F26 Bayes' Theorem, Forensic Science, and the Law: Long-Lost Relatives or Feuding Family?

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Learning Overview: After attending this presentation, attendees will have a better understanding of Bayes' theory and the presentation of DNA evidence at trial.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by promoting an awareness of how the findings and testimony of an expert can fit into the overall presentation of the evidence in the case.

The past several years have seen widespread adoption of the Likelihood Ratio (LR) for reporting the statistical weight of DNA inclusions. The LR presented in court is represented as:

$$\mathrm{LR} = \frac{\Pr(E|H_1,I)}{\Pr(E|H_2,I)}$$

where E is the evidence, I is relevant case information, H_1 is a proposition that represents one view point, and H_2 is an alternate proposition that is mutually exclusive to the H_1 proposition. This equation describes the ratio of the probabilities of the evidence given two competing propositions. Note that it is NOT the ratio of the probabilities of the propositions.

This LR is one term found in the odds form of Bayes' Theorem

$$\underbrace{\frac{\Pr(H_1|E,I)}{\Pr(H_2|E,I)}}_{\text{Posterior odds}} = \underbrace{\frac{\Pr(E|H_1,I)}{\Pr(E|H_2,I)}}_{\text{LR}} \times \underbrace{\frac{\Pr(H_1|I)}{\Pr(H_2|I)}}_{\text{Prior odds}},$$

where posterior odds are the product of an LR and prior odds. Prior odds are the belief in the propositions based on other (non-LR) evidence. Posterior odds gives the final ratio of the propositions considering both an LR and the other evidence in the case. Note that it is posterior odds that address the ratio of the propositions after considering the evidence.

Recently there have been several court decisions and publications that address the use of Bayes' Theorem in the United States legal system in a negative light. Much of the criticism is directed toward a jury of lay persons being responsible for combining the prior odds with the LR presented by an expert to come to a final decision. There have been other decisions that seem to directly support the use of Bayesian thinking at court—although not by name. However, there are several aspects of the trial process where the court seems to both expect and instruct the jury to use a Bayesian framework—although not by that name.

Things get more complicated when the Hierarchy of Propositions is not followed, resulting in an LR for the DNA profile (subsource level) being transposed to the probability of guilt (offense level). Several of the negative publications and decisions seem to mix levels of this hierarchy as well as transpose an LR to the posterior odds.

This presentation will cover a review of the Hierarchy of Propositions, the three components of Bayes' Theorem, then look at current Federal Juror Instructions to see if there really is a discordance between Bayes' Theorem, forensic science, and the role of the decision maker (jury). The goal of this presentation is to encourage all stake holders in the justice system to start a dialogue with each other to better understand how each role relates to the other, how to work together to best inform the decision maker, and perhaps to discover some relationships that shows we might agree more than we realize. The goal of this presentation is to advance a dialogue between the scientist and both prosecuting and defense attorneys in how to best communicate DNA findings to a jury.

Forensic DNA, Testimony, Bayes' Theorem

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