B99 A Pathway Toward Firearm Population Statistics

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Learning Overview: After attending this presentation, attendees will know about a project to develop a reference tool mark population database and associated statistical distributions of similarity scores to quantify the weight of evidence of a comparison. The presentation will highlight the overall design, workflow, potential implementation steps, and limitations of the system.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by describing a foundational statistical resource for reporting statistical confidence in firearm and tool mark examination.

The database is intended to serve as a foundational resource for tool mark examiners to report a statistically sound estimate for the weight of the evidence or uncertainty of an examination result. The population statistics describe the frequency distributions of a similarity score for, respectively, same-source comparisons and different-source comparisons of tool marks, such as firearm marks on cartridge cases and bullets. Like DNA analysis, these distributions are needed for the estimation of the weight of the evidence, such as a likelihood ratio, or other confidence metrics such as error rates. The effort builds on the NFI Scratch software, which provides a framework to create and maintain a reference tool mark database and associated statistical analysis tools. The database will contain measurement data of tool marks from a large variety of known tools, including the Federal Bureau of Investigation (FBI) firearm reference collection. The software mines the database for tool mark comparisons of a population relevant to a case and generates the respective frequency distributions. These distributions can then be used to evaluate the weight of the evidence. The system is designed to enable the use of different similarity metrics or scores, such as those developed by the National Institute of Standards and Technology (NIST) and the Netherlands Forensic Institute (NFI). The system is an important component in ongoing efforts by the FBI to implement objective measurement and analysis into casework. The presentation will highlight the overall design, workflow, potential implementation steps and limitations of the system.

No matter what statistical method or model is used, a large and diverse reference collection of ground truth tool mark data is required to achieve meaningful results. Therefore, the framework is designed as a living system to be maintained and updated on an ongoing basis with new tool marks and comparison metrics to ensure relevance to actual casework. The resulting reference populations can also be used to further advance research on objective comparison metrics and statistics, allowing developers to provide better tools to support the examiner's conclusions. There is also potential for this research to be applied in other pattern evidence disciplines.

The project was a joint effort by the National Institute of Standards and Technology (NIST), the Federal Bureau of Investigation (FBI), and the Netherlands Forensic Institute (NFI).

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