to be exposed to new ideas from different, but related, areas, stimulating new advances and new collaborations.

Four emerging areas are included in this issue. They are: *nonparametric and semiparametric regression, joint modeling of longitudinal and survival data, missing data* and *causal inference.* All are of substantial importance in biological, biomedical, environmental, and engineering studies. These four areas have enjoyed some significant developments in the past several years. There remain numerous open questions that are subject to debate and controversy. Although the approaches and emphases may be different in each area, they share many related features. Round table discussions were held at the 2002 Joint AMS-IMS-SIAM Summer Research Conference to provide a forum for researchers in each of the four areas to debate the merits of various approaches and exploit insights from other areas to stimulate new ideas for addressing controversial issues. Summaries of the discussions, with post-conference inputs from some of the researchers, are reported at the beginning of this issue with the hope to generate additional thoughts and research.

There were five keynote presentations given by Raymond Carroll, Rod Little, John Rice, James Robins and Butch Tsiatis. Papers related to these presentations are included herein. Altogether, there are eighteen papers in this issue. We thank all the contributors of this special issue and the conference participants for this brainstorming experience.

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