



Department of Chemistry Seminar Series Spring 2023

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Validating Machine and Human Decision-Making in Forensic Fire Debris Analysis



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Due to its qualitative nature, fire debris analysis has not historically employed the use of statistical analysis nor probabilistic reporting methods to help determine the strength of the evidence produced by the analyses performed. This work presents a background on the chemical complexity inherent in the samples of fire debris analysis, including an ever-present background of pyrolysis products as the catalyst that led to the creation of the National Center for Forensic Science's Fire Debris Database. The Fire Debris Database contains over 1,000 case-work relevant ground truth samples for training and validation purposes. Included also is a newly proposed analyst workflow using linear sequential unmasking to help mitigate bias, a discrete scoring system for quantification of the analysis, and the Receiver Operating Characteristic curve (ROC curve) construct of decision theory to help visualize a bridge between categorical and probabilistic reporting. This is one approach for establishing an evidentiary value threshold for analytical decision-making processes like fire debris analysis that currently require the analyst to report the outcome only as a categorical statement, while still maintaining use of the current standard method already accepted in judicial proceedings. Three analysts assessed 20 randomly chosen single-blind known ground truth samples from the Fire Debris Database following the ASTM E1618-19 standard fire debris analysis method using the workflow which requires them to assign discrete scores to their findings that are more reflective of the strength of the evidence than the 'positive for ignitable liquid' or 'negative for ignitable liquid' categorical statement currently required. Furthering the workflow and its applications, the use of subjective logic is currently being added as a basis for quantifying the uncertainty that exists for both human and machine decisions, and discusses potential ways of taking it into account when formulating an expert forensic opinion. This is currently the research group's work that is considered still-in-progress, but a brief overview of the new developments will be included here.