Strengthening the Science in Forensic Science

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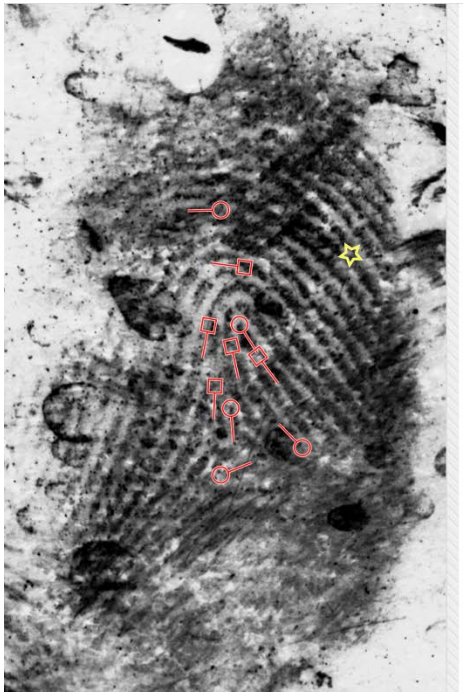
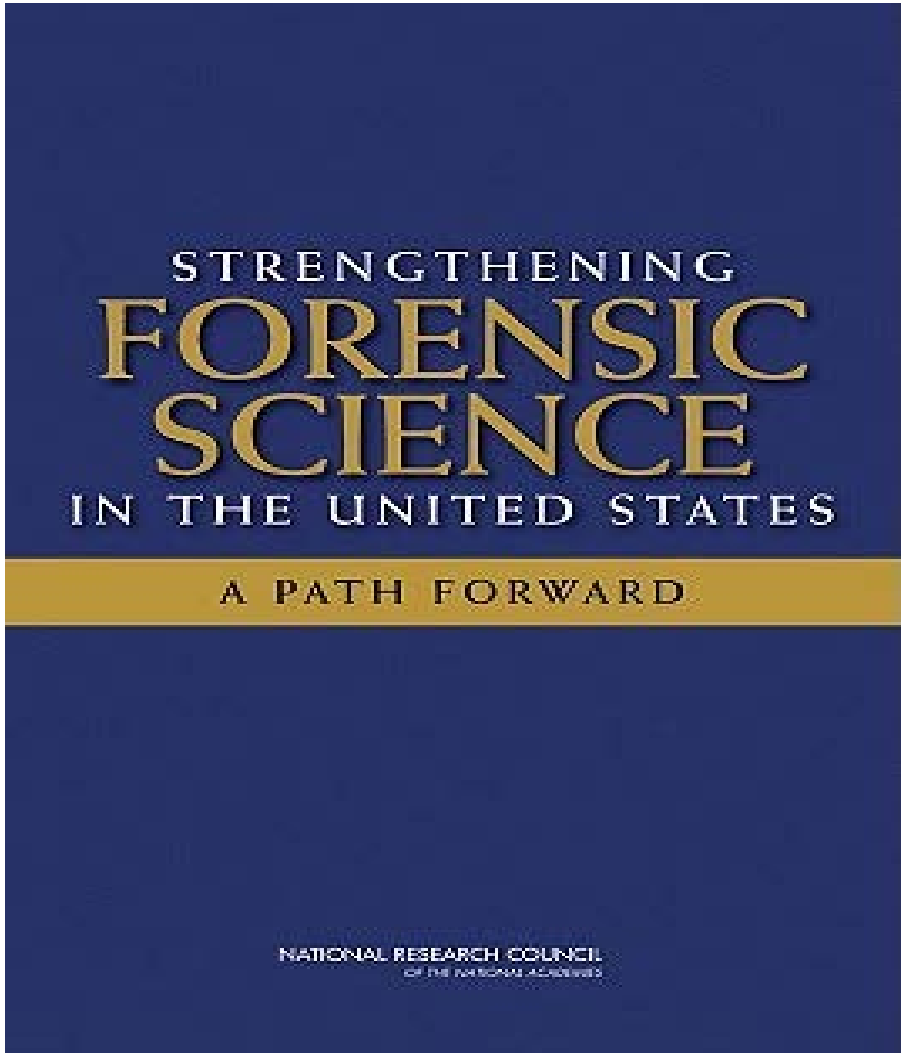


Known shoe

Crime scene impression


STRENGTHENING
FORENSIC
SCIENCE
IN THE UNITED STATES
A PATH FORWARD
NATIONAL RESEARCH COUNCIL

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THE IMPACT OF FORENSIC SCIENCE RESEARCH AND DEVELOPMENT

A community in transition

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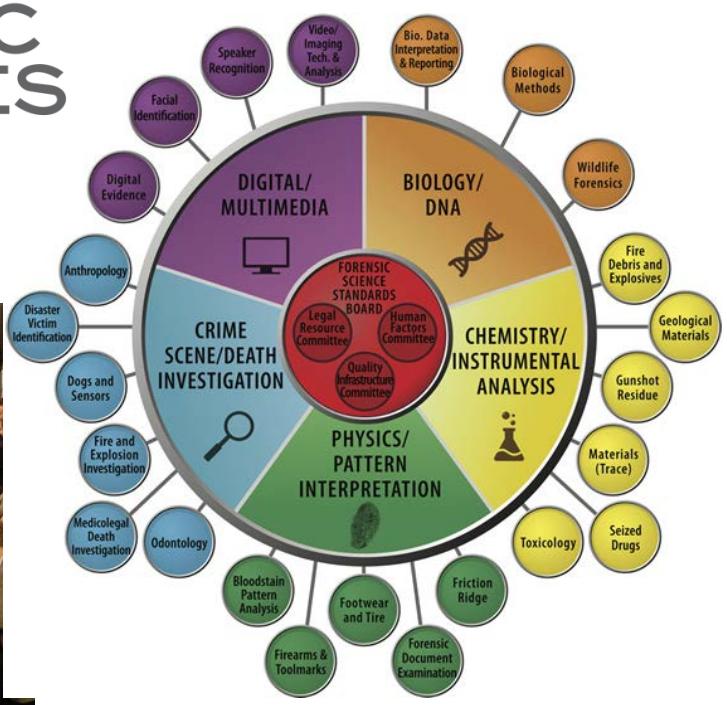
NIST FORENSIC SCIENCES



Discussion - Kafadar

- Eyewitness identification is error-prone
  - Innocence Project results are striking
- Memory of witnesses is affected by a wide range of factors
  - Case-related (age, conditions, distance, time elapsed, etc.)
  - Procedural (line-up, instructions, feedback, etc.)
- Important role for experimental design
  - Use design principles in developing appropriate procedures (blinding, obtain EW input promptly)
  - Statistical designs for evaluating procedures (simultaneous/sequential, role of jury instructions)
- Statistical modeling strategies – find relevant covariates (e.g., confidence of witness)
- Statistical analysis tools – use of ROC curves, logistic models for studying eyewitness accuracy

Discussion - Winkel

- Firearms (also toolmarks) – e.g., matching cartridge cases
- Very common form of "pattern evidence"
- Standard approach
  - Practitioner identifies regions of interest in crime-scene casing images (questioned)
  - Practitioner examines analogous regions in test-fire casing images from suspect weapon (known)
  - If sufficiently similar, examiner is likely to identify the weapon as the source of the crime-scene casing ("an identification")
  - But … How likely is it to obtain similar markings from another weapon
- Here a distance-measure is developed
  - Need to assess distribution of distances among casings fired from same gun
  - Need to assess distribution of distances among cases fired from different guns (e.g., how do we sample these?)

Discussion - Neumann

- Fingerprints – pattern evidence that is relevant in many, many cases
- Standard approach similar to what was previously described for firearms
- Neumann and collaborators are leading the efforts to develop Bayes factors (likelihood ratios) for latent prints
  - BF = $Pr(E \mid H_p) / Pr(E \mid H_d)$
  - BF assists trier of fact to assess evidence and update beliefs about H_p and H_d
  - BFs are challenging for pattern evidence
    - Data is high-dimensional
    - Great deal of flexibility in identifying features
    - Not obvious what probability models to use
    - How to represent the "relevant population" in the denominator
- Today – Linear random effects model to build Bayes factor based on inter-feature distances
  - Statistical questions:
    - Does parameterization in terms of tau's help? Perhaps just underlying "true" d_ij.
    - Dependence among multiple measures involving the same feature (e.g., one point distorted in the print)

Discussion - Spiegelman

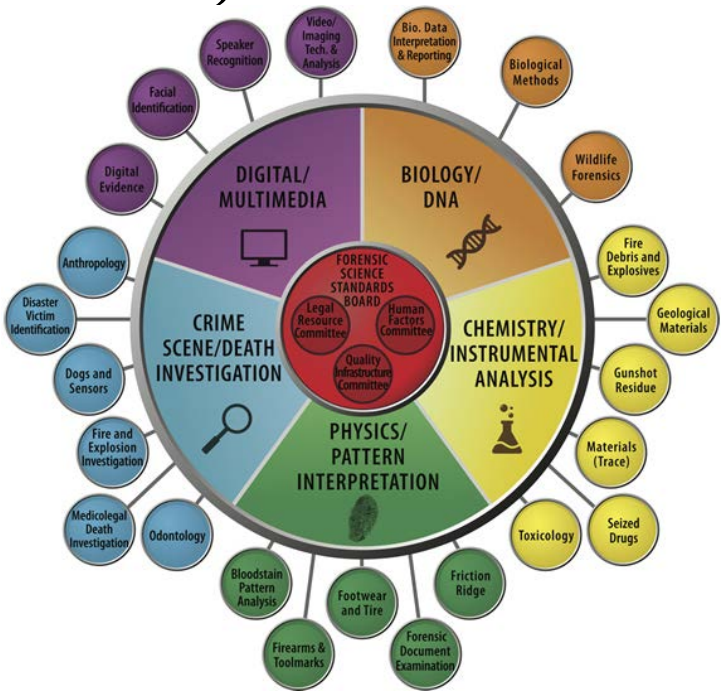
- Biomarkers (e.g., genetic predictor of disease) and Forensic markers (e.g., evidence of arson at a fire scene)
- A critical statistician's perspective – we can bring experience from one discipline to another
- Important lessons to consider
  - Statistical samples rather than anecdotal evidence
  - Study sample should be representative of the population of interest
    - Appropriate variability
    - Danger of selective sampling
  - How do we convey uncertainty?
- Two relevant forensic disciplines
  - Arson – older anecdotal theories about indicators of arson not supported by current understanding and test fires
  - Blood pattern analysis – absence of studies with known truth (e.g., was this pattern causes by a bullet)

Statistics in Forensic Science

- Studies that provide information about the forensic evidence type under study
  - Determinants of eyewitness accuracy
  - Effect of judge's instructions on jury weighing of eyewitness testimony
  - Test fires in arson
- Studies of the reliability and accuracy of forensic examiners
  - Reliability
    - Does a given forensic examiner reach the same conclusion given the same data
    - Do different forensic examiners reach the same conclusion from a given data set
  - Accuracy
    - How well do examiners do in cases with known ground truth (black box study)
  - Role of Context (non task-relevant information)
- Developing quantitative approaches to the evaluation and interpretation of evidence
  - Likelihood ratio / Bayes factors

How can I get involved?

- ASA Advisory Committee on Forensic Science (Chair: Karen Kafadar, Vice-Chair: Hal Stern)
- Organization of Scientific Area Committees (OSAC) for Forensic Science – aiming for a statistician on each subcommittee
- Questions?
- Contact: sternh@uci.edu



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