the suggestion that θ has the same sort of reality as x, the observation.

This article has served to put into sharp contrast the Bayesian and Berkeley schools of statistics. Perhaps it is appropriate to close by remarking on a point of agreement between them.

By and large, all statisticians agree on the use of probability to model uncertainty. Perhaps we should unite on this agreement and look outside mainstream statistics. There we would notice a growth industry in *ad hoc* uncertainty modeling: fuzzy sets, possibility theory, varieties of belief representations, inexact logics, ... While we debate the niceties of priors versus sample spaces, there are many out there developing alternatives to our tools for inference and decision. Moreover, their alternatives, despite so many flaws obvious to us, are apparently far more attractive to those who award research and development funds. Many projects are building decision support systems and inference engines with what I can only describe as "inbuilt irrationality." Is it right that we stand idly by, waiting for their comeuppance? Professor Lindley is one of the few explaining carefully and patiently the flaws of these alternatives to probability modeling. It might be wise for us to forget, at least for the time being, some of the disagreements within statistics and put our energies into the wider debate of the value or otherwise of nonprobabilistic modeling of uncertainty.

ADDITIONAL REFERENCES

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Comment

Joseph B. Kadane

I want to supplement Lindley's admirable overview of Bayesian Statistics with some references and speculations about how modern computing may both influence Bayesian thought and be useful in accomplishing the agenda that Lindley, and before him Savage and others, have set out. The simplest Bayesian analyses, using exponential family likelihoods and stated priors in the conjugate form, do not require computing at all. Raiffa and Schlaifer (1961) give a still rather complete treatment of the computation of posterior distributions under these conditions. Modern Bayesian thought goes beyond these ideas in several respects. The important dimensions of generalization are:

a) The prior may not be stated, but may instead have to be elicited.
b) The likelihood may not be in the exponential family, or the prior may not conjugate with it.
c) The problem may not be the computation of a posterior distribution (or some functional of it) but rather a design problem.
d) Robustness may be of special concern.

I give some brief comments on each in turn.

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1. ELICITATION

The idea of elicitation is to discover a prior that models the user's opinions well. Unfortunately this very important problem has not received the attention it deserves from the Bayesian computing community. For example, in Goel's (1988) survey of Bayesian programs, only two of the more than thirty listed concern elicitation, and neither of those was ready to be released. Nonetheless, this is a natural area for computation, particularly of the interactive sort. An early attempt of my own is given in Kadane, Dickey, Winkler, Smith and Peters (1980). For some more recent work in elicitation see Chaloner and Duncan (1983) and Gavaskar (1988). A very interesting recent work by DuMouchel (1988) uses graphical methods in the elicitation of a generalized ANOVA model.

As I have already remarked, I consider elicitation to be a very fruitful area for future work. One would think that the flexibility offered by modern devices such as mice would be useful in permitting users to express their views. While to date all the work reviewed here has assumed a given, known likelihood function, future elicitation work will, I believe, deal with the fact that likelihoods, as well as priors, are subjective and hence subject to elicitation (Bayarri, DeGroot and Kadane, 1988). Perhaps Lindley's work reported here will be the basis for future computer work in elicitation.