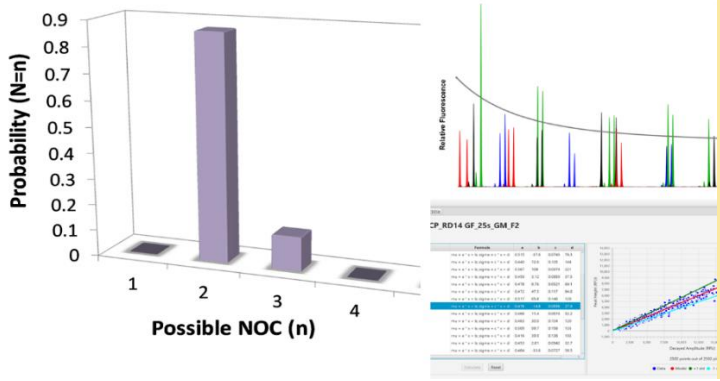
Moving Knowledge from Research to Impact

SUCCESS STORY

National Institute of Justice (NIJ) and Rutgers University

Advancing Mixture Interpretation Analysis with NOCIt



"One could argue that a better approach than opting for the minimum number of contributors to a mixture might be to determine the number of contributors best supported by the data."

—Jaheida Perez, et al. Croat Med J. 2011; 52: 314–26
The New York City Office of Chief Medical Examiner (OCME)

Problem and Solution Synopses

DNA samples recovered from crime scenes often contain at least two contributors. Complex forensic DNA mixture interpretation can be challenging and requires computational advancements that support its use. Using forensic probabilistic tools to identify a DNA sample's number of contributors (NOC) is crucial to accurately computing the weight of evidence for a person of interest. Traditionally, calculating the NOC for a forensic short tandem repeat (STR) DNA profile involves evaluating peaks per locus and dividing by two, ratios of alleles/allelic balance at a locus, and review to ensure all loci fit the estimated NOC. However, this method provides only an estimate about the minimum NOC that could explain the mixture rather than the probability of a certain NOC. Furthermore, there can be variation between analysts which introduces subjectivity when using this method to determine NOC. Thus, there is a need for objective, continuous, probabilistic frameworks that use all the information present in an STR profile to draw inferences for the NOC.

Drs. Catherine Grgicak and Desmond Lun at Rutgers University developed and validated a probabilistic system, "NOCIt", that determines a probability distribution on the NOC given an STR electropherogram. NOCIt incorporates models of peak height (including degradation and differential degradation), forward and reverse stutter, and noise and allelic drop-out—in addition to accounting for the number of alleles, and thus is considered a fully continuous system. The algorithm's performance was recently evaluated by conducting a large-scale validation on 815 ultraviolet-damaged, inhibited, differentially degraded, or uncompromised laboratory generated DNA mixture samples containing up to five contributors.

Dr. Grgicak and colleagues determined that NOCIt calculates accurate, repeatable, and reliable inferences about the NOC—significantly outperforming manual methods that rely on filtering the signal.

Key Benefits of NOCIt

- Provides an objective method to aid with testimony to a jury
- Enables consistency across analysts during interpretation
- Shows the probability estimates for different NOC and can support the interpretation made by the scientist
- Removes the uncertainty associated with assigning the NOC, giving forensic stakeholders higher confidence in their interpretations
- Reports the probability of the NOC, allowing analysts to determine likelihood ratios across all likely NOC results
- Outperforms methods that rely on binary determinations of peak presence or absence
- Eliminates unlikely contributor estimates from consideration
- Models noise directly, removing the need for analytical thresholds
- Estimates the NOC in both degraded and uncompromised DNA mixture samples

NOCIt trial licenses and all mixture data is freely available to the forensic community for implementation and validation purposes. See reverse side for more details.

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More Information

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Research Support

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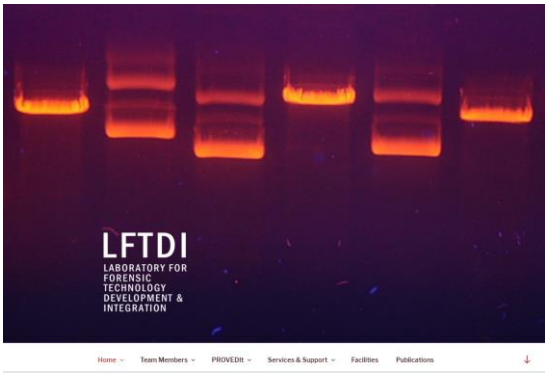
NIJ is the research, development, and evaluation agency of the U.S. Department of Justice. NIJ is dedicated to improving knowledge and understanding of crime and justice issues through science. NIJ provides objective and independent knowledge and tools to inform the decision-making of the criminal and juvenile justice communities to reduce crime and advance justice, particularly at the state and local levels.

The NIJ Office of Investigative and Forensic Sciences (OIFS) is the federal government's lead agency for forensic science research and development. OIFS' mission is to improve the quality and practice of forensic science through innovative solutions that support research and development, testing and evaluation, technology, information exchange, and the development of training resources for the criminal justice community.

NIJ Research & Development

Dr. Grgicak was awarded grants 2011-DN-BX-K558 and 2014-DN-BX-K026 by the NIJ, Office of Justice Programs, U.S. Department of Justice as well as W911-NF-14-C-0096 from the Department of Defense (DOD). NIJ provided the initial investment that allowed the group to develop a NOCIt prototype. In 2014, the team received a DOD Rapid Innovation Fund award to improve the models and advance the prototype. Along with producing NOCIt, the team made all mixture data available to the forensic community via the Project Research Openness for Validation with Empirical Data (PROVEDIt) database. PROVEDIt has been used in 19 distinct studies, including the National Institute of Standards and Technology's MIX13 study and STRMix's Collaborative Exercise on DNA Mixture Interpretation.



Laboratory for Forensic Technology Development & Integration Website

Bringing Research to Practice

NOCIt inventors authored Patent No: US10504614B2. Fast-track evaluation licenses are available for students, crime laboratories, and research laboratories; these licenses allow free use for 6 months. NOCIt is currently part of a software suite that is licensed to four crime laboratories (three U.S. and one international), three U.S. academic research laboratories, and two students (one U.S. and one international). To attain a fast-track evaluation license, the user simply fills out their information and electronically agrees to the license. Once the license is agreed to, the user can download the software immediately. Manual and tutorial samples are also included, allowing for immediate testing. To learn more about NOCIt's validation see the FTCoE webinars and podcasts that include:

- 2018 NIJ R&D Symposium Series: Forensic Biology webinar
- Validation and tutorial of NOCIt for determining the number of contributors
- Just DNA mixture interpretation podcast

The Future

Moving forward, Dr. Grgicak's research will include computing the probability of the NOC given a known person or persons contributed and will explore the effects of conditioning on a known contributor to the mixture, such as a victim's STR profile. The team will investigate whether NOCIt's probabilities will concentrate more around the true number or in the direction of n-1 contributors and will explore if these modifications impact the likelihood ratio. Because NOCIt is engineered to take STR data from any platform, other work will include testing NOCIt on next-generation sequencing data produced from low- and high-template mixtures. The PROVEDIt database plays an important role in establishing a path forward for DNA mixture interpretation. These projects highlight the importance of research funding that can simultaneously produce technological advances and database resources that will inevitably lead to greater confidence in forensic DNA mixture reports.

Image Credits

Page 1—Catherine Grgicak

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