Abstracts of the Invited Papers

Bayesian Models and Methods in Public Policy and Government Settings

Stephen E. Fienberg
Carnegie Mellon University

Abstract: Starting with the neo-Bayesian revival of the 1950s, many statisticians argued that it was inappropriate to use Bayesian methods, and in particular subjective Bayesian methods in governmental and public policy settings because of their reliance upon prior distributions. But the Bayesian framework often provides the primary way to respond to questions raised in these settings and the numbers and diversity of Bayesian applications has grown dramatically in recent years. Through a series of examples, both historical and recent, we argue that Bayesian approaches with formal and informal assessments of priors AND likelihood functions are well-accepted and should become the norm in public settings. Our examples include U.S. election night forecasting, censustaking and small area estimation, studies reported to the U.S. Food and Drug Administration, assessing global climate change, and measuring declines in disability among the elderly.

Parametric bootstrap: a way to combine Bayesian and frequentist ideas

Snigdhansu Chatterjee and Partha Lahiri
University of Minnesota and University of Maryland, College Park

Abstract: Multi-level models have applications in a wide range of research areas, including medical statistics and biostatistics, small area problems, geostatistics, image analysis, problems involving hidden, missing or latent layers, and others. We present interesting connections between the Bayesian and parametric bootstrap methods --- the two methods commonly used to implement a multi-level model. We show that if the ¯rst few moments of the appropriately centered and scaled hyperparameter under its bootstrap and posterior distributions are close to each other, then the resulting Bayesian and parametric bootstrap predictive distributions are also close. This result has several implications, including the following:

- The predictors thus obtained have both desirable frequentist and Bayesian properties.
- This result suggests a systematic way of selecting prior for the hyperparameters that ensures the propriety of the posterior.
- There is a potential computational advantage since the parameteric bootstrap or Bayesian computation may be substituted for each other depending on convenience.

Objective Bayesian Methods for Frequentists

James O. Berger
Duke University

Abstract: Several examples will be given to demonstrate how objective Bayesian methods can relatively easily be used to obtain nice frequentist solutions to non-standard problems for which direct frequentist analysis appears difficult. The "added value" in having the frequentist solutions developed from the Bayesian side will also be discussed.

Impact of Bayesian Methods in Survey Sampling: an Appraisal

J. N. K. Rao
Carleton University, Ottawa, Canada

Abstract: According to Hansen, Madow and Tepping (1983) "Probability-sampling Designs and randomization inference are widely accepted as the standard approach in sample surveys". In this talk, I will advance reasons for the wide use of this design-based approach, particularly by federal agencies and other survey organizations conducting complex large-scale sample surveys on topics related to public policy. I will also discuss the impact of Bayesian methods in survey sampling in two different directions: non-parametric posterior inferences from large samples and hierarchical Bayes for small area estimation based on parametric models. Possible uses of Bayesian methods at the design stage will also be mentioned.

Why Bayes, for statistics in general and missing data problems in particular?

Roderick J Little
University of Michigan, Ann Arbor

Abstract: An assessment of strengths and weaknesses of the frequentist and Bayesian systems of inference suggests to this author that calibrated Bayes, a compromise based on the work of Box, Rubin and others, captures the strengths of both approaches. Calibrated Bayes asserts that inferences under a particular model should be Bayesian, but model assessment can and should involve frequentist ideas. The author considers this approach in the context of missing data problems. The key to Bayesian methods is creating a defensible predictive distribution for the missing values, and then averaging over this distribution to create a posterior distribution given the observed data. Multiple imputation is one way of achieving this averaging, and offers some advantages in allowing the imputation model and analysis model to differ. Some examples of the Bayesian approach to missing data are offered.

Objecive priors: a selective review

Malay Ghosh
University of Florida, Gainesville

Abstract: Bayesian methods are increasingly applied in these days in the theory and practice of statistics. Any Bayesian inference depends on a likelihood and a prior. Ideally one would like to elicit a prior from related sources of information or past data. However, in its absence, Bayesian methods need to rely on some ``objective'' of ``default prior'', and the resulting posterior inference can still be quite valuable.

Not surprisingly, over the years, the catalog of objective priors also has become prohibitively large, and one has to set some specific criteria for the selection of such priors. Our aim is to review some of these criteria, compare their performance, and illustrate them with some simple examples. While for very large sample sizes, it does not possibly matter what objective prior one uses, the selection of such a prior does influence inference for small or moderate sample sizes. While without any nuisance parameters, Jeffreys' general rule prior, namely the positive square root of the determinant of the Fisher information matrix meets most of the desired selection criteria, it is possible to find some suitable alternate priors as well even in such situations.

Adjustment for density maximization (ADM): approximating probability distributions.

Carl N. Morris
Harvard University

Abstract: Maximum likelihood methods work by calculating two derivatives of a log-likelihood function and using that to approximate the likelihood function with a Normal distribution. While the central limit theorem tells us that this will approximate accurately for sufficiently large samples, MLE methods may approximate poorly when sample sizes are small, or when the parameter space is bounded.

The ADM was developed, although not named then, in (Morris 1988). Like the MLE, it also uses the first two derivatives of a log-likelihood or a log-posterior density, and just as easily can be used to fit any chosen Pearson family of distributions. Because the Normal is a Pearson family, the ADM includes the MLE, but ADM also accommodates other Pearson families: Gammas, Inverted Gammas, Fs, Betas, and the t. These distributions are easy to work with because, like the Normal, their CDFs, quantile functions, and simulations are widely available. (Unfortunately the Pearson families are univariate, so in vector situations ADM is used only to replace one dimension with multivariate MLE approximations.)

The talk will show how to apply ADM methods in Bayesian generalized hierarchical models. Of course when non-informative frequency-friendly hyperpriors define a Bayes

(or proper Bayes) rule, then that rule and it's approximations can possess excellent frequency procedures. Because shrinkage factors exist in [0,1], Beta distributions provide more accurate approximations than the Normal distribution for shrinkages (Christiansen and Morris, JASA 1997). The ADM also will be applied to approximating posterior credibility intervals in hierarchical models.

Abstracts of the Poster Session

Bayesian Designs for Therapeutic Medical Device Trials at CDRH/FDA

Pablo Bonangelino
U.S. Food and Drug Administration

This poster will present two examples of the use of Bayesian designs for medical device trials that we have seen at the General and Surgical Devices Branch of the Division of Biostatistics of FDA's Center for Devices and Radiological Health (CDRH) in recent years. There will be an overview of the approach taken by the General and Surgical Devices Branch towards Bayesian statistical methods. The poster will then present the two examples: Bayesian adaptive designs using predictive probability; and incorporating prior data in a confirmatory study. The poster will conclude with general and regulatory considerations about the use of these types of designs.

A new class of average moment matching priors

N. Ganesh[1] and P.Lahiri[2]
[1]*National Opinion Research Center and* [2]*University of Maryland, College Park*

Abstract: We derive a new class of priors for the variance component in the Fay-Herriot model, a mixed regression model widely used in small area estimation. This class includes the well-known uniform or superharmonic prior. The proposed class of priors is used to construct simultaneous credible intervals for the Fay-Herriot model. Through simulation we illustrate the use of our class of priors.

Hierarchical Bayes Modeling of Survey-Weighted Small Area Proportions

Benmei Liu[12], Partha Lahiri[1], Graham Kalton[2]
[1]*University of Maryland, College Park and* [2]*WESTAT*

Abstract: When a Hierarchical Bayes area level model is used to produce estimates of proportions of units with a given characteristic for small areas, it is commonly assumed that the survey weighted proportion for each sampled small area has a normal distribution and that the sampling variance of this proportion is known. However, these assumptions are problematic when the small area sample size is small or when the true proportion is near 0 or 1. In an effort to overcome these problems, we test two alternative models for the survey weighted proportion using a Monte Carlo simulation study in which stratified simple random samples are generated from a fixed finite population. We compare the results obtained from these alternative models with those obtained from two commonly used models.

Applications of Bayesian Methods in Small Area Estimation.

Donald Malec
U.S. Census Bureau

Abstract: Small area estimation, where sample data is either nonexistent or too sparse to warrant strictly randomization techniques, is one of the exceptions where statistical modeling is typically used in survey sampling. Examples illustrating how Bayesian methods can be a used to overcome four typical problem areas associated with modeling this type of data will be presented. These four areas being: 1) accounting for all the uncertainty of the parameters within a model without resorting to asymptotics, 2) providing model checks against key sample statistics, 3) accounting for the sample design and selection and 4) guarding against incorrect specifications of 'borrowing strength'.

The Prior Selection and Approximations in a Hierarchical Bayes Approach: An Application to the Small Area Income and Poverty Estimation

Santanu Pramanik
University of Maryland, College Park

Abstract: In the context of Small Area Income and Poverty Estimation (SAIPE) project of the U.S. Census Bureau, we consider two important issues in the hierarchical Bayesian inference, namely the selection of prior for the variance component and highly accurate simple approximations to various posterior moments involved. Our goal is to select a prior distribution for the variance component that yields good frequentist properties of the resulting Bayes estimators of different parameters and hyperparameters of interest. We also discuss several approximate hierarchical Bayes methods which are designed to present the Bayesian methodology in a transparent way, which facilitates the interpretation of the methodology to the data users. In addition, the approximations result in easy applications of the Bayesian methodology in situations where the same method must be routinely implemented by data users with minimal or no knowledge of the sophisticated Monte Carlo Markov Chain (MCMC) method, which requires good understanding of the burn-in sample, number of chains, number of replications, skip intervals, etc. By applying our methodology on data related to the SAIPE project of the U.S. Census Bureau, we demonstrate the utility and accuracy of our approach in solving real life small area estimation problem.

Bayesian Nonparametric Approach to Multiple Testing

Anindya Roy
University of Maryland at Baltimore County

Abstract: Motivated by the problems in genomics, astronomy and some other emerging fields, multiple hypothesis testing has come to the forefront of statistical research. In multiple testing, error measures which are variants of the False Discovery Rate provide a desirable compromise between the statistical goal of error control and the scientific goal of discovering as many false hypotheses as possible. These important error measures are functionals of the distribution of the p-values. We propose a non-parametric Bayesian framework for fitting p-value distribution in single-step multiple testing problems. Under this framework, the more challenging case of modeling dependent p-values can be addressed by considering a Dirichlet mixture of multivariate skew-normal kernel prior for probit transforms of the p-values. We also show that the Dirichlet mixture of skew-normal kernel has important shape restriction properties for the estimated p-value denisty, a property often observed in typical multiple testing examples. We illustrate the methodology with some real life examples.

This is joint work with Subhashis Ghosal

Using Laplace and Frequentist Variance Approximations for Poststratified Totals when Categorical Variables are Massively Missing

Yves Thibaudeau
Statistical Research Division, U.S. Census Bureau

Abstract: Tierney and Kadane (1986) and Tierney, Kass and Kadane (1989) revive the method of Laplace to approximate posterior moments, in particular posterior variances. In turns, posterior variances can serve to approximate the variances of MLE's. I derive a short-hand for Laplace-style variance approximations from formulae suggested by TKK. I focus on estimating the variances of transition probabilities in longitudinal surveys (Bishop Fienberg Holland 1977 page 167), in presence of missing data. A thorough simulation is testimony to the accuracy of my method and serves as confidence builder. Then, using data from the Survey of Income and Program Participation (SIPP), I show how maximum likelihood estimation and Bayesian variance approximation in the poststratified environment (Little 2004) serve to support frequentist estimation. To show this I use Horwitz-Thompson estimation and balanced repeated replication (BRR) in the context of transition through time in SIPP in presence of massively missing categorical variables.

Assessing Uncertainty in Measurement

Blaza Toman and Will Guthrie
Statistical Engineering Division,
National Institute of Standards and Technology

Abstract: The International Vocabulary of Metrology defines measurement uncertainty as a "parameter that characterizes the dispersion of quantity values that are being attributed to a measurand based on the information used". Somewhat counter-intuitively, however, in the high-precision measurements common in the physical sciences, this dispersion is often caused primarily by systematic effects that are not estimable from the measurement data. These systematic effects have many possible causes including inaccuracies in instrument calibration, resolution limitations in instrument displays, and environmental effects.

As the data contain no information about these effects, the metrologist needs to draw on other sources to quantify the required uncertainty. Such sources may include related physical data, expert opinion, or manufacturer's specifications. The job of the metrologist is then to combine all of this information with that provided by the measurement data to arrive at a realistic assessment of the uncertainty in the result.

Given these features, the natural statistical paradigm for uncertainty analysis is Bayesian. This was essentially recognized by the authors of the *Guide to the Expression of Uncertainty in Measurement* (GUM), a 1993 publication of the International Organization for Standardization, but, because they were not trained statisticians, the methodology presented there is a Bayesian-frequentist hybrid. This poster explains the method of uncertainty quantification practiced in metrology, its Bayesian underpinnings, and some of the challenges that statisticians working in this field face when trying to reconcile the GUM methodology with standard statistical practice.

Bayesian Benchmarking of the Finite Population Means of Small Areas

Ma. Criselda Toto and Balgobin Nandram
Worcester Polytechnic Institute

Abstract: The main goal in small area estimation is to make inference about the finite population in each small area based on the samples from all areas. However, the direct estimates for small areas turn out to be not always reliable, so we use models to "borrow strength" from the ensemble. But when we use models, the combined estimates from each of the small areas do not usually match the direct estimate when estimation is directly perform on the large area. Benchmarking is done by applying a constraint on the data that will ensure that the total of the small areas will match the grand total. We use a Bayesian sampling-based approach to show how to benchmark the finite population means of small areas. We apply our results to the 1978 Iowa Enumerative Survey and satellite data on corn and soybeans.

A Bayesian Approach in a Randomized Study with an Additional Historical Control

Xu (Sherry) Yan[1], Yunling Xu
[1]*U.S. Food and Drug Administration*

Abstract: For a medical device, patient level data may be available from earlier studies on previous generations of the device. One may seek to reduce the sample size by using such prior data to augment the con-current control in a randomized study of the new generation through a Bayesian approach. In this poster, we will discuss a Bayesian approach together with its associated potential problems in a regulatory setting with a case study.