B140 Evaluating Likelihood Ratios, Decision Thresholds, and Fire Debris Analysts' Performances

Mary R. Williams, MS, National Center for Forensic Science, Orlando, FL 32816-2367; Michael E. Sigman, PhD, University of Central Florida, Orlando, FL 32816; Frances Whitehead, BS, University of Central Florida, Orlando, FL 32816-2367*

Learning Overview: After attending this presentation, attendees will understand how to evaluate the diagnostic performance of fire debris analysts with the aid of a ground truth database and a score-based decision threshold.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by graphically demonstrating the relationship between evidential value, weight of the evidence, and a score-based decision threshold. An understanding of these relationships is important for practicing forensic analysts that are required to develop and perform robust diagnostic analysis. Attendees will understand how to implement a simple method for validating an analyst's performance, setting decision thresholds, and determining the associated error rates.

In recent years, forensic science research has often placed an emphasis on determining evidential value and limiting reporting to probabilistic statements of evidential values rather than diagnostic statements that represent a decision on the part of the analyst. Yet, many forensic science disciplines and the courts in the United States require analysts to continue making diagnostic statements about evidence (i.e., a "sample is positive for ignitable liquid residue" as opposed to "the probability of observing the evidence is 100 times greater in samples containing ignitable liquid residue than in samples that contain no ignitable liquid residue."). The relationship between evidential value, strength of evidence, and the decision threshold for diagnostic statements is easily understood through the construct of decision theory based on Receiver Operating Characteristic (ROC) curves.

The ROC curve is a plot of the true positive rate as a function of the false positive rate for a set of diagnostic decisions made at a corresponding set of decision thresholds. The ROC curve describes the performance of a binary (two state) system, which lends itself to the legal framework where questions are often posed in binary form. Establishing a ROC curve requires two factors: (1) a set of ground truth samples belonging to the two states, and (2) a scoring system that reflects the weight of the evidence relative to the two states. In some cases, ground truth forensic samples may be difficult to obtain; however, a new database of ground truth fire debris samples exists and will be introduced in this presentation. A seven-point discrete confidence rating scale for sample scoring will be applied to ground truth fire debris samples. Sample analysis will implement the American Society for Testing and Materials (ASTM) E1618 Standard Method coupled with principles of linear sequential unmasking. ROC curves, optimal decision thresholds, and error rates will be presented for three test analysts with differing experience levels. The general methodology is well established in published literature and applicable across many forensic disciplines.

This project was supported by Award Number 2017-IJ-CX-0023 awarded by the National Institute of Justice, Office of Justice Programs, United States Department of Justice. The opinions, findings, and conclusions or recommendations expressed in this presentation are those of the authors and do not necessarily reflect those of the Department of Justice.

Fire Debris Analysis, Performance Validation, Decision Theory

*Presenting Author