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Introductory Remarks

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Introductory remarks

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Current research on statistical topics spans a wide range of ideas and fields of application. Much is connected with the systematic theory of methods for the analysis of empirical data, especially for situations, common in many areas of science and technology, where the random or haphazard element in the data is too strong to be ignored. Modern computer technology is important in enabling large amounts of data to be explored quickly and efficiently, in allowing methods involving iterative calculations to be handled as a matter of routine and in facilitating display of the results of analysis via sophisticated graphical devices. This has allowed both the development of new methods and also the application of ideas long known in principle but until relatively recently too complicated for other than occasional use. Some of the key ideas involved go back in essence to the 19th century, for example to Gauss, and others are more strongly associated with the first half of the 20th century, in particular to the pioneering work of R. A. Fisher, although many of the detailed developments are, of course, much more recent.

In a further band of applications the complex structure and large extent of the data are of the essence rather than an incidental complication. In 1986 the Science and Engineering Research Council recognized the existence of these newer kinds of application by launching an Initiative under the name Complex Stochastic Systems.

The papers that follow represent a fairly small part of the work supported under that Initiative.

F. P. Kelly develops some of the elegant probability theory required for studying the properties and control of large networks. The immediate application is to telecommunication systems but the implications are broader, both in an engineering and an economic context, for example. Image analysis yields many important instances of complex stochastic systems. Major progress has of course been possible by relatively informal methods. The challenge to a more formal statistical approach is to provide methods both based on a stochastic model for the true 'scene' under study and at the same time computationally feasible. The papers of W. Qian & D. M. Titterington and R. J. Aykroyd & P. J. Green provide examples of this line of work and illustrate some of the areas of application that benefit from the new methods.

A major source of the 'complexity' of the above topics is the need to reflect lack of independence in some relevant sense. This feature is also present in the study of expert systems and the paper by D. J. Spiegelhalter, A. P. Dawid, T. A. Hutchinson & R. G. Cowell provides and illustrates a probabilistic approach to this important topic.

Modern instrumentation frequently yields automatically large amounts of multidimensional data and the calibration and reduction of such data raises special

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problems, some aspects of which are addressed by P. J. Brown, C. H. Spiegelman and M. C. Denham.

Many complex stochastic systems require for their numerical study the evaluation of high-dimensional multiple integrals and techniques for this are discussed by A. F. M. Smith.

Other kinds of complex stochastic system not represented in the present issue include neural nets, (chaotic) nonlinear time series, aspects of signal processing and the mathematical modelling of population genetics.

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