Handwriting Analysis

Presented by: Dr. Alicia Carriquiry

Date

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csafe
Center for Statistics and Applications in Forensic Evidence

CSAFE 1.0 Accomplishments - I

Project Title: G – Towards a Score-Based Likelihood Ratio for Handwriting Evaluation

Major Accomplishments:

- Collaborated with LAPD research on study of handwriting complexity
  - Research paper on reliability of signature complexity assessments
  - Draft manuscript on machine learning techniques for objective assessment of signature complexity
  - Consult on design of study to relate complexity to handwriting expert analyses
- Developed **handwriter** software to analyze handwriting images and extract letters/features for use in modeling handwriting evidence.
  - Research manuscript being revised for *Statistical Analysis and Data Mining*
- Developed a hierarchical model for assessing questioned sample vs databased of potential authors. Model outputs a posterior probability of writership for each potential writer in closed set.
  - Two research manuscripts in preparation.
- Data collection of 900+ writing samples from over 100 participants to support research in this area.
  - Article describing the data published in *Data in Brief.*
- Multiple invited presentations.

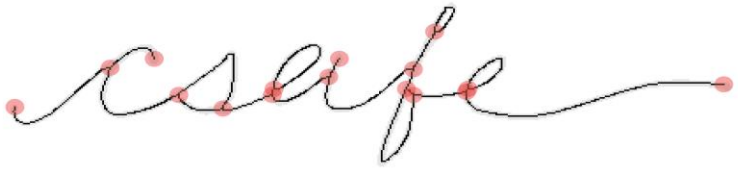
handwriter

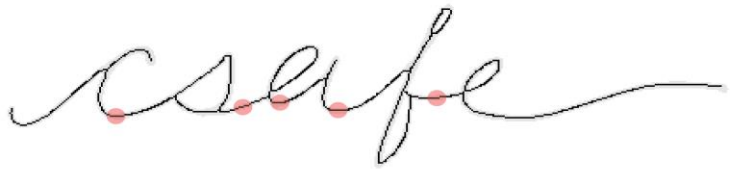
a) 

b) 

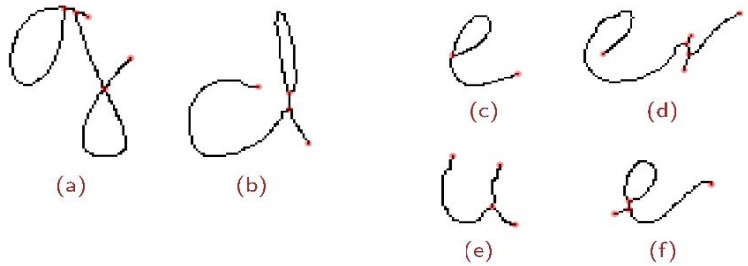
c) 

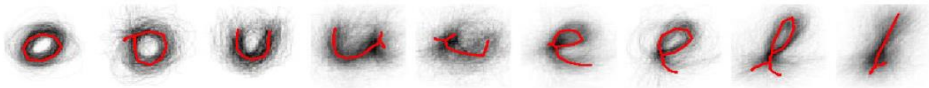
d) 

e) 

f) 

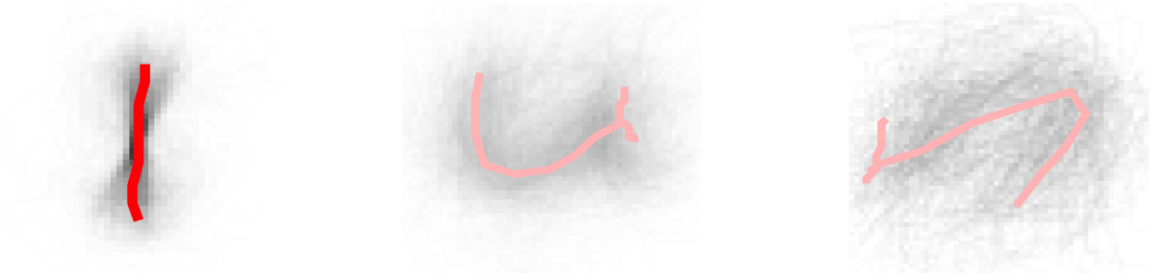
handwriter



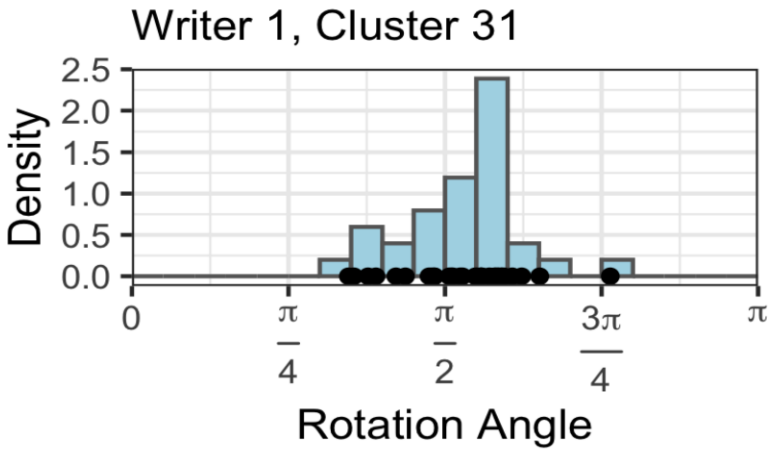


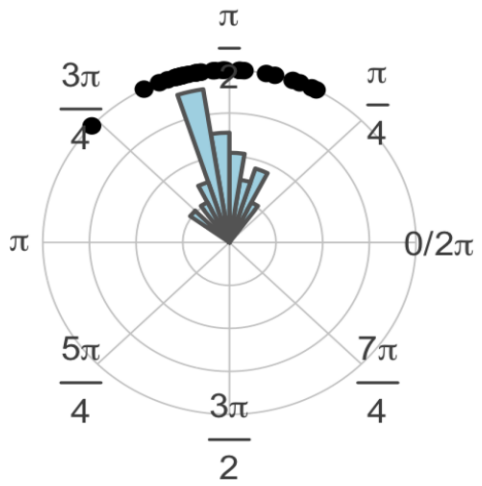
$Y_{writer(doc)}$	$Cluster_1$	$Cluster_2$	$Cluster_3$	$Cluster_4$	...	$Cluster_{39}$	$Cluster_{40}$
$Y_{1(1)}$	42	21	9	5	...	1	1
$Y_{38(2)}$	39	91	23	6	...	0	1
$Y_{95(2)}$	38	81	16	14	...	0	0
⋮							

Statistical modeling

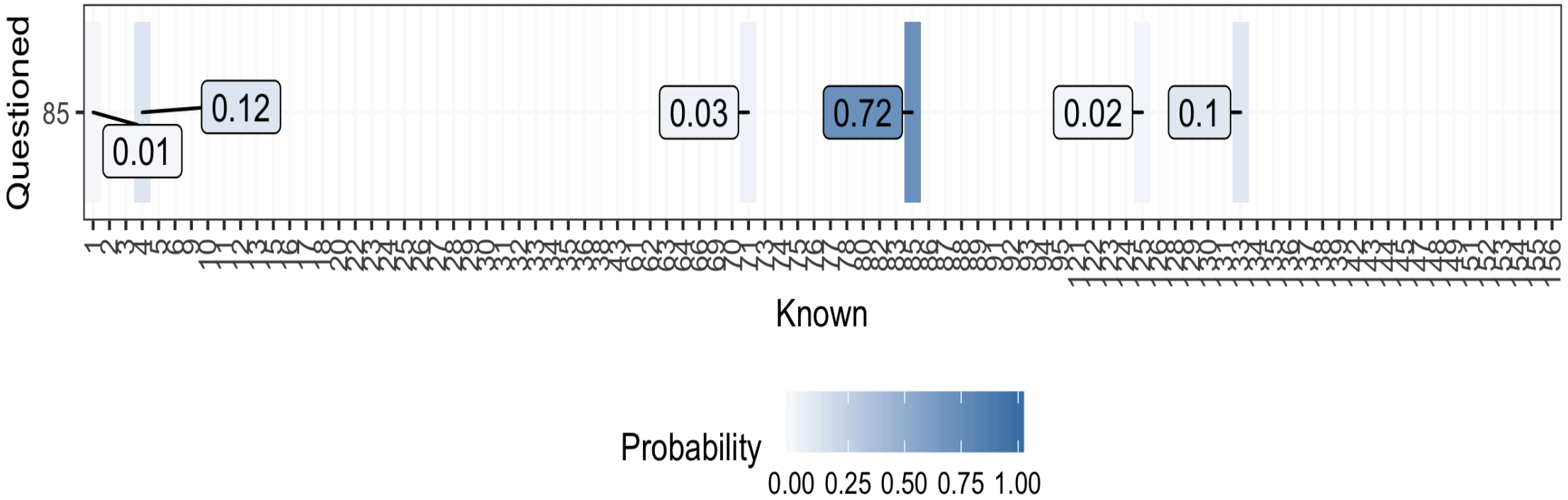


(a) Cluster #31 (b) Cluster #29 (c) Cluster #16



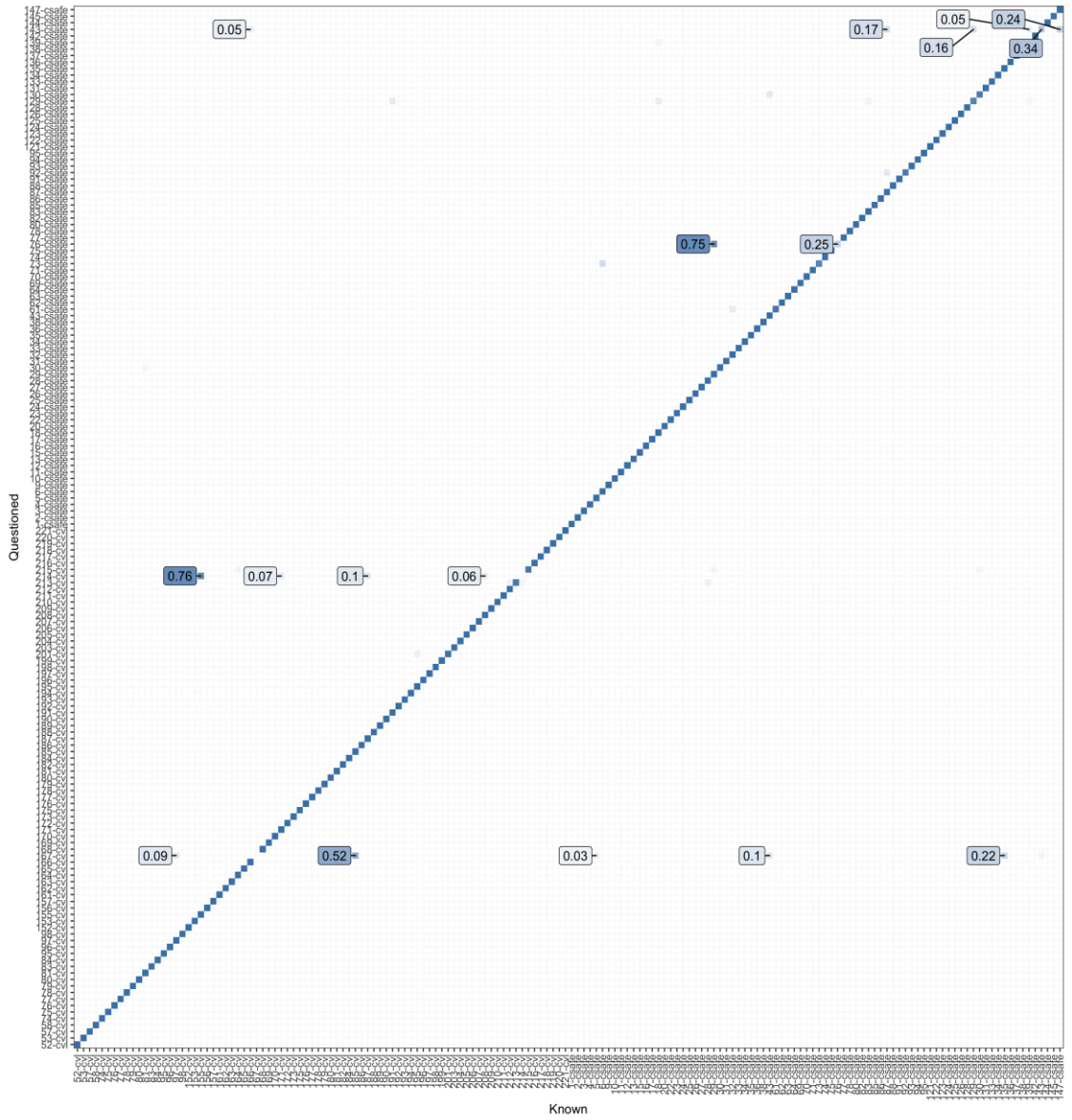


Output


Questioned
85
0.01
0.12
0.03
0.72
0.02
0.1
Known
Probability
0.00 0.25 0.50 0.75 1.00

Results I

Result is 97.34% (95.62, 98.75) of $\bar{p}$ assignments to the true writers.



CSAFE 1.0 Accomplishments - II

Project Title: G – Towards a Score-Based Likelihood Ratio for Handwriting Evaluation

Impact:

- Open-source software to analyze handwriting and identify features is a major new resource for the community. (Existing analogues are costly)
- Publicly available data is a significant new resource for the handwriting analysis research community
- Novel methodological publications on the analysis of signature complexity assessments and on analysis of handwriting samples (in a closed set)

Research Area Objectives

Forensic document examination has seen the development of a number of automated systems (e.g., FISH, WANDA, FLASH ID) capable of extracting features of writing that can then be compared between documents.

-These systems are expensive and their algorithms are proprietary.

CSAFE has developed an open-source program called **handwriter** that outputs graphs, or geometric representations of handwriting, that are reminiscent of the graphemes produced by FLASH ID.

-Used to estimate the posterior probabilities of authorship of a questioned document for writers in a closed set.

CSAFE 2.0 Objectives:

- Expanding and enhancing the statistical model to estimate probability of writership.
- Revising **handwriter,** to produce beta version.
- Continuing to collect standard writing samples from a large set of writers

CSAFE 2.0 Handwriting Projects and Lead Investigators

HW I- Handwriting Evaluation

Lead PI: Alicia Carriquiry, ISU
Co-PI: Danica Ommen, ISU

Team

Alexandra Arabio (Undergrad), Dr. Amy Crawford, Madeline Johnson (Grad), Dr. Lotem Kaplan, James Kruse (Grad), John Libert (NIST), Madison McGregor (Undergrad), Robert Ramotowski (NIST), Anyesha Ray (Undergrad), James Taylor (Undergrad).

Collaborators

Gary Licht (Iowa DCI).

CSAFE 2.0 – Research Plan

- Better understand limitations of current modeling approach, including the number of clusters in which to group similar graphs.
- Explore utility of adding document-level and graph-level features to probability model.
- Relax the requirement that the set of potential writers be closed.
- Extensively stress-test **handwriter**. Validate the program on a wide variety of writing samples. Produce a well-documented beta version to community of potential users.
- Design a quality metric for handwriting that can be included as part of the estimate of probability of writership.

Resources and Needs

- There are at least three ways in which input and participation by questioned documents examiners (QDEs) will be critical:
  - Collection of realistic handwritten samples to add to the database.
  - Beta-testing of **handwriter**.
  - Calibration of **handwriter** relative to QDEs assessments.

Thanks for joining us today

We welcome your insights, suggestions, participation!

Please contact us:

www.forensicstats.org

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