B141 Validating Fire Debris Classification With Ground Truth Samples

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Learning Overview: After attending this presentation, attendees will understand how to validate fire debris classification using machine learning methods and ground truth samples.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by introducing a new publicly available fire debris database and demonstrating the use of the database records to validate fire debris classification as positive or negative for the presence of ignitable liquid residue by machine learning methods.

Validating the performance of computational classification methods requires the use of casework-relevant samples with known ground truth class assignment for each sample. In the case of fire debris analysis, the samples must each contain fire debris from burned substrate materials and possibly an ignitable liquid residue, the presence or absence of ignitable liquid residue must be known, the relative strength and the degree of weathering of any ignitable liquid contribution must be representative of casework. A database of laboratory-created fire debris records that meet these criteria has recently been released for free public access online by the National Center for Forensic Science. Uses of the new database for training and validation will be highlighted in brief, and use of the database records for validation of machine learning classification methods will be explored in more detail.

Machine learning methods will be described for classifying database samples as positive or negative for ignitable liquid residue based on decision theory and estimates of the sample evidentiary value. Multiple bootstrapped training sets were created from the fire debris database records for each computational method. The multiple data sets were each split 80:20 for training and cross validation of a machine learning method. Following training and cross validation, the models were then used to evaluate a set of 129 fire debris samples from experimental large-scale burns. The mean and standard deviation for the calculated log likelihood ratios for the large-scale burn samples were then compared with the interpretation of an informed analyst. Machine learning methods investigated in this work include k-nearest neighbors, linear and quadratic discriminant analysis, and support vector machines. The average areas under the receiver operating characteristic curves for each machine learning method ranged from 0.78 to 0.92 with relative standard deviations of less than 6.5%.

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Fire Debris Analysis, Performance Validation, Machine Learning

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