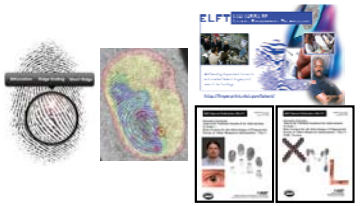
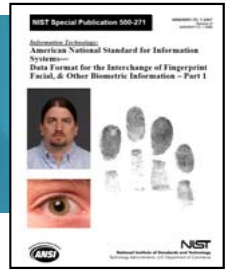
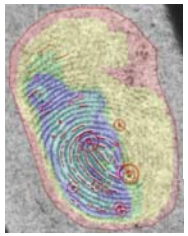
NIST Forensic Science Activities: Latent Fingerprints

2009 National Academies Report

"Strengthening Forensic Science in the United States: A Path Forward"







- Accuracy, reliability, and validity of latent fingerprint analysis
- Standards for data interoperability & sharing
- Human factors research to advance validation, reliability & proficiency testing
- Advanced measurement of technologies to automatically map, record & recognize latent fingerprint features

"promote the development of forensic science [as applied to latent fingerprints] into a mature field of multi-disciplinary research and practice"

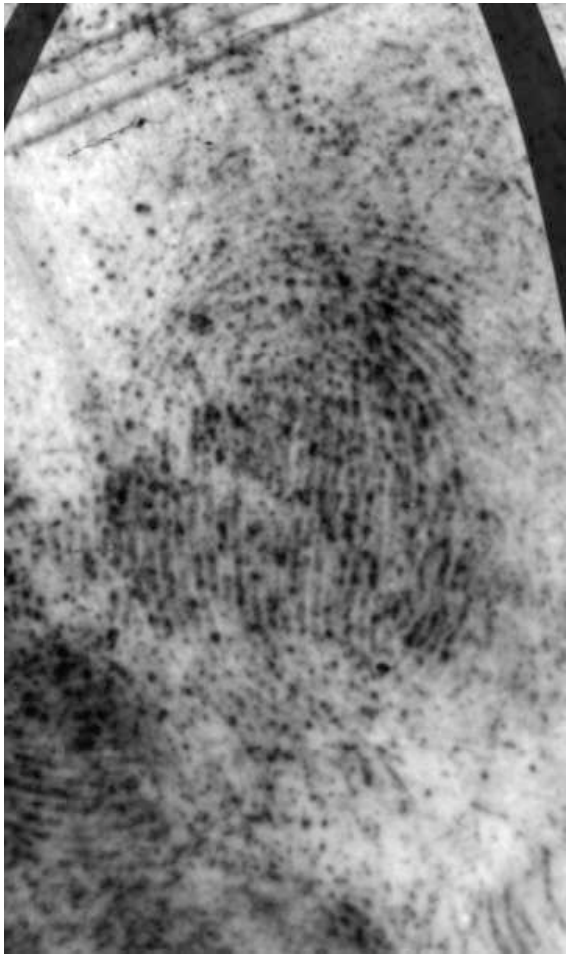
What are Latent Fingerprints?

“Conventional” Fingerprints

Rolled (ink capture)

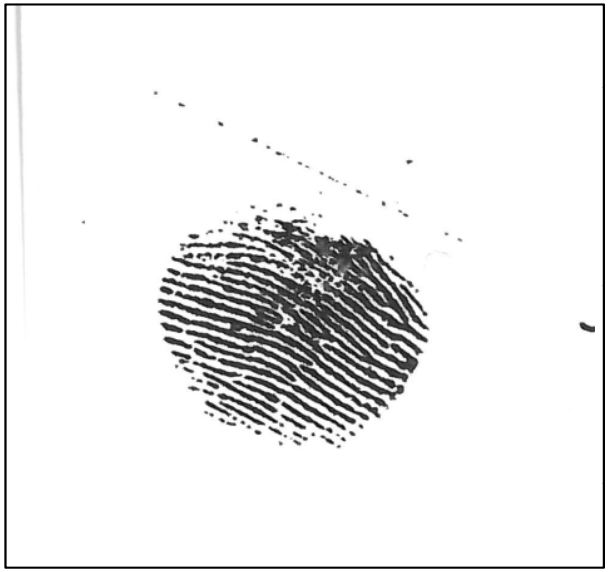
Plain (ink capture)

Latent Fingerprint
(powder lift)



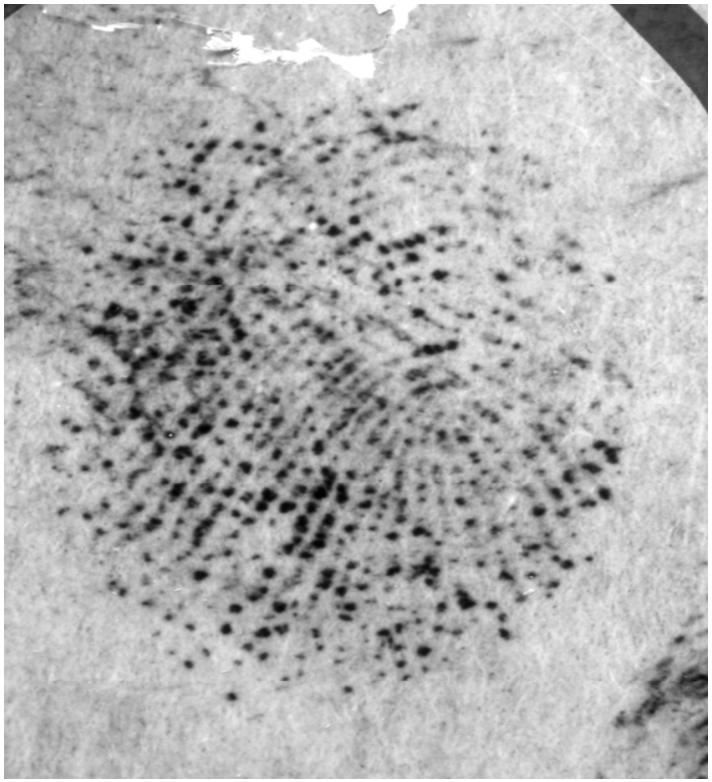
Why Are Latents Difficult?

Tip



Smudge

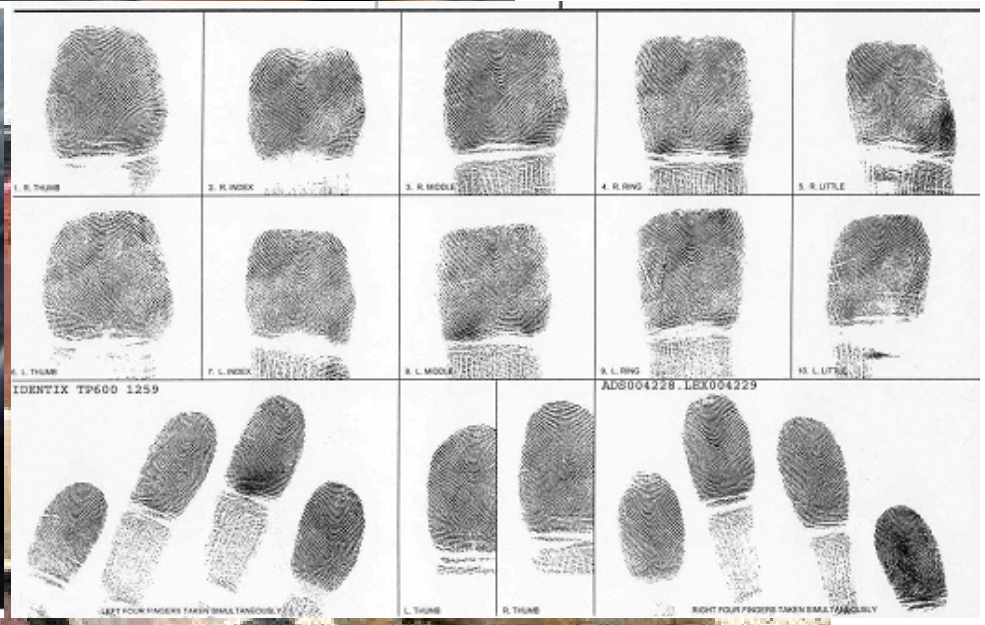
Discontinuous Ridges

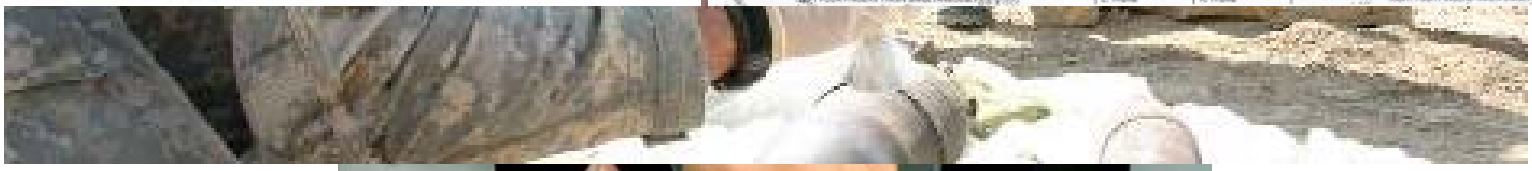


Why Are Latents Important?

Homeland Security

Law Enforcement / Criminal Justice

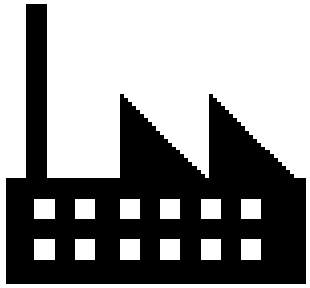




NIST Fingerprint Milestones

- **1960s** – NIST reports feasibility of automated fingerprint matching
- **1986** – 1st standard for fingerprint exchange: ANSI/NIST
- **2000** – ANSI/NIST widely used in the US and internationally
- **2003** – 1st large-scale automatic fingerprint matching test (FpVTE)
  - DHS uses results for developing operational systems
- **2006** – NIST initiates testing of latent fingerprint matching systems
- **2009** – NIST tests use of extended features sets for latent ID
  - FBI uses results for Next Generation Identification system
- **2010** – ANSI/NIST adopts extended feature sets

Customers and Community



Industry

- **Developers & Researchers:**
  - **Measurement & failure analysis**
  - **Standards**
  - **Conferences, Journals**
  - **Reference data**

Academia

NIST

Government

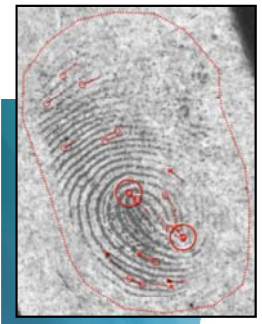
- **Users & Practitioners:**
  - **Performance rankings**
  - **System integration & tuning**
  - **Standards**
  - **Conferences, Workshops**

Law Enforcement

Framework: Latent ID Search

Automated Latent Identification System (AFIS)

Latent Fingerprint & Search Features

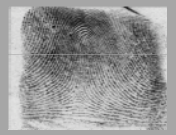


Input

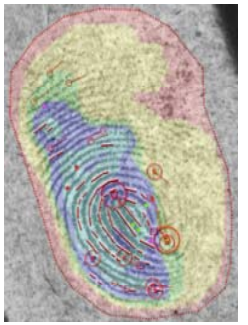
Output

Mark-up

List of Candidates

Rank	Subject ID	Candidate Print
1	0733091	
2	1304033	
3	3952340	
...		
20	0847121	

Latent Fingerprint & Comparison Features



Compare *Compare* *Compare*

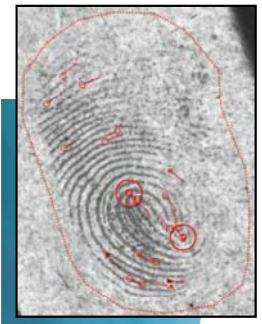
Examiner & Workstation

Examiner & Workstation

Latent Workstation

Automated Latent Identification System (AFIS)

Latent Fingerprint & Search Features



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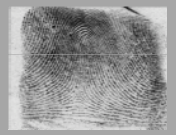
1	0733091	
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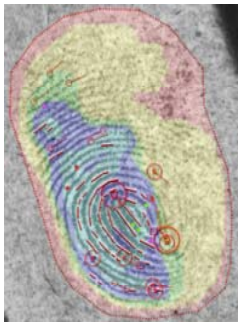
Latent Fingerprint & Comparison Features



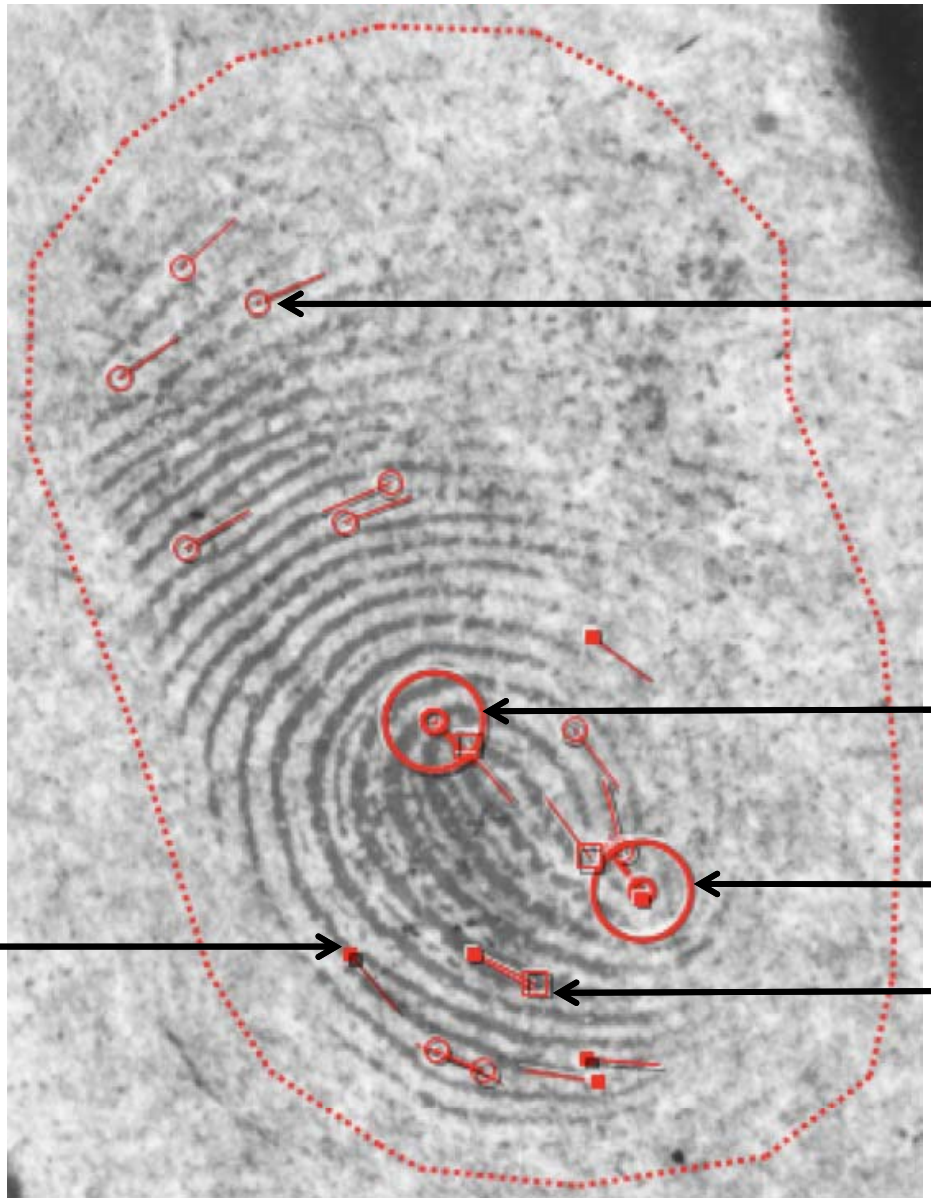
Compare *Compare* *Compare*

Examiner & Workstation

Examiner & Workstation

Latent Workstation: Feature Markup

Examiner & Workstation



Latent Workstation Screenshot

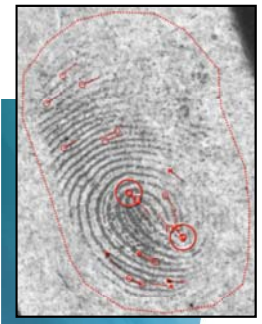
Usability Research

- Design **tools and human-computer interfaces** that are efficient, effective, and intuitive
- New interaction paradigms: moving away from mouse-and-click to **touch technologies that mimic the way examiners work** with photographs, loupes, and pins
- Elimination of examiner bias through **standardization of processes and procedures**
- Promote **validity, reliability, and traceability**

Interoperable Feature Standards

Automated Latent Identification System (AFIS)

Latent Fingerprint & Search Features



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Mark-up

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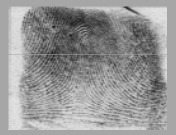
1	0733091	
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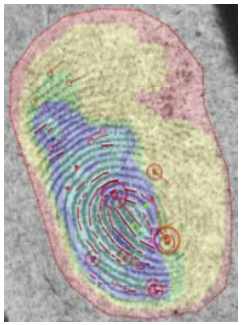
Latent Fingerprint & Comparison Features

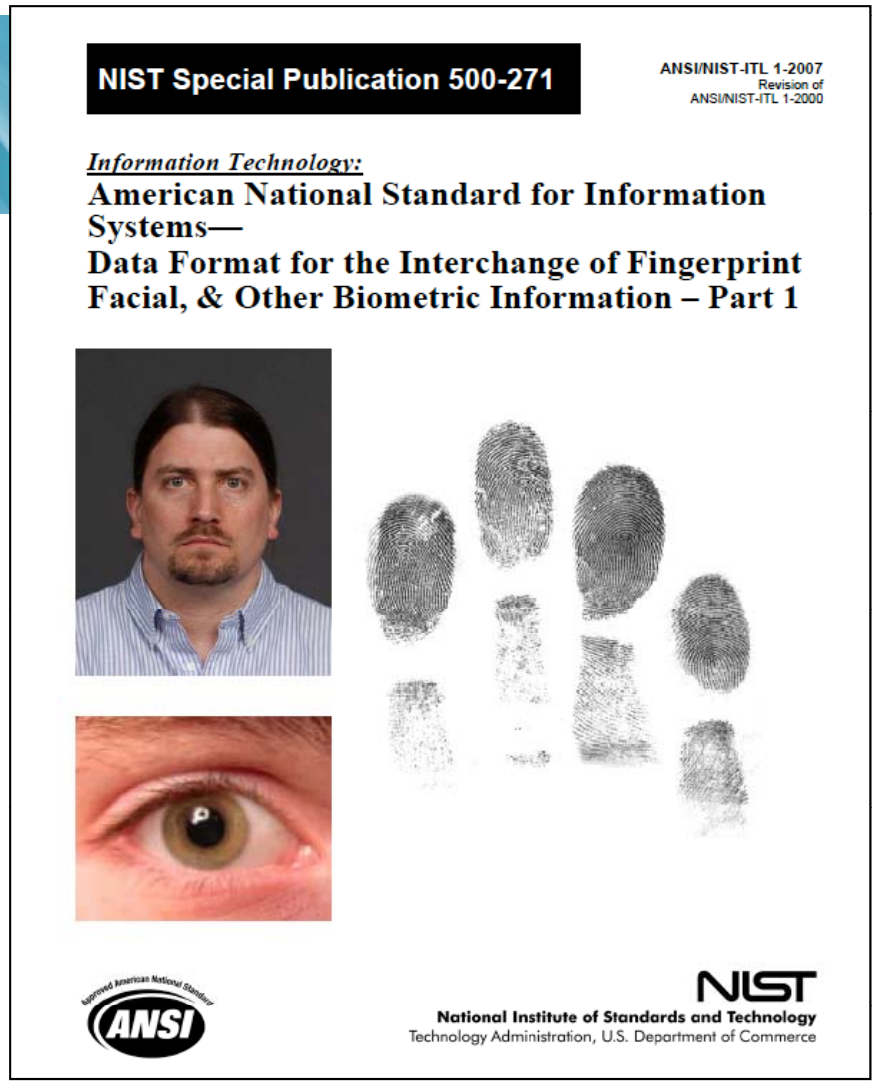


Compare *Compare* *Compare*

Examiner & Workstation

Examiner & Workstation

The ANSI / NIST-ITL Standard

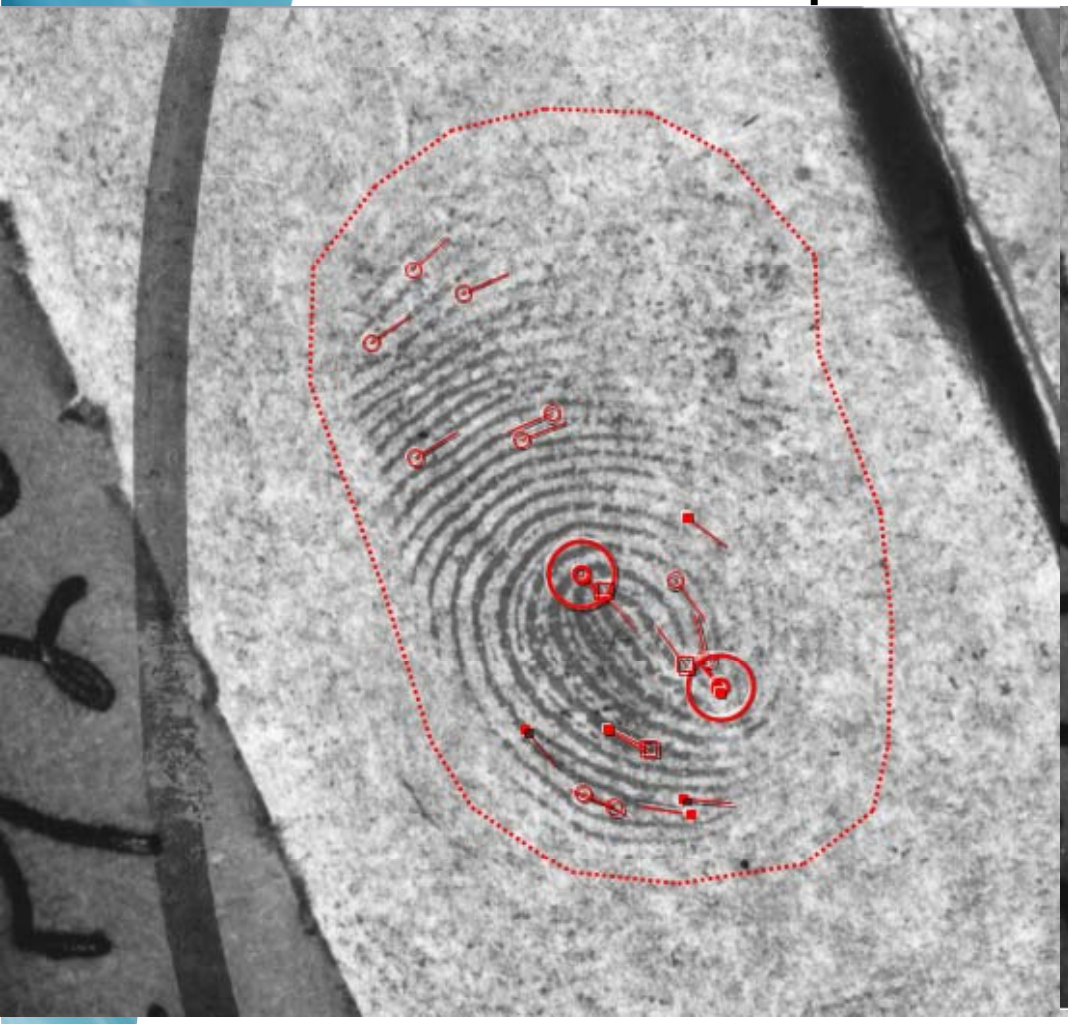


Legacy of Evolving Interoperability:

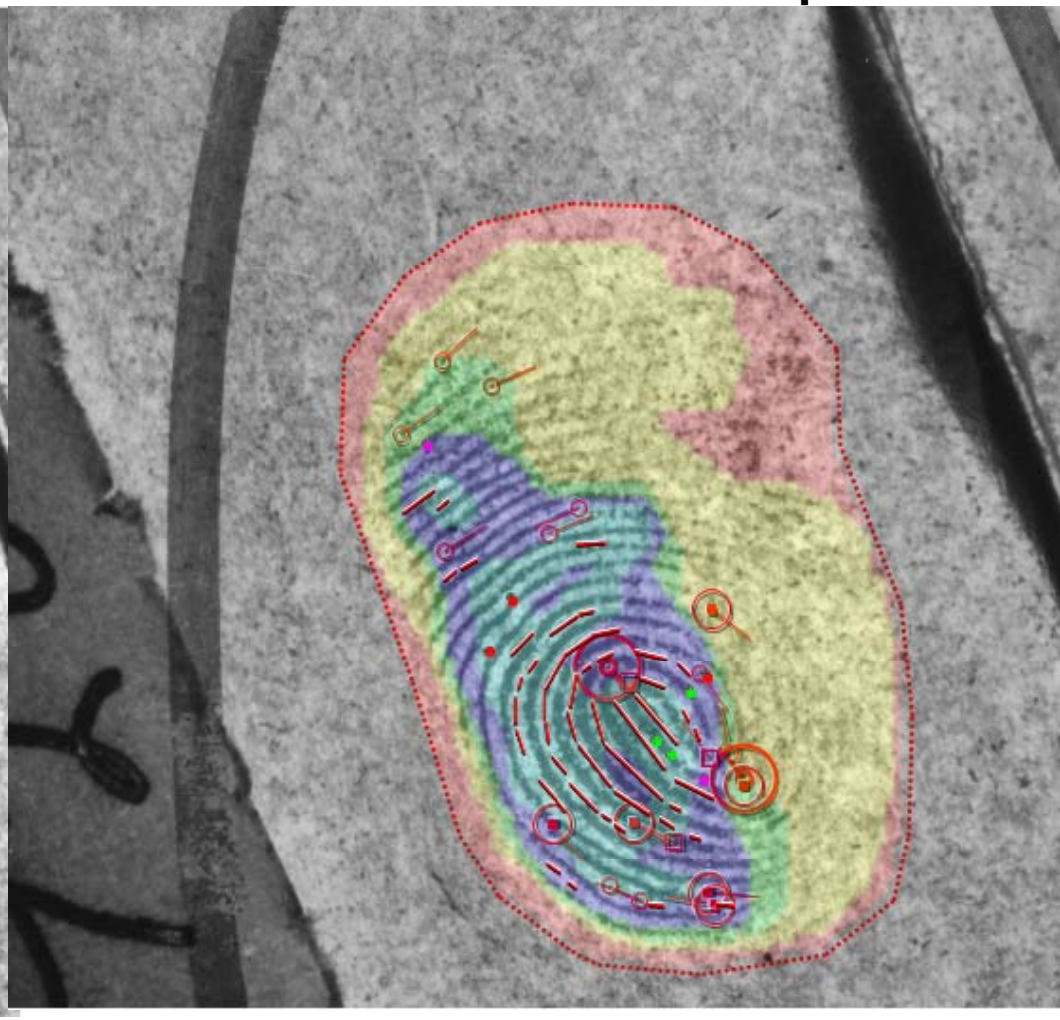
- **1986** – Standardized Minutiae
- **1993** – Standardized Images
- **2000** – Proprietary Feature Blocks
- **2010** – Extended Features
- ***Soon*** – Universal Standard Features for Interoperable Search

Feature “Evolution”

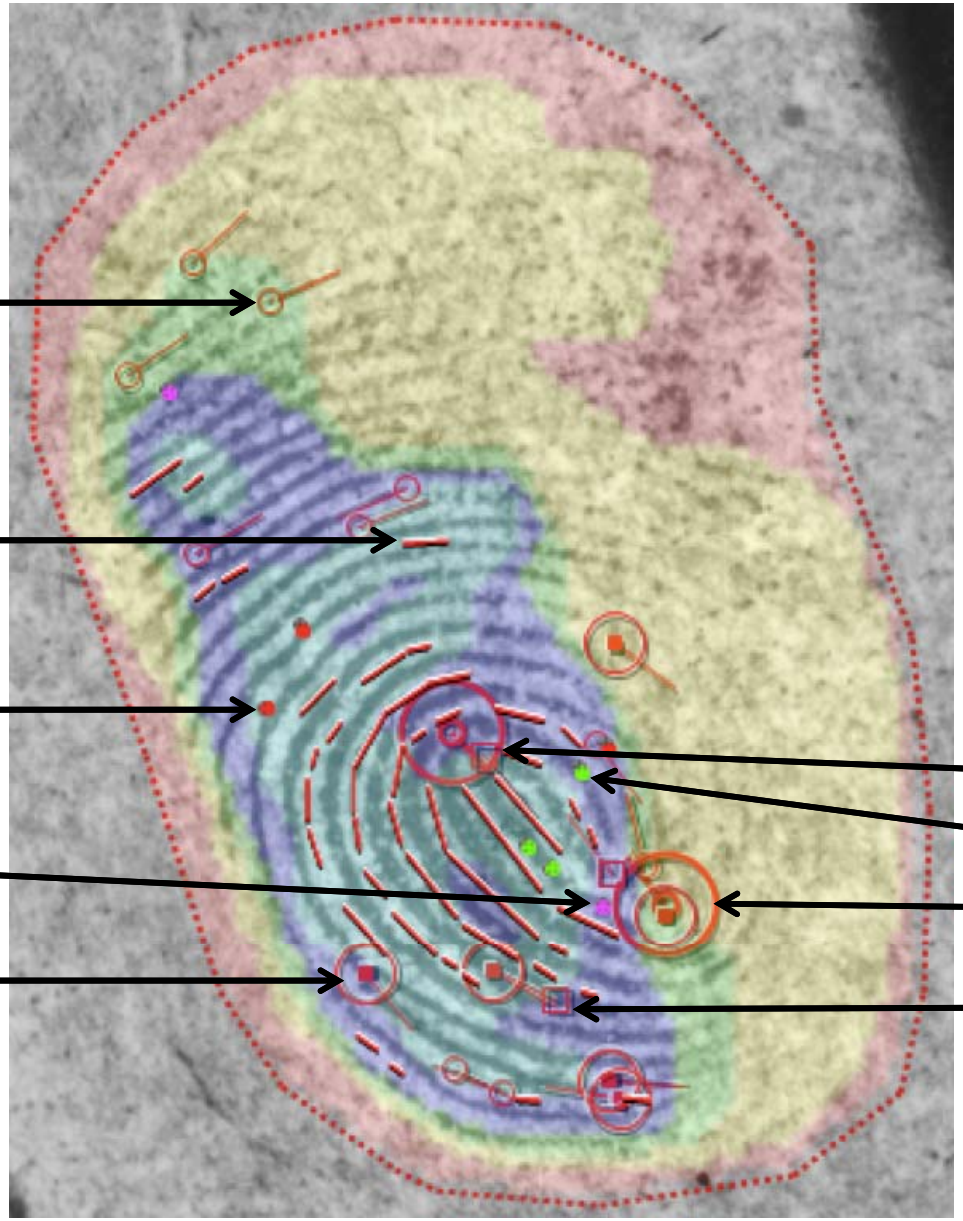
Standard Feature Markup



Extended Feature Markup



Extended Feature Set (EFS)

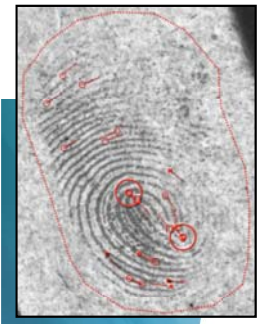


- Feature quality map
  - interoperable
- Complete feature set:
  - pores
  - ridge shape
  - incipient ridges
  - dots
  - creases
  - scars
  - ridge paths
- Improved definitions
- Correspondences

Latent ID Search Performance

Automated Latent Identification System (AFIS)

Latent Fingerprint & Search Features



Input

Output

Mark-up

List of Candidates

Rank	Subject ID	Candidate Print
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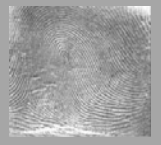
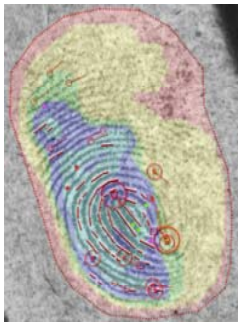
...		
20	0847121	

Latent Fingerprint & Comparison Features

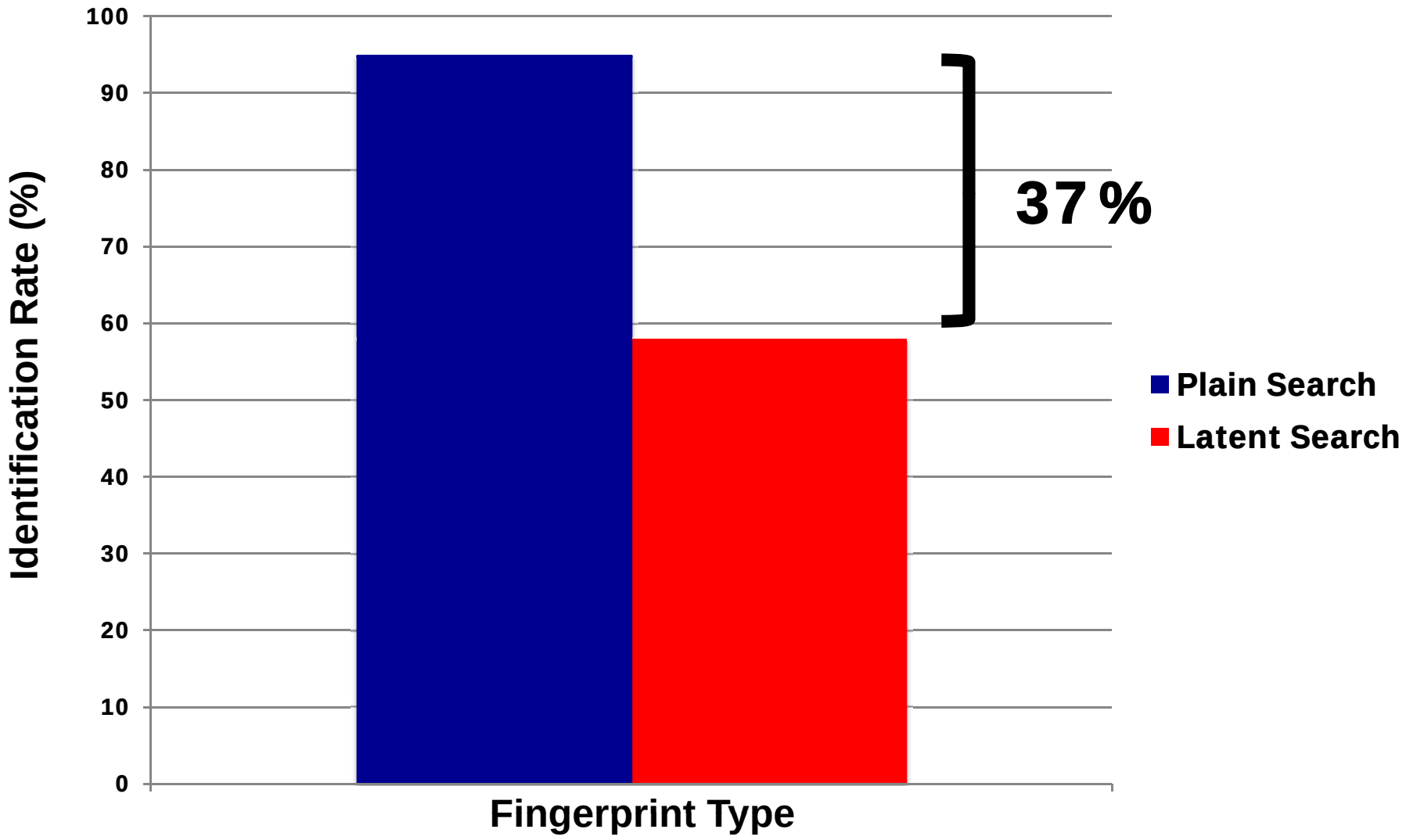


Compare *Compare* *Compare*

Examiner & Workstation

Examiner & Workstation

State-of-the-art Performance Measurement: Plain vs. Latent Print Search Accuracy

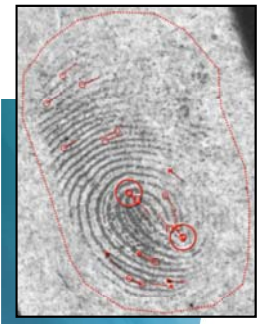


NIST National Institute of Standards and Technology U.S. Department of Commerce

“Lights out” Search

Automated Latent Identification System (AFIS)

Latent Fingerprint & Search Features



Input

Extract

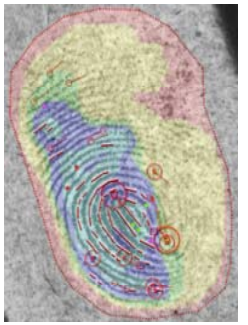
Mark-up

Output

List of Candidates

Rank	Subject ID	Candidate Print
1	0733091	
2	1304033	
3	3952340	
…		
20	0847121	

Latent Fingerprint & Comparison Features



Compare

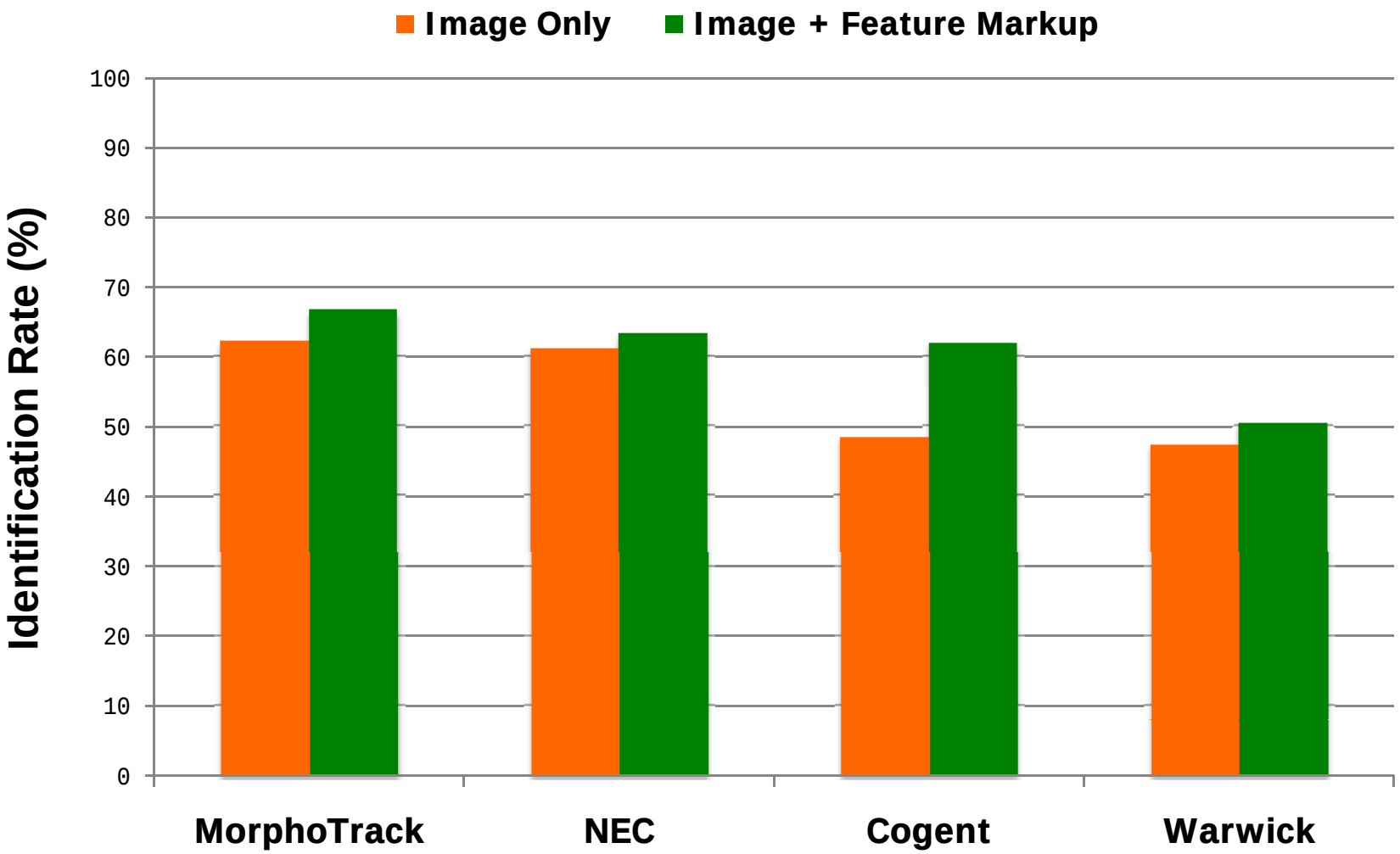
Compare

Compare

Examiner & Workstation

Examiner & Workstation

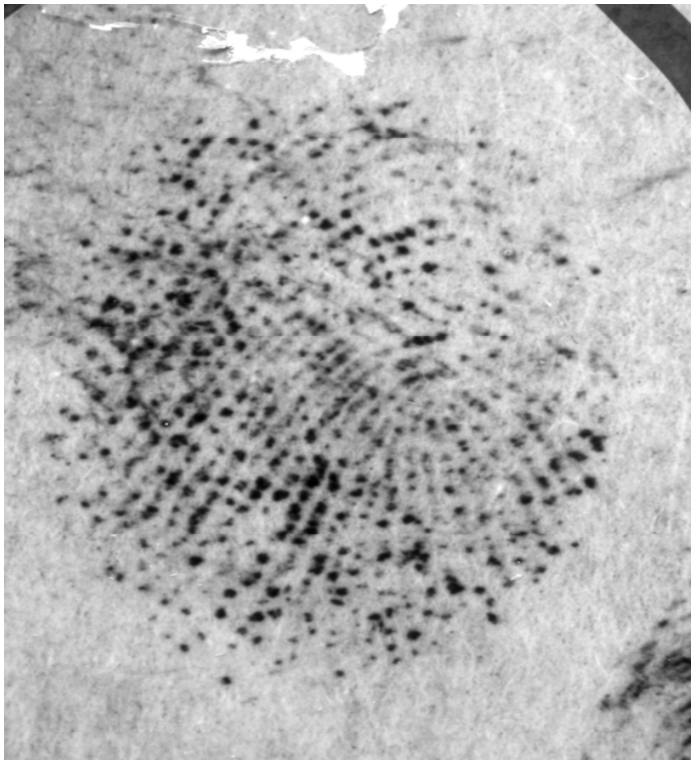
State-of-the-art Performance Measurement
"Lights out" vs. Latent + manual mark-up



Latent Image Quality: “Triage”

Lights Out

?

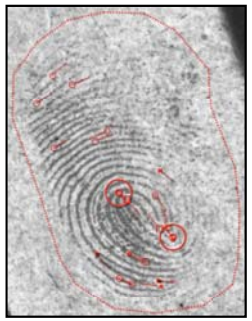


Examiner

Candidate List Review

Automated Latent Identification System (AFIS)

Latent Fingerprint & Search Features



Input

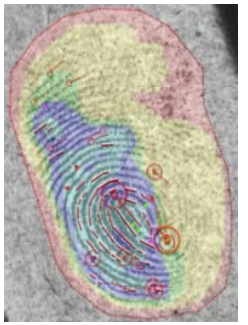
Output

Mark-up

List of Candidates

Rank	Subject ID	Candidate Print
1	0733091	
2	1304033	
3	3952340	Match
...		
20	0847121	

Latent Fingerprint & Comparison Features



Compare

Compare

Compare

Examiner & Workstation

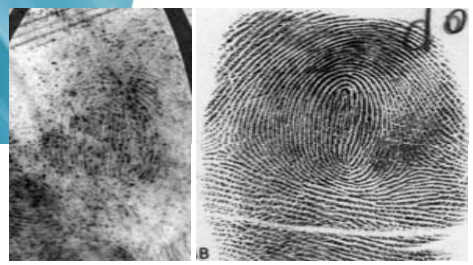
Examiner & Workstation

Future Work

- Measurement of large-scale latent ID search accuracy, and the time vs. accuracy trade-off:
  - prediction of large-scale operational system performance
  - better understanding of resource requirements
- Evaluation of interoperable latent feature sets for ID search
  - interoperability at a higher level of accuracy
- Measurement and Calibration of Latent Quality algorithms & metrics
  - workflow optimization schemes (quality directed processing)
  - less manual processing ➔ decreased case backlog
- Evaluation/Validation of match probability models
  - statistically quantifiable examiner match decisions
- Evaluation of automated latent palm-print matching systems

Questions?

Match Probability Models



- ✓ MATCH
- NON-MATCH

+ ***% Confidence***