NIST
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Overview of Statistics Focus Area in NIST Forensic Science Research

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Research Areas

- Assessing Weight of Evidence
- Footwear and Tire Tread Analysis
- DNA Analysis
- Drug Identification / Purity
- Firearms ID
- Analysis of Explosive Residues
- Trace Analysis of Fibers

DNA Analysis

- S. Gittelson, C.R. Steffen, M.D. Coble (2016) "Low-Template DNA: A Single DNA Analysis or Two Replicates?" *Forensic Science International*.
- Goal: To determine how many replicate PCR amplifications to perform on low-template DNA
  - Analysis focuses on expected value of information from an additional replicate versus a larger single sample.
  - Bottom Line: Two samples are better in many cases

Drug Purity

- B. Toman, M.A. Nelson, K.A. Lippa (2016) "Chemical Purity Using Quantitative ^{1}H-Nuclear Magnetic Resonance," *Metrologia*.
- Goal: Demonstrate method for suitable for traceable drug purity assessments
  - Two primary purity standards each used to calibrate two secondary standards compatible with final analyte
  - Bayesian hierarchical model allows assessment of uncertainty from both experimental observations using different standards and primary standards

Firearms ID

- J. Song, T.V. Vorburger, W. Chu, J. Yen, J.ASoons, D.B. Ott, N.-F. Zhang (2017) "Estimating Error Rates for Firearm Evidence Identifications in Forensic Science," in submission.
- Goal: Determine error rates for firearms ID's using Congruent Matching Cells (CMC) method
  - CMC method originally assumed binomial distribution for matching and non-matching cells
  - New examination of beta-binomial and dependent binomial models both offer better fidelity to data

Analysis of Explosive Residues

- E. Sisco, M. Najarro, D. Samarov, J. Lawrence, "Quantifying Stability of Trace Explosives under Different Environmental Conditions," in review.
- Goal: Investigate stability of trace deposits of six explosives (ETN, PETN, RDX, HMX, TNT, Tetryl) to determine environmental stabilities and lifetimes.
  - Samples inkjet printed onto sample traps to achieve trace amounts, then exposed to 1 of 7 environments
  - Exponential decay model fit using non-linear least squares, false discovery rate controlled in pairwise comparisons of decay rates for each explosive

Summary

- Statistics Focus Area in NIST Forensic Science Research program covers use of statistics in both fundamental and applied projects
- Some areas overlap with CSAFE research (e.g. footwear analysis and firearms ID) and some do not (e.g. drug ID/purity and DNA)
- A wide range of statistical methods have been used, as appropriate, in different applications