

JAMES C. SPALL

GUEST EDITOR'S INTRODUCTION

Data. Understanding. These words represent the cornerstone of much of the scientific process.

The field of statistics is devoted to providing the link between data and understanding. As such, modern statistical methods have been used in every conceivable branch of engineering and the physical and social sciences to draw objective conclusions about different types of processes.

The language of statistics is, largely, mathematics. Virtually all statistical methods (including those in the theme articles of this issue) are based on manipulating data via mathematical formulas. Perhaps because of this mathematical orientation, statistics has acquired the reputation of being a dry and difficult subject. In college, we probably all knew students who approached their required course in statistics with dread and did all they could to postpone or avoid the course. Such an attitude is unfortunate, for our world is inherently random—either because systems can never be fully explained (e.g., local weather systems or an individual's behavior) or because systems are sufficiently complicated that we model them as random (e.g., the tossing of a coin). The field of statistics provides the formal methods for coping with such randomness when attempting to understand a system. As a golfer, I recall that when I took my first course in statistics as an undergraduate, I was excited by the idea that I could use some of what I learned to test different brands of golf balls objectively despite the confusing claims of the various manufacturers (not to mention the amount of randomness in my test shots!). Others who found the subject interesting no doubt had their own motivations.

Still, many remain suspicious of the field. Countless examples of flawed statistical results are citable, including misleading cause and effect statements in a medical context (often as a result of confusing correlation with causation) or embarrassingly wrong election or economic forecasts. (Such flawed results can almost always be traced to incorrect assumptions or faulty methods.) For every such example, however, many instances exist of statistics allowing an analyst to make meaningful inferences in the face of confusing data. These instances range from relatively minor applications, such as debunking claims of paranormal phenomena, to more serious problems, such as verifying Einstein's Theory of

Relativity or establishing the efficacy of the drug AZT in alleviating the symptoms of AIDS.

At APL, statistical techniques have been employed in a wide range of Navy and other programs, as shown in the six theme articles of this issue. The first article, by Forest C. Deal, Jr., illustrates the use of statistical entropy (which is loosely related to thermodynamic entropy) in helping a ship captain know what types of aircraft or ships are nearby and where they are located. Larrie V. Hutton, in the second article, considers how neural networks can be used as a statistical tool in classification problems such as target recognition. The third and fourth articles, whose principal authors are Larry J. Levy and John L. Maryak, respectively, consider a widely used type of mathematical model for dynamic systems, the state-space model. Both of these articles describe broadly applicable techniques for building and analyzing such models. In the fifth article, Syed W. Ali gives an overview of some of APL's efforts in an area that is receiving much media attention—statistical quality control. Jacqueline K. Telford, in the final theme article, describes several procedures for determining how many tests are needed to draw valid conclusions about the reliability of devices.

The theme articles share the characteristic that the techniques developed can be applied to problems other than those in which the authors may have been most interested. Perhaps you, the reader, will determine that one of the procedures presented may help you to make the transition from data to understanding in a different type of problem.

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