Latent Print Analysis

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CSAFE
Center for Statistics and
Applications in Forensic Evidence

Latent Print Analysis: Broad Themes

Areas

- Evidence Assessment: Quality Metrics

- Proficiency Testing & Quality Assurance

- Case Processing

Emphasis on

- Coordination across team projects

- Applied studies

- Demonstrable impact & transferability

CSAFE 1.0 Accomplishments

Quality Metrics for Latent Fingerprints

Goal: Calibrate values of QMs to "accuracy of assessment" in latent print examinations

Major Accomplishments:

- Identified features (characteristics) of "quality" and distinctiveness that LPEs have associated with "value" on assessing usability of print.

-- Researched available algorithms that can be implemented on latent print images

-- Implemented two algorithms (code) plus *FRstat* (code not available)

-- Initiated tests on latent prints through HFSC's QA program

Impact:

-- Demonstrated feasibility of calculating quantitative "quality" scores in latent prints

-- Illustrated its use in a forensic lab as "prototype" for other labs

-- Introduced objectives and value of quantitative QMs to forensic lab personnel

CSAFE 1.0 Accomplishments

Latent Fingerprint Proficiency Testing (3 CSAFE 1.0 projects)

Goals:

- Better understand commercially available latent print proficiency tests (e.g., difficulty, examiner perceptions)
- Facilitate implementation of blind proficiency testing

Major Accomplishments:

- Established collaboration with a primary provider of forensic science proficiency tests (Collaborative Testing Services, Inc); practitioner surveys distributed with proficiency tests
- Webinar: implementation & maintenance of blind QC program at Houston Forensic Science Center
- 2-day meeting at Allegheny County Office of the Medical Examiner; report and webinar
   8 quality managers, 4 lab directors, Chief Medical Examiner, Director of education from 7 lab systems

Impact:

- FS Publications on proficiency testing process (print quality, perceptions of difficulty, similarity to casework)
- Research/Quality Associate at HFSC helps to implement blind proficiency testing, introduce data collection procedures, provide immediate feedback to the lab
- Strong collaboration between lab managers & QA professionals in adopting blind proficiency tests

*Projects will be merged to form CSAFE 2.0

CSAFE 1.0 Accomplishments

Forensic Processing and Human Factors at Crime Laboratories (2 CSAFE 1.0 projects)

Goals:

- Establish collaboration with a crime lab
- Document latent print workflow to identify areas for potential improvement
- Explore task relevance and knowledge of error rates

Major Accomplishments:

- CSAFE-sponsored webinar, publication, presentation: latent print processing procedures at HFSC
- Hired Research/Quality Associate at HFSC: data collection, blind quality control), provide immediate feedback to lab → Strong & productive collaboration between crime lab QM academic researchers

Impact:

- Publications for FS Community communicating:
  - Examination of case flow in a crime lab
  - Analyst attitudes and perceptions of error in FS field
  - Requests for task-irrelevant information in evidence submission forms
  - Analyst perceptions of what information is relevant to their analytical tasks

*Projects will be merged to form CSAFE 2.0 LPA IV project

CSAFE 1.0 Accomplishments: Example

Project Title: Collecting, Understanding and Reporting Fingerprint Evidence

Goal: Improve analysis of latent prints on seized drug bags

Accomplishments:

- Understand Former Standard Operating Procedure: Sample bags, empty chosen bags, weigh contents, store drug in new bag, infer total drug weight, analyze original bags.

- Study 1 (4 analysts): effects of heat & humidity on ninhydrin processing on drug ID and accurate weighings (none); identify best method for capturing fingerprints (Magnetic powder > DFO, NHy, DFO + NHy)

- Study 2: Compare ratings scales (Modified Dove scale > original) & image styles

Impact:

- Change in ACOME's Standard Operating Procedure: safer process for personnel

2.0 Research Area Objectives

Fingerprints: valuable as probative evidence, remain key for many legal decisions.

- Most common form of pattern evidence analysis

- Issues remain: Real-world accuracy, Probability of "coincidental" match

Accuracy in assessments is closely related to quality of evidence.

- Latent print examiners agree: accuracy of conclusions depends on #features & "quality".

- Need empirical evidence to quantify relationship between quality/number of minutiae & examiner assessments in lab environments

Goals: Enhance understanding of latent print analysis & examination:

- Study relationship between output of quality metrics for image quality & accuracy of assessments in real-world case processing

- Studies of proficiency testing

- Studies of forensic processing in crime labs.

CSAFE 2.0 Latent Print Projects and Lead Investigators

LPA I- Predicting Accuracy of Forensic Evidence Assessments using Quality Metrics
Lead PI: Karen Kafadar, UVA

LPA II- Implementing Item Response Theory to Improve Proficiency Testing for Pattern Evidence
Lead PI: Amanda Luby, Swathmore College

LPA III- Blind Proficiency Testing
Lead PI- Robin Mejia, CMU; Sharon Kelley, UVA

LPA IV- Forensic Processing at Crime Laboratories
Lead PI: Brett Gardner, UVA; Robin Mejia, CMU

LPA V- Statistical Failures in Forensic Contributions to Exoneration
Lead PI: Simon Cole, UCI

CSAFE 2.0

Predicting Accuracy of Forensic Evidence Assessments using Quality Metrics
Goal: Implement QMs in practice; establish relationship to Accuracy of Assessments
Proposed Activities:
- Solicit Crime Lab participation (beyond HFSC)
- Create Set of Test Latent Prints for blind LPEs (some have matches, some don't)
- Assess accuracy of (blind) assessments (correct inclusions/exclusions)
- Use machine learning algorithms to extract a subset of results from 3 quality metric algorithms to develop estimates of assessment accuracy based

Potential Impact:
- Enable Lab directors to prioritize workflow
- Provide estimates of accuracy of assessment based on QM scores
- Transfer research, knowledge, experience on QMs for LPs to other pattern evidence

CSAFE 2.0 Blind Proficiency Testing

Goals:

- **Expand the use of blind proficiency testing in a way that enables within and inter-lab studies**

- **Establish consortium to support blind proficiency testing (e.g., shared SOPs, best practices, possibly materials)**

Proposed Activities:

- Work with Houston Forensic Science Center and Allegheny County Office of the Medical Examiner to increase use of blind testing and analyze results

- Create consortium of labs to facilitate implementation of blind proficiency testing via published protocols, shared materials, purchasing power.

- Analyze results & assess impact of blind testing on existing QA programs.

- Extend collaboration with CTS: additional research on examiner perceptions to increase ecological validity of open proficiency tests.

Potential Impact:

Testing entire case pipeline will enable laboratories to identify process improvements.

Consortium to help set standards to aid implementation, facilitate shift to blind testing.

CSAFE 2.0

Item Response Theory for Proficiency Tests of Pattern Evidence

Goal: Provide standardized analysis methods for proficiency test results

Proposed Activities:

- Statistical & psychometric analyses of FBI "Black Box" and "White Box" studies
- Develop IRT framework for annual proficiency tests (cf SAT or ACT)
- Develop and pilot a proficiency test, containing easier and more difficult latent print comparisons

Potential Impact:

- Better understand cognitive processes involved in latent print analysis, including "verification" step of ACE-V
- Demonstrate validity and improve consistency of annual proficiency exams

2.0 Case processing at Crime labs

Goal: Study workflow differences across labs: effects of process changes & exposure to contextual information

Proposed Activities:

- Study case processing at three laboratories with contrasting policies
- Examine contextual factors and case processing variables across laboratories
- Evaluate effects of Implementing procedural changes in lab case flow where possible
- Quantify financial and operational costs of procedural changes
- Experiments on case processing of identical prints at multiple labs

Potential Impact:

- Expand & strengthen current lab collaborations between forensic professionals & academic researchers
  - Results will inform and improve routine procedures at collaborating laboratories through feedback
  - Practitioners will provide feedback and input on ongoing research
- Create exemplar for assessing electronic data to improve case processing, implementing available quality metrics, and evaluating outcomes related to procedural changes

CSAFE 2.0: Statistics, Forensic Science, and Exonerations

Goal: Improve understanding of contribution of forensic science to both proper & wrongful convictions

Proposed Activities:

- Reconcile forensic coding between National Registry of Exonerations (NRE) and IP.
- Study role of different disciplines in NRE forensic cases.
- Devise new coding scheme for forensic cases for NRE.
- Perform comprehensive study of forensic science in exoneration cases.
- Implement new, improved coding scheme for forensics for NRE going forward.

Potential Impact:

- Inform forensic community: causes of & ways to avoid unintended consequences of forensic science
- Improve accuracy to categories of forensic problems by inductively deriving categories from actual data (vs "typical" researchers' categories).
- Develop actionable recommendations concerning importance of statistical reasoning.

Resources & Needs: Engaging FS Community

- Need more labs to participate in QM study: Test prints in labs (with and without matches)

- Need more (anonymized) CTS results for robust IRT analysis

- QA managers: Do you have anonymized proficiency testing data to share?

- Forensic professionals: How can we solicit you input for this research?

- More ideas?