Bayesian approach works without independence: it has only been assumed here for simplicity and comparison with beliefs. What the Bayesian view does is to force one to consider the subtle nature of the dependence between the witnesses.

III: $p(a_i \mid A) = p(\bar{a}_i \mid \bar{A}), \quad (i = 1, 2).$

This asserts that the witnesses are equally reliable whether A is true or false. Again it is easy to imagine circumstances where this is not true. In some cultures there is a tendency for witnesses to say what they think will please the listener. So if A is the event "the airport is near," veracity is more likely when A is true than when it is false. Consequently one cannot be sure that $p(a_i \mid A)$ and $p(\bar{a}_i \mid \bar{A})$ are both p_i.

The Bishop certainly did not recognize the distinction, as have many writers after him. The Bayesian approach does not demand the equality: it merely forces one to recognize that two types of veracity are possible.

Applied to the Bishop's problem, the rector's approach forces one to consider one's initial belief in the event, the nature of the dependence between the witnesses, and the two forms of reliability that arise. We suggest that, on reflection, it will be admitted that all three features are relevant to the final answer. Even if the independencies and the equalities of the reliabilities are admitted, as the Bishop and the modern equivalent tacitly do, the result is still different from the Bishop's. It is of interest to enquire when they are equal. Equating (2) and $1 - (1 - p_1)(1 - p_2)$ easily gives after a little algebra the condition that

$$(1 - \pi) = p_1 p_2 \pi + (1 - p_1)(1 - p_2)(1 - \pi).$$

The righthand side is $p(a_1, a_2)$, the unconditional probability that both witnesses assert A is true, so that the Bishop and rector only agree (under assumptions II and III) if

$$p(\bar{A}) = p(a_1, a_2).$$

In words, the probability that the event is false has to be equal to the probability that both witnesses assert its truth. This is surely unreasonable.

I put it to the readership: my challenge has survived, probability does do better. Let us support the rector of Tunbridge Wells and not the Bishop of Bath and Wells: let us favor truth and not the establishment. (Bayes was a minister in the unestablished church.)

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Comment

David J. Spiegelhalter

It is fairly predictable that I should agree wholeheartedly with Professor Lindley's lucid justification of probability as the correct paradigm for handling uncertainty in expert systems (but how strange it is to see him cast in the role of defender of orthodoxy!). In particular, his emphasis on remembering the background evidence H is crucial to avoid any conception that there is a single "true" probability of an event, and the frequent references to the operational meaning of probability gives a practical as well as a theoretical justification. However, playing the devil's advocate, I see two main reasons why the artificial intelligence community may not be convinced by the argument.

Firstly, he turns all statements expressing uncertainty into expressions of probability concerning (at least theoretically) verifiable events, whereas many constructors of expert systems would prefer to keep their propositions deliberately imprecisely defined in order to look more like human reasoning, and do not provide an operational means of verification. Secondly, even if verifiable events *are* being considered, the scoring rule argument presumes a certain type of evaluation procedure which many might claim was rarely appropriate, since the criteria for the "success" of an expert system may only require a very coarse handling of uncertainty.

Nevertheless, the theoretical arguments concerning optimality and coherence are only one weapon in the armoury. Pearl (1986b), in a recent strong advocacy of probability, uses no normative criteria but concentrates on the power of the theory in adequately modeling complex evidential reasoning, and I feel, in the end, it will be the intuitive appeal and flexibility of probabilistic reasoning that will change the current climate.