FORENSICS @ NIST | #NISTForensics

Five decades of fingerprint research at NIST

Elham Tabassi
Information Technology Laboratory
7 November 2018

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

… October 1966

PAGE 10 IDENTIFICATION NEWS OCTOBER-NOVEMBER, 1966

AUTOMATION AND THE FINGERPRINT EXPERT

EDITOR'S NOTE: One of the first articles of its kind, "Automation and the Fingerprint Expert" was originally delivered at the 21st Annual Conference of the I.D./I.A.I. on June 28, 1966, by Mr. C. Lester Trotter, Assistant Director of the F.B.I. We believe that you will find the subject matter both interesting and timely.

I bring to you personal greetings from the Director of the FBI, Mr. John Edgar Hoover, who sends his best wishes for a most successful and informative conference.

We are continually fascinated by things automatic, or self-moving. While automation has become a by-word since the invention of the electronic computer, actually automation has been steadily progressing since the advent of the Industrial Revolution and is an entirely accepted part of our everyday life. derstandable that some of us may be inclined to attribute almost a human status to an automated object.

The electronic computer actually is a glorified coin operated vending machine. A coin inserted, a selection of merchandise is made, the machine delivers the merchandise and possibly delivers change. And it can but deliver only the merchandise with which it has been stocked, or programmed, to deliver.

The electronic computer, a post World War II development, is a fantastic device. It has been adapted to a number of occupational applications which have been impressively successful, as for example, control of airline reservations, income tax return review and space technology. Adaptation of the electronic computer to the searching and maintenance of a ridge formation on a given card with other cards in the fingerprint file having the same gross ridge characteristics in an attempt to identify a prior recording of the same fingerprint impressions. His eye and brain make allowances for distortion and of variations in the legibility of the pattern ridges. The eye and the brain also readily discard fingerprints in the file which are different in the smallest particular from the one being searched. The technician also recognizes the need for and conducts all reference searches which might be necessary due to illegibility, distortion or borderline patterns.

Having found a fingerprint record with similar ridge formation, our fingerprint technician can positively and irrefutably identify it, once and for all, in a fraction of a minute. After the appropriate

Functions of the Fingerprint Expert

First let us review briefly the unctions a fingerprint technician

Computerizing Fingerprints Problem Is Different

Most of the successful applications of the computer to the economy involve the processing of sta-

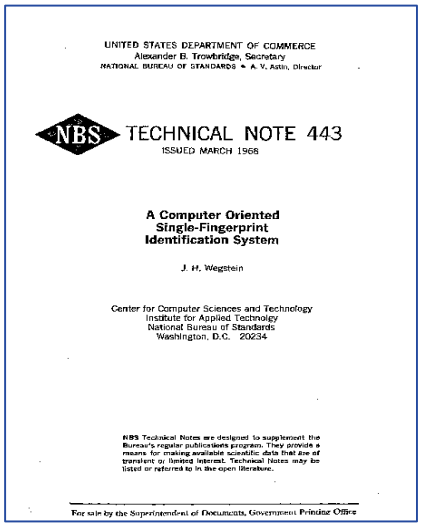
Let's Use the Machine

Since the computer has such phenomenal reaction time, we should

Latent Prints

It is extremely doubtful that the searching of a crime scene latent fingerprints can be adapted to computer operation within the foreseeable future. The problems of dis-

… research in friction ridge


UNITED STATES DEPARTMENT OF COMMERCE
Alexander B. Trowbridge, Secretary
NATIONAL BUREAU OF STANDARDS • A. V. Astin, Director

NBS TECHNICAL NOTE 443
ISSUED MARCH 1968

A Computer Oriented Single-Fingerprint Identification System

J. H. Wegstein

Center for Computer Sciences and Technology
Institute for Applied Technology
National Bureau of Standards
Washington, D.C. 20234

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NBS TECHNICAL NOTE 466
ISSUED JULY 1968

Matching Fingerprints by Computer

J. H. Wegstein and J. F. Rafferty

Center for Computer Sciences and Technology
Institute for Applied Technology
National Bureau of Standards
Washington, D. C. 20234

and

Walter J. Pencak

Federal Bureau of Investigation
Washington, D. C. 20535

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Maurice H. Stans, Secretary
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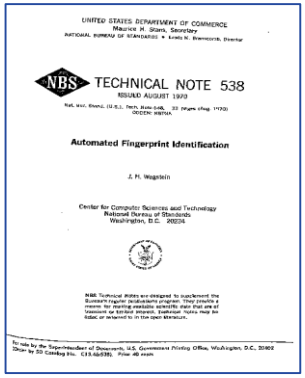
NBS TECHNICAL NOTE 481
ISSUED APRIL 1969

A Semi-automated Single Fingerprint Identification System

J. H. Wegstein

Center for Computer Sciences and Technology
Institute for Applied Technology
National Bureau of Standards
Washington, D.C. 20234

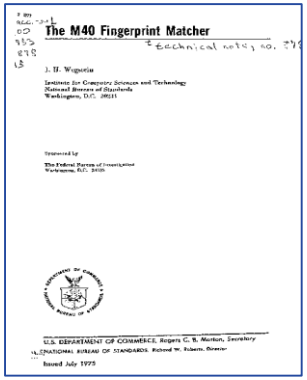

UNITED STATES DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary
NATIONAL BUREAU OF STANDARDS • Lewis M. Branscomb, Director

NBS TECHNICAL NOTE 538
ISSUED AUGUST 1970

Automated Fingerprint Identification

J. H. Wegstein

Center for Computer Sciences and Technology
National Bureau of Standards
Washington, D.C. 20234


The M40 Fingerprint Matcher

Technical note no. 719

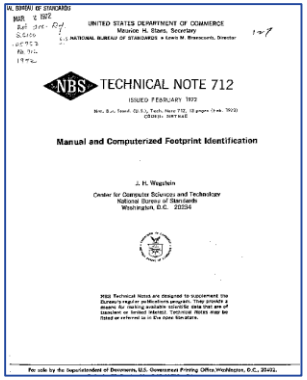
J. H. Wegstein

Institute for Computer Sciences and Technology
National Bureau of Standards
Washington, D.C. 20211

Sponsored by
The Federal Bureau of Investigation
Washington, D.C. 20535

U.S. DEPARTMENT OF COMMERCE, Rogers C. B. Morton, Secretary
NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

Issued July 1975

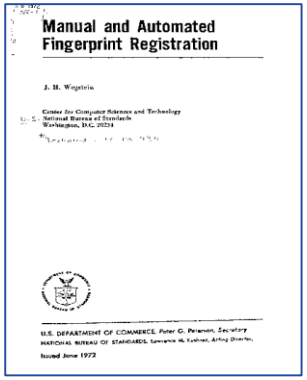

UNITED STATES DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary
NATIONAL BUREAU OF STANDARDS • Lewis M. Branscomb, Director

NBS TECHNICAL NOTE 712
ISSUED FEBRUARY 1972

Manual and Computerized Footprint Identification

J. H. Wegstein

Center for Computer Sciences and Technology
National Bureau of Standards
Washington, D.C. 20234

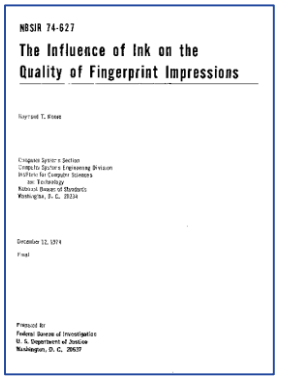

Manual and Automated Fingerprint Registration

J. H. Wegstein

Center for Computer Science and Technology
National Bureau of Standards
Washington, D.C. 20234

U.S. DEPARTMENT OF COMMERCE, Peter G. Peterson, Secretary
NATIONAL BUREAU OF STANDARDS, Lawrence M. Kushner, Acting Director

Issued June 1973


NBSIR 74-627

The Influence of Ink on the Quality of Fingerprint Impressions

Raymond T. Moore

Computer Systems Section
Center for Systems Engineering Division
Institute for Computer Sciences
and Technology
National Bureau of Standards
Washington, D. C. 20234

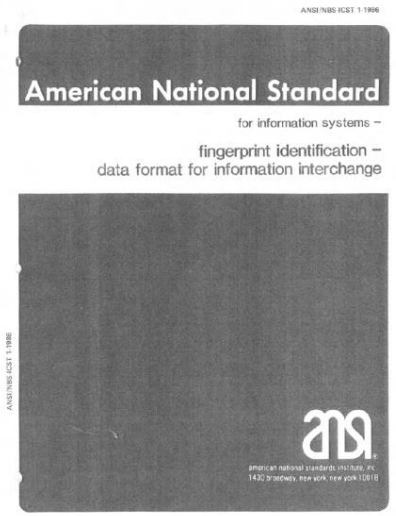
December 12, 1974

Final

Prepared for
Federal Bureau of Investigation
U. S. Department of Justice
Washington, D. C. 20537

… standards for friction ridge

Another key landmark in our work occurred in 1986 with the introduction of the ANSI/NIST Standard for the exchange of fingerprint information between systems.



American National Standard
for Information Systems –

Fingerprint Identification –
Data Format for Information Interchange

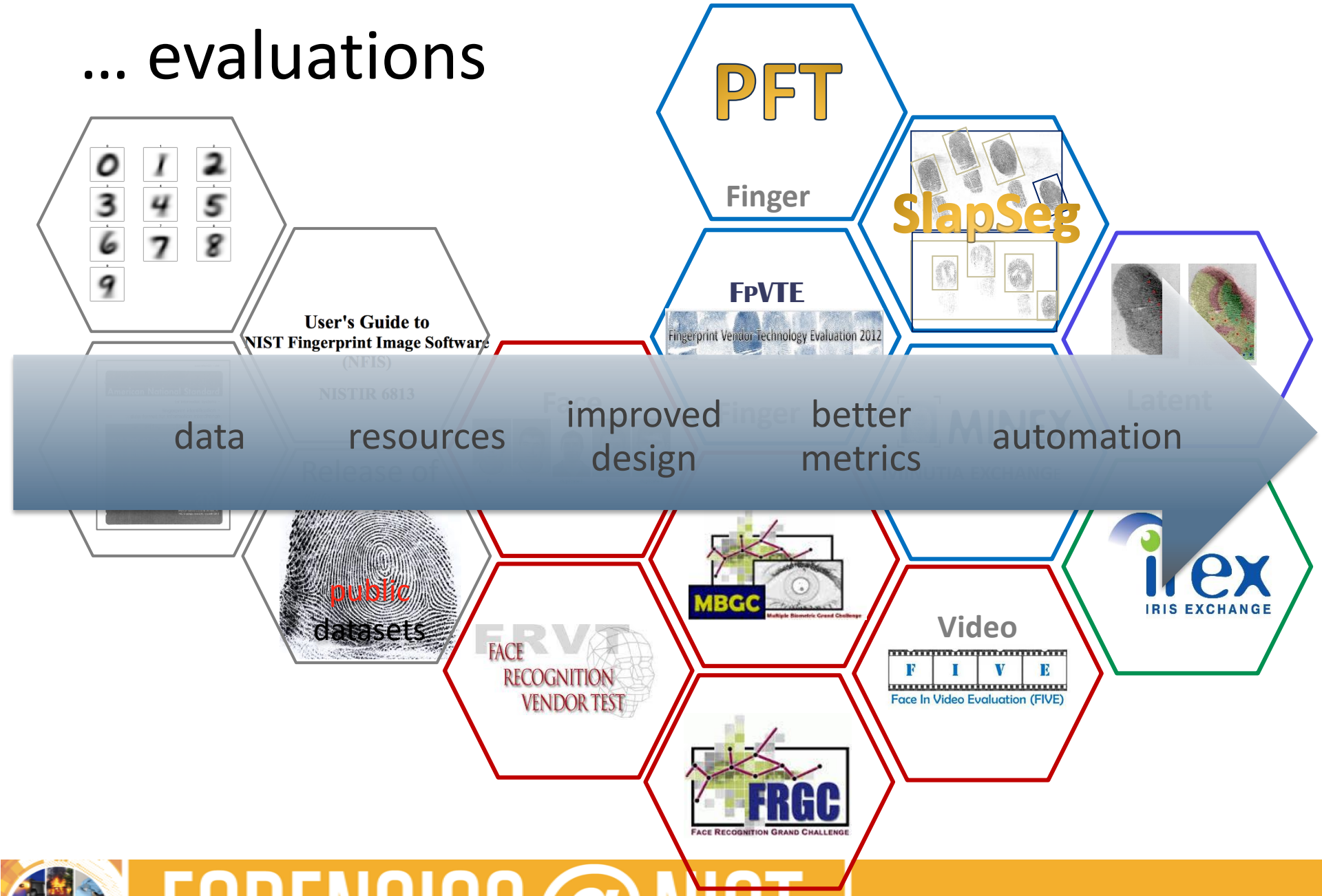
Sponsor

Institute for Computer Sciences and Technology
of the National Bureau of Standards

Approved August 25, 1986

American National Standards Institute, Inc

… evaluations



Latent fingerprint matching accuracy

Poor Ridge Clarity

Partial Ridge Area

Complex Background

AFIS Performance (Rank-1 accuracy)

- Plain: 98.5%
- Latent: 67.2% (70.2% with image + markup)

C. Watson, G. Fiumara, E. Tabassi, S. L. Cheng, P. Flanagan, W. Salamon. Fingerprint Vendor Technology Evaluation, NISTIR, 8034, 2012.
* M. Indovina, V. Dvornychenko, R. Hicklin, and G. Kiebuzinski. ELFT-EFS Evaluation of Latent Fingerprint Technologies: Extended Feature Sets, NISTIR, 2012.

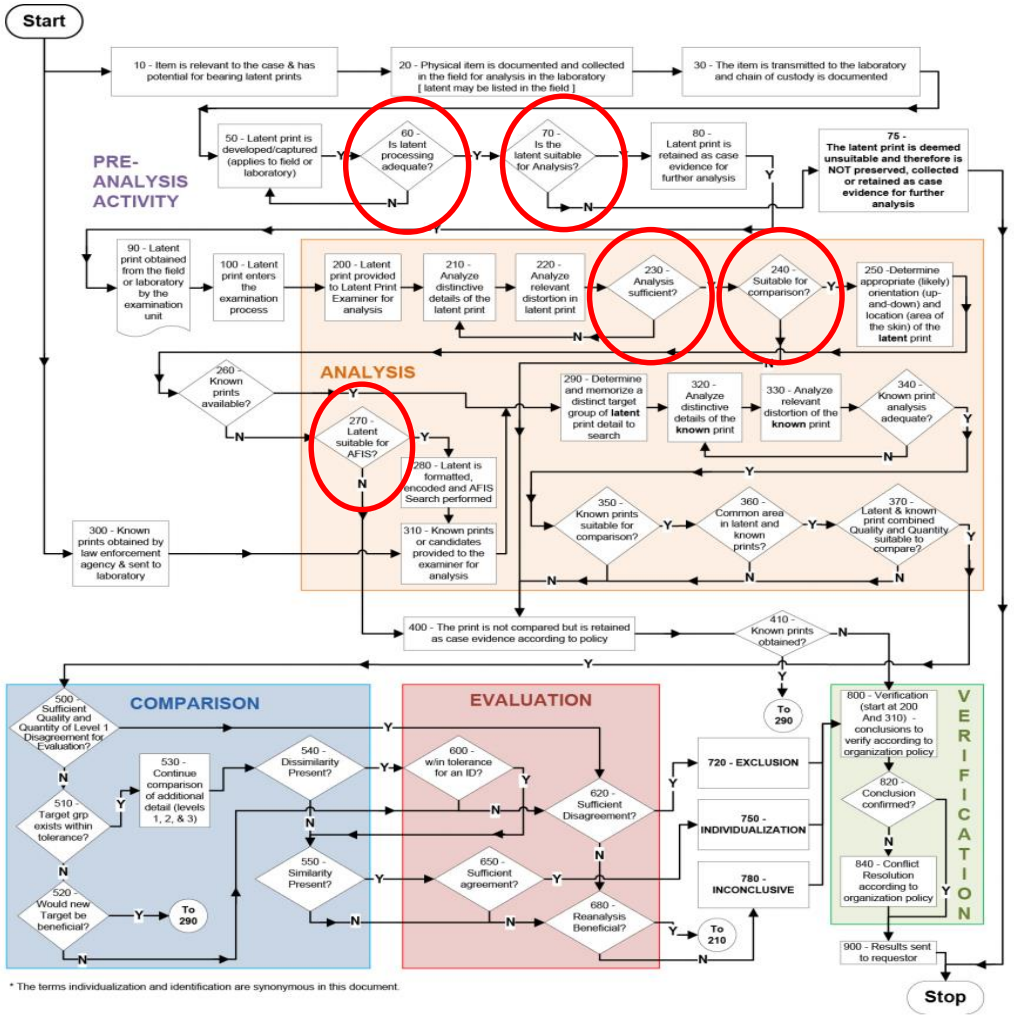
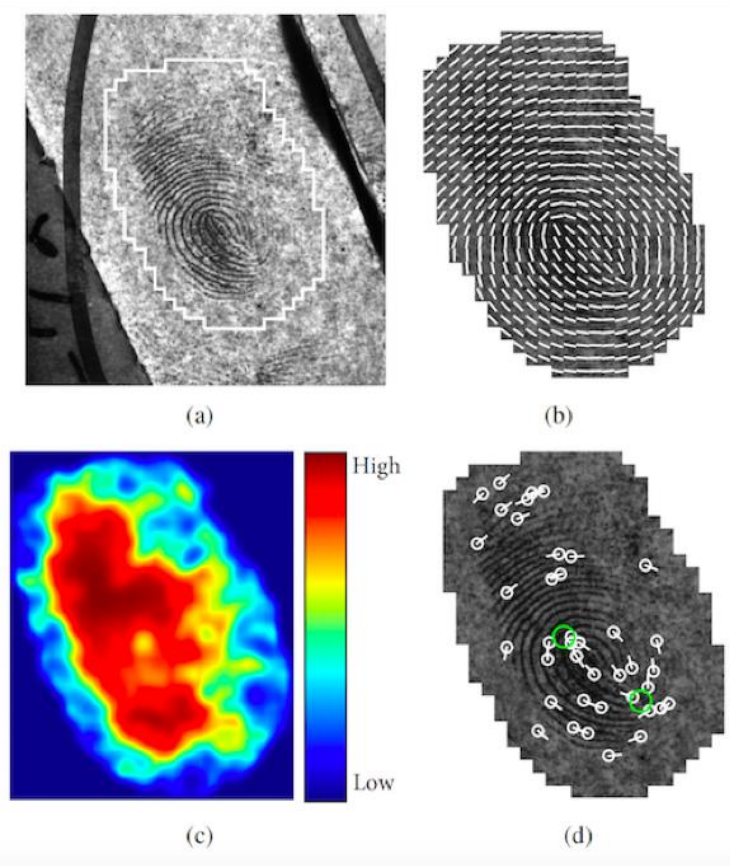


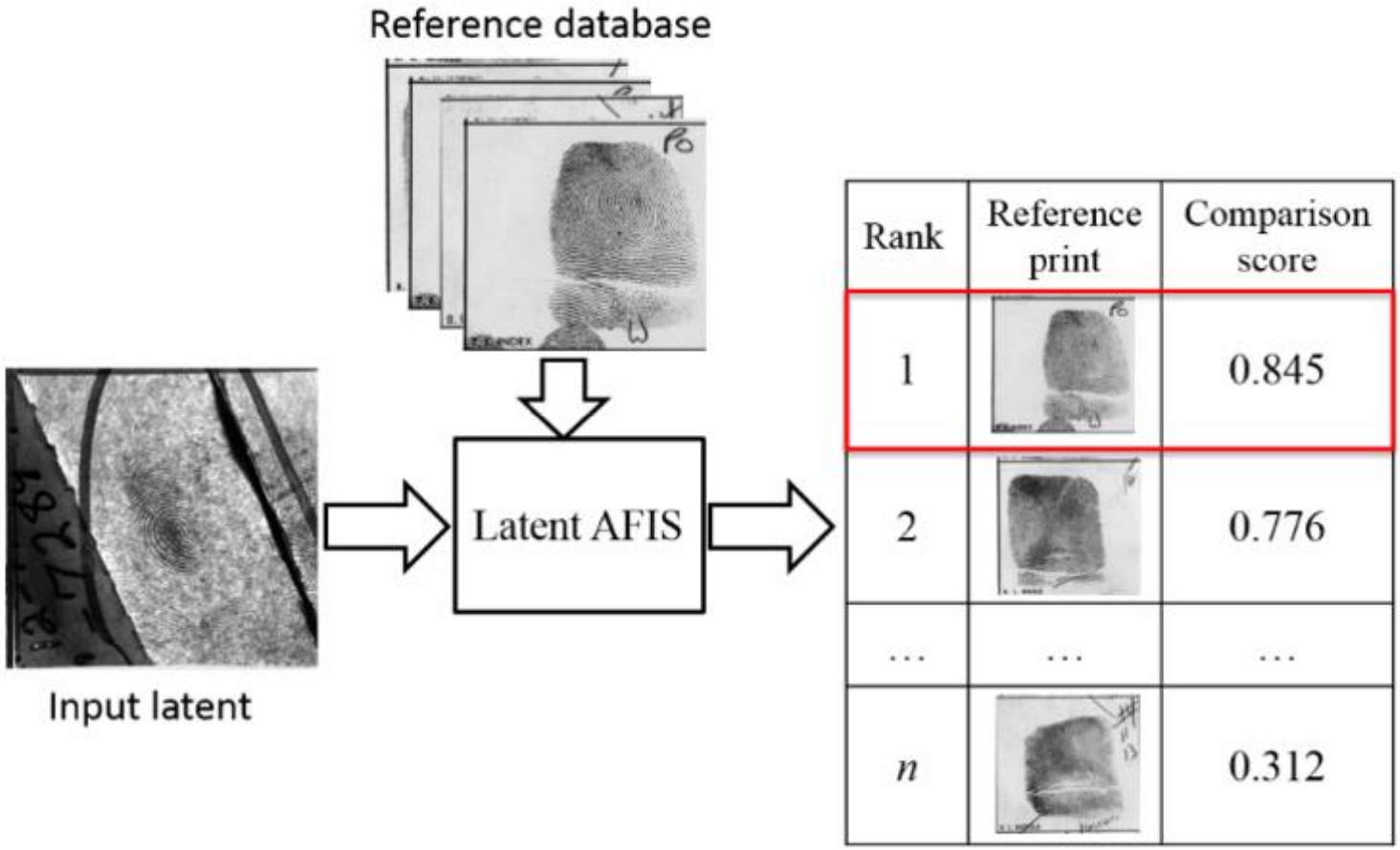
Figure 1.1: The Latent Print Examination Process Map

Latent image quality



Latent Fingerprint Value Prediction: Crowd-based Learning,
IEEE Transactions on Information Forensics and Security
Volume: PP Issue: 99, September 2017

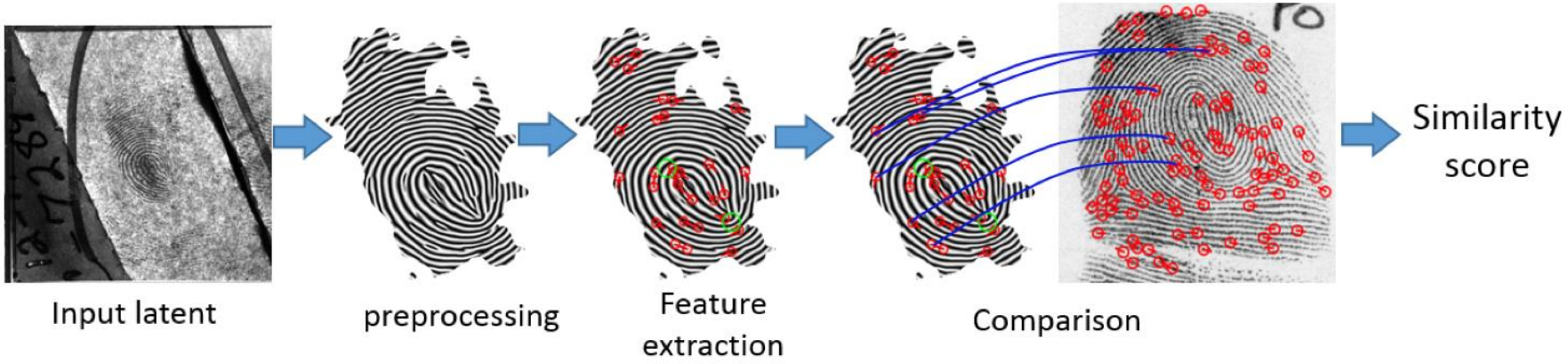
Open source latent recognition algorithm



The “lights-out” capability for latent search is one of the major objectives of FBI’s Next Generation Identification program (Next Generation Identification, 2016).
It is also a priority in the NRC (2009) and PCAST (2016) reports.

Open source latent recognition algorithm Technical approach

- 500 ppi – MSU + IARPA project. NIST will evaluate the algorithm.



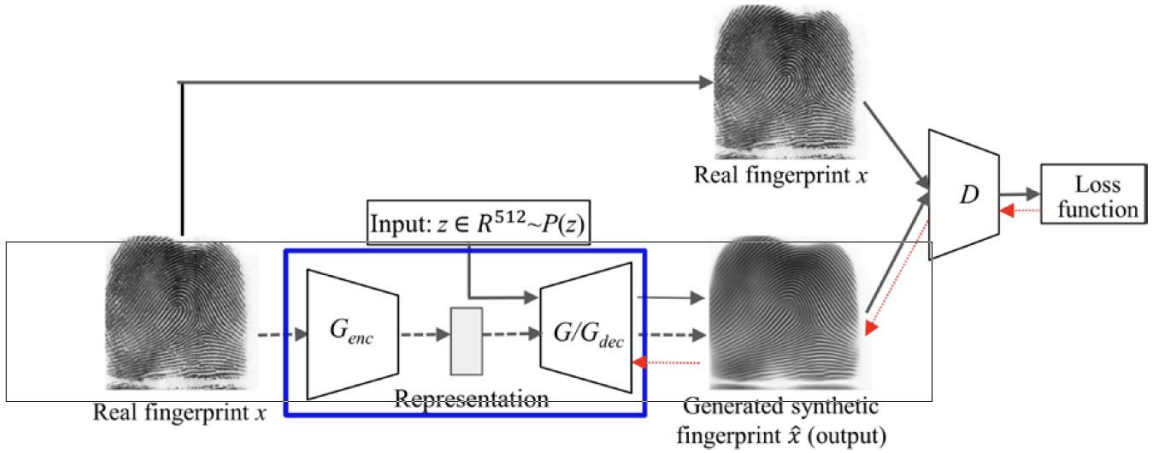
K. Cao and A. K. Jain, "Automated Latent Fingerprint Recognition", *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 2018.

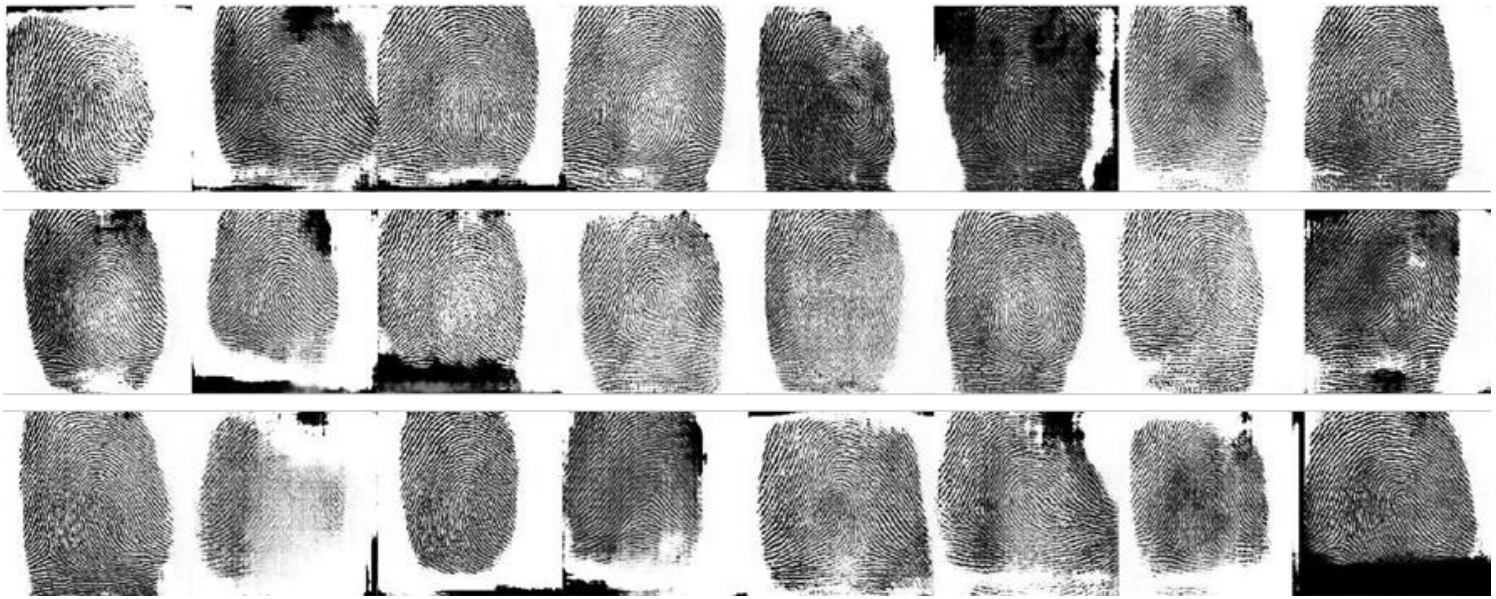
- 1000 ppi – Deep learning based approach

Data – Real

The Making of NIST Special Database 302: Greg Fiumara

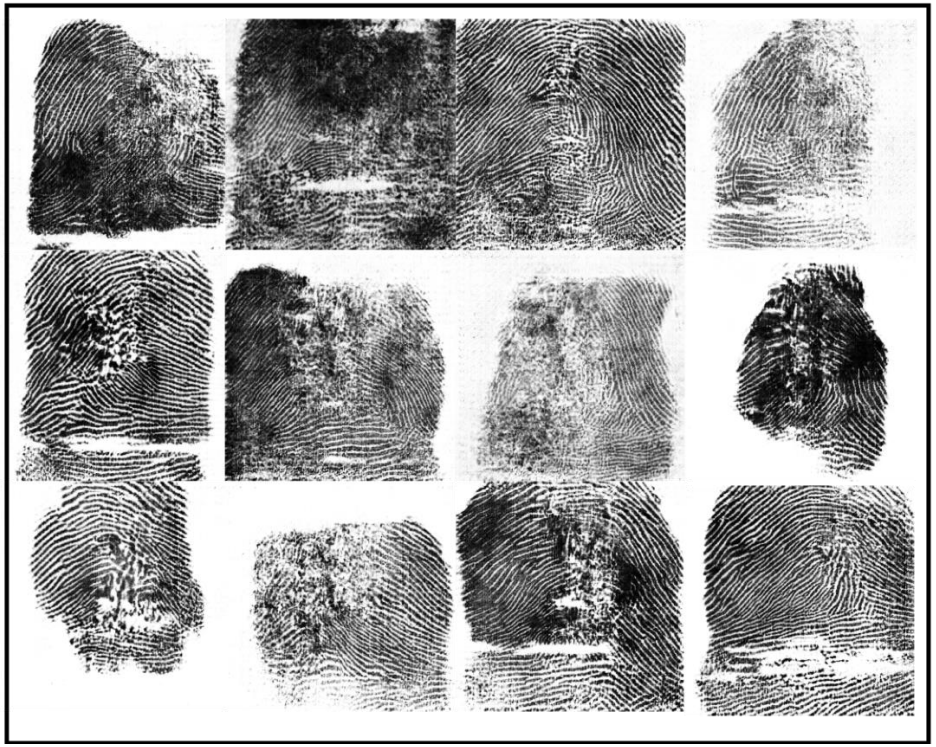
Data – Synthetic



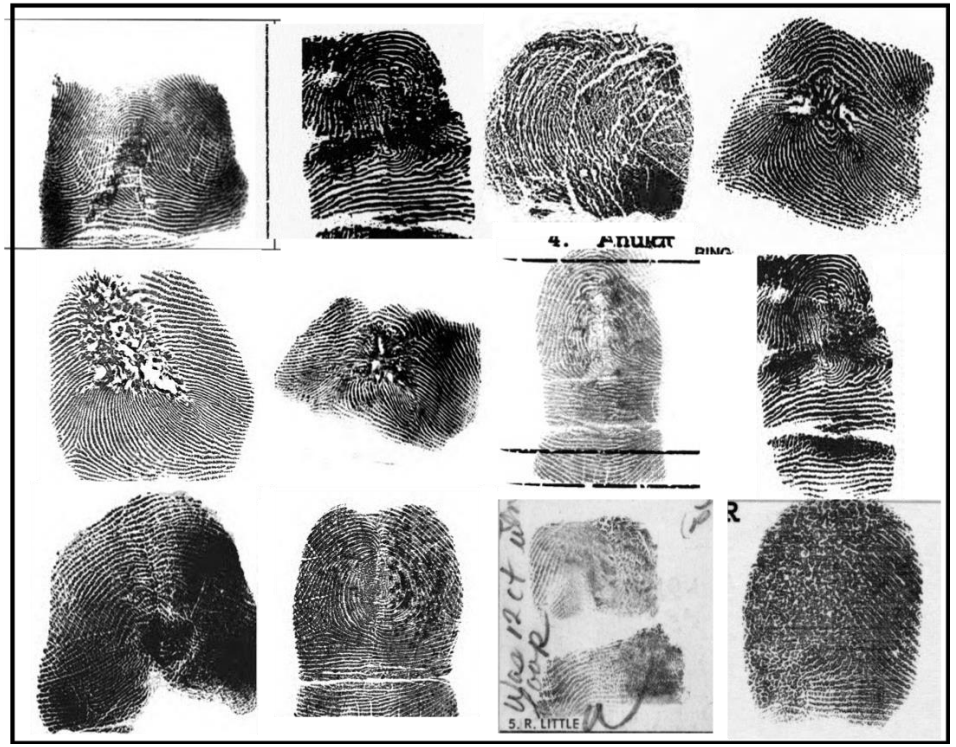


Data – Real and Synthetic

Synthetic Altered Fingerprints

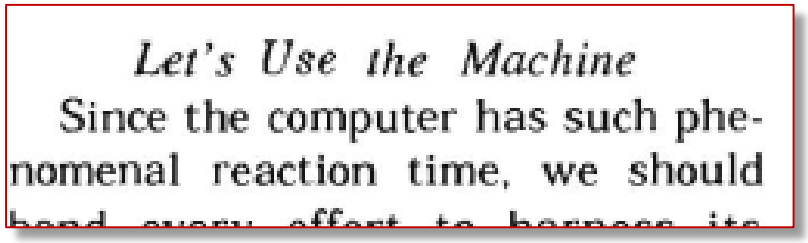


Operational Altered Fingerprints



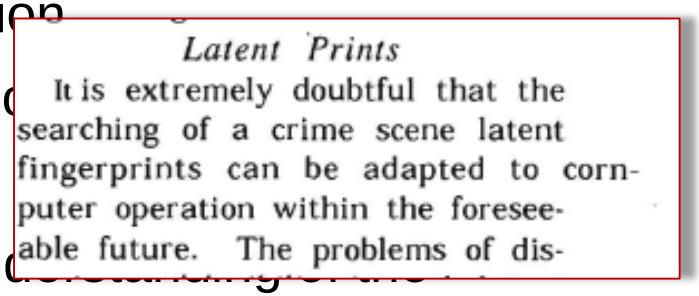
Research area

- Examining discriminating value of the various ridge formations and clusters of ridge formations
  - Close non-matches
  - Rarity of features
- Measuring information content
  - Sufficiency for individualization or exclusion
  - Uncertainty of individualization or exclusio
- Population statistics
  - provide examiners with a more robust und prevalence of different ridge flows and crease patterns



Let's Use the Machine

Since the computer has such phe-
nomenal reaction time, we should



Latent Prints

It is extremely doubtful that the searching of a crime scene latent fingerprints can be adapted to corn-puter operation within the foresee-able future. The problems of dis-

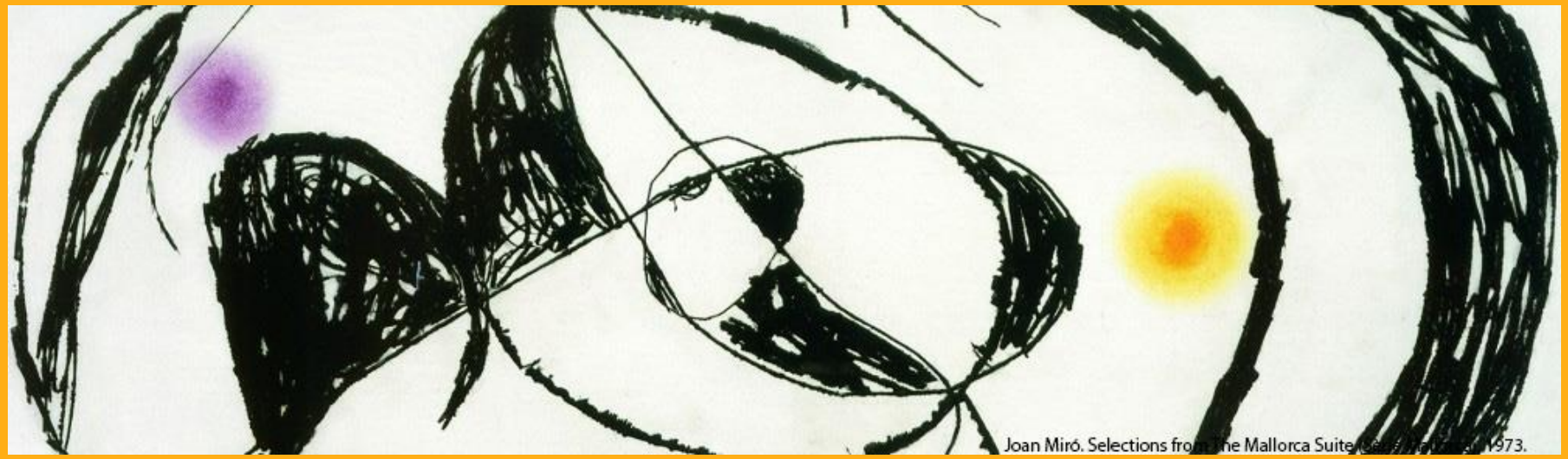
- Large scale Latent evaluation
- Presentation attack detection

The Making of NIST Special Database 302
Greg Fiumara

The confidence interval for the likelihood ratio with application to biometrics data
Larry Tang

Towards objective methods

A framework to understand, analyze and quantify errors and uncertainty in friction ridge forensic determination.



Joan Miró. Selections from the Mallorca Suite, 1973.

Let's Use the Machine

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