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Stochastic Convergence and Probability Inequalities 6. Asymptotic Behavior of Estimators and Tests 8. Categorical Data Models 9. Weak Convergence and Gaussian Processes This is even more evident today, when massive datasets with an impressive amount of details are produced in novel field such as genomics or bioinformatics at large. Because, in such a context, exact statistical inference may be computationally out of reach and in many cases not even mathematically tractable, they have to rely on approximate results. Traditionally, the justificatio for these approximations was based on the convergence of the firs four moments of the distributions of the statistics under investigation to those of some normal distribution. Today we know that such an approach is not always theoretically adequate and that a somewhat more sophisticated set of techniques based on asymptotic considerations may provide the appropriate justification This need for more profound mathematical theory in statistical large-sample theory is patent in areas involving dependent sequences of observations, such as longitudinal and survival data or life tables, in which the use of martingale or related structures has distinct advantages. Unfortunately, most of the technical background for understanding such methods is dealt with in specifi articles or textbooks written for a readership with such a high level of mathematical knowledge that they exclude a great portion of the potential users. We tried to bridge this gap in a previous text Sen and Singer []: Large Sample Methods in Statistics: An Introduction with Applications , on which our new enterprise is based. While realizing that the foundations of the large-sample statistical methods we proposed to address stem from the basic concepts and principles that underlie finit sample setups, we decided to integrate both approaches in the present text. In summary, our intent is to provide a broad view of finite-sampl statistical methods, to examine their merits and caveats, and to judge how far asymptotic results eliminate some of the detected impasses, providing the basis for sound application of approximate statistical inference in large samples. Chapter 1 describes the type of problems considered in the text along with a brief summary of some basic mathematical and statistical concepts required for a good understanding of the remaining chapters. Chapters 2 and 3 lay out the two basic building blocks of statistical inference, namely, estimation and hypothesis testing. There we address issues relating to the important concepts of likelihood, sufficien y, and invariance, among others. Chapter 5 is devoted to stochastic processes, given their importance in the development of models for dependent random variables as well as their significanc as paradigms for many problems arising in practical applications. Chapters 6 and 7 contain the essential tools needed to prove asymptotic results for independent sequences of random variables as well as an outline of the possible extensions to cover the dependent sequence case. Chapter 8 discusses some general results on the asymptotics of estimators and test statistics; their actual application to categorical data and regression analysis is illustrated in Chapters 9 and 10, respectively. Finally, Chapter 11 deals with an introductory exposition of the technical background required to deal with the asymptotic theory for statistical functionals. The objective here is to provide some motivation and the general fl vor of the problems in this area, because a rigorous treatment would require a much higher level of mathematical background than the one we contemplate. The 11 chapters were initially conceived for a two-semester course for second-year students in biostatistics or applied statistics doctoral programs as well as for last-year undergraduate or first-yea graduate students in statistics. A more realistic view, however, would restrict the material for such purposes to the firs eight chapters, along with a glimpse into Chapter Chapters 9 and 10 could be included as supplementary material in categorical data and linear models courses, respectively. Because the text includes a number of practical examples, it may be useful as a reference text for investigators in many areas requiring the use of statistics. Finally, we must acknowledge the Cary C. In this context, statistical inference relates to the process of drawing conclusions about the unknown frequency distribution or some summary measure

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therefrom of some characteristic of a population based on a known subset thereof the sample data, or, for short, the sample. Drawing statistical conclusions involves the choice of suitable models that allow for random errors, and this, in turn, calls for convenient probability laws. It also involves the ascertainment of how appropriate a postulated probability model is for the genesis of a given dataset, and of how adequate the sample size is to maintain incorrect conclusions within acceptable limits. As such, finit methodology has experienced continuous upgrading with annexation of novel concepts and approaches. Bayesian methods are especially noteworthy in this respect. Nevertheless, it has been thoroughly assessed that the scope of exact statistical inference in an optimal or, at least, desirable way, is rather confine to some special classes of probability laws such as the exponential family of densities. In real-life applications, such optimal statistical inference tools often stumble into impasses, ranging from validity to effica y and thus, have practical drawbacks. This is particularly the case with large datasets, which are encountered in diverse and often interdisciplinary studies, more so now than in the past. Such studies, which include biostatistical, environmetrical, socioeconometrical, and more notably bioinformatical genomic problems, in general, cater to statistical reasoning beyond that required by conventional finite-sampl laboratory studies. Although this methodology may yet have an appeal in broader interdisciplinary fields some extensions are needed to capture the underlying stochastics in large datasets and thereby draw statistical conclusions in a valid and efficien manner. The genesis of asymptotic methods lies in this infrastructure of finite-sampl statistical inference. Therefore it is convenient to organize our presentation of asymptotic statistical methods with due emphasis on this finite to large-sample bridge. To follow this logically integrated approach to statistical inference, it is essential to encompass basic tools in probability theory and stochastic processes. In addition, the scope of applications to a broad domain of biomedical, clinical, and public health disciplines may dictate additional features of the underlying statistical methodology. We keep this dual objective of developing methodology with an application-oriented spirit in mind and 1 2 Motivation and Basic Tools thereby provide an overview of finite-sampl exact or small statistical methods, appraising their scope and integration to asymptotic approximate or large-sample inference. We propose some simple statistical models for such problems, describe their finite-sampl analysis perspectives, and, with this in mind, stress the need for asymptotic methods. We conclude with a summary of some basic tools needed throughout the text. In this process, we are faced with models that may have different degrees of complexity and, depending on regularity assumptions, different degrees of restrictiveness. They dictate the complexity of the statistical tools required for inference which, in many instances, call for asymptotic perspectives because conventional finite-sampl methods may be inappropriate. Let us firs appraise this scenario of statistical models through some illustrative examples. Suppose that we are interested in selecting a random sample to estimate the proportion of defective items manufactured in a textile plant. The data consist of the number x of defective items in a random sample of size n. For a random variable X representing the number of defective items in the sample, four possible stochastic models follow. Let Y denote the height of a randomly selected individual and F denote the underlying distribution function. In such a context, three alternative stochastic models include the following: This is, perhaps, a more realistic model, because, in practice, we are only capable of coding the height measurements to a certain degree of accuracy e. In this case, using a multinomial distribution with ordered categories would be appropriate. Our objective is to verify whether the level xi has some influenc on the expected life of the lamps. As in Example 1. We consider a study designed to evaluate the association between the level of fat ingestion X on weight Y of children in a certain age group. Under this model, X is, in general, assumed fi ed and known without error. Again, many assumptions about the stochastic features of the model may be considered. This is the error in variables simple linear regression model. This is referred to as a measurement-error model [Fuller]. We suppose that in a study similar to that described in Example 1. Because the same response Y is observed two or more times on the same subject, this type of data is generally referred to as repeated measures. Some possible assumptions for the stochastic components of the model follow: In the study described in Example 1. This is a special case of repeated measures data where the

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repeated observations are taken sequentially along an ordered dimension time. To express the variation of Y with X, taking time into consideration, a useful model is the random coefficient model: Again, we may consider different assumptions for the stochastic components of the model. Furthermore, eij is independent of ai , bi. Because given ai , bi , the Yij are independent, this model is usually referred to as the conditional independence model. In a typical ecological study, we are interested in assessing the association between the concentration of a certain atmospheric pollutant like SO2 X and the death count Y in a certain region, controlling for temperature T and relative humidity H. To specify the stochastic components of the model we may assume consider the following assumptions: We consider a bioassay experiment designed to compare the effects of a standard preparation SP and an experimental preparation EP on the occurrence of some response Y , such as death or tumor onset. The random variables XS and XT are called tolerances. In many assays, it is conceived that the experimental preparation behaves as if it were a dilution or concentration of the standard preparation. Possible stochastic models follow: As such, often, it is advocated that instead of the dose, one should work with dose transformations called dose metameters or dosages. We consider a study designed to investigate the mutagenic effect of a certain drug or a toxic substance. We let mj denote the numbers of subjects having a positive response under dose j. Here the response, Y , assumes the value 1 if there is a mutagenic effect and 0 otherwise. Possible stochastic models are given below. Both logit and probit models may be employed in more general situations where we intend to study the relationship between a dichotomous response and a set of explanatory variables along the lines of linear models. For the logit case, such extensions are known as logistic regression models. In a broader sense, the models discussed above may be classifie as generalized linear models. We consider the OAB blood classifica tion system where the O allele is recessive and the A and B alleles are codominant. This genetic system is said to be in Hardyâ€"Weinberg equilibrium if the following relations hold: A problem of general concern to geneticists is to test whether a given population satisfie the Hardyâ€"Weinberg conditions based on the evidence provided by a sample of n observational units for which the observed phenotype frequencies are nO , nA , nB , and nAB. In this section, we build on the examples discussed earlier, as well as on additional ones, by considering more general statistical models that seem more acceptable in view of our limited knowledge about the data generation process. In this context, we outline the difficultie associated with the development of exact inferential procedures and provide an overview of the genesis of approximate large-sample methods along with the transit from their small-sample counterparts. We start with Example 1.

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6: Hellinger distance - Wikipedia

This book is an introduction to the field of asymptotic statistics. The treatment is both practical and mathematically rigorous. In addition to most of the standard topics of an asymptotics course, including likelihood inference, M-estimation, the theory of asymptotic efficiency, U-statistics, and rank procedures, the book also presents recent research topics such as semiparametric models, the.

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