Notes

Whether Bayes's theorem should be explicitly used as suggested in Question 3 has been the subject of considerable academic and some judicial debate. On the academic side, among the first articles are Michael O Finkelstein & William Fairley, *A Bayesian Approach to Identification Evidence*, 83 Harv. L. Rev. 489 (1970)(proposing the use of Bayes's theorem); Laurence H. Tribe, *Trial by Mathematics:Precision and Ritual in the Legal Process*, 84 Harv. L. Rev. 1329 (1971) (criticizing the proposal); Finkelstein & Fairley, *A Comment on "Trial by Mathematics,"* 84 Harv. L. Rev. 1801 (responding to Tribe); and Tribe, *A Further Critique of Mathematical Proof*, 84 Harv. L. Rev. 1810 (1971) (rejoinder). A further critique appears in L. Brilmayer & L. Kornhauser, *Review: Quantitative Methods and Legal Decisions*, 46 U. Chi. L. Rev. 116 (1978). See generally two symposia: *Probability and Inference in the Law of Evidence*, 66 B. U. L. Rev. 377-952 (1986) and *Decision and Inference in Litigation*, 13 Cardozo L. Rev. 253-1079 (1991). On the judicial side, compare *Plemel v. Walter*, 303 Ore. 262, 735 P.2d 1209 (1987) and *State v. Spann, supra* (both approving an explicit use) with *Connecticut v. Skipper*, 228 Conn. 610, 637 A.2d 1104 (1994) (disapproving an explicit use).

Those approving an explicit use in a criminal case argue that jurors tend to underestimate the probative force of background statistical evidence. Such insensitivity to prior probability of outcomes appears to be a general phenomenon in subjective probability estimation. See, e.g., *Judgement Under Uncertainty: Heuristics and Biases*, at 4-5 (Daniel Kahneman, Paul Slovic & Amos Tversky, eds., 1982). Empirical studies based on simulated trials tend to support this. See, e.g., Jane Goodman, *Jurors' Comprehension and Assessment of Probabilistic Evidence*, 16 Am. J. Trial Advocacy 361 (1992). They also point to what is called the prosecutor's fallacy: the risk that the jury will misinterpret the low population frequency of the blood type as the probability of innocence. Those opposed to explicit use object that jurors would be invited to estimate a probability of guilt before hearing all the evidence, which they view as inconsistent with the presumption of innocence and the instruction commonly given to jurors to withhold judgement until all the evidence is heard. On the other hand, if the jurors wait until they hear all the evidence before estimating their priors, the statistics are likely to influence those estimates. Some scholars further object to any juror quantification of the probability of guilt as inconsistent with the "beyond a reasonable doubt" standard for criminal cases. Since conviction is proper despite some doubt, it is not clear why quantification of that doubt by a juror would be per se objectionable. There is some evidence that quantification of the burden of proof influences verdicts in an appropriate direction. Dorothy K. Kagehiro & W. Clark Stanton, *Legal vs. Quantified Definitions of Standards of Proof*, 9 L. & Hum. Behav. 159 (1985).

Perhaps the strongest case for an explicit use by the prosecution arises if the defense argues that the trace evidence does no more than place defendant in a group consisting of those in the source population with the trace in question.

Known as the defense fallacy, the argument assumes that without the trace defendant is no more likely to be guilty than anyone else in the source population. (This is an unlikely scenario since there is almost always other evidence that implicates the defendant.) The prosecution might then be justified in using Bayes's theorem to show what the probabilities of guilt would be if the jurors believed at least some of the other evidence. Conversely, the prosecutor's fallacy (that the frequency of the trace in the population is the probability of innocence) assumes that the prior probability of defendant's guilt is 50%. If the prosecutor makes such an argument, the defense should then be justified, using Bayes's theorem, to demonstrate what the probabilities would be if some or all of the other evidence were disbelieved.

Another set of issues is presented if identifying the source of the trace does not necessarily imply guilt. A thumb print on a kitchen knife, used as a murder weapon, may have been left there innocently. The complication here is that the same facts suggesting guilt that are used to form the prior probability of authorship of the print would also be used to draw an inference from authorship of the print to guilt. If this is an impermissible double use, it would be hard or impossible to partition the non-statistical evidence among uses.

Whether an explicit use of Bayes's theorem is allowed in the courtroom may stir legal academics more than jurors. In one empirical study the jurors simply disregarded the expert's Bayesian explanations of the statistics. See David L. Faigman & A. J. Baglioni, Jr., *Bayes' Theorem in the Trial Process: Instructing Jurors on the Value of Statistical Evidence*, 12 Law & Hum. Behav. 1 (1988). The more important (and often ignored) teaching of Bayes's theorem is that one need not assert that a matching trace is unique or nearly unique in a suspect population to justify its admission as powerful evidence of guilt.

3.4 Screening devices and diagnostic tests

Screening devices and diagnostic tests are procedures used to classify individuals into two or more groups, utilizing some observable characteristic or set of characteristics. Most familiar examples come from medical diagnosis of patients as "affected" or "not affected " by some disease. For our discussion we adopt the clinical paradigm, but the central ideas are by no means limited to that context.

False positives and negatives

No diagnostic test or screening device is perfect. Errors of omission and commission occur, so we need to distinguish between the *true* status (say, A = affected or U = unaffected) and the *apparent* status based on the test (say, + = test positive or − = test negative). A *false positive* diagnosis is the occurrence of a positive outcome (+) in an unaffected person (U); it is denoted