Objectives of this presentation

- Expose my views on the opportunities and challenges a probabilistic (LR-based) assessment of the weight of evidence may pose in traditional forensic identification areas.
- Focus on one area: fingerprint comparison. But the considerations will apply to other areas.
- More emphasis is put on the perspective of the fingerprint examiner and organisations than on the perspective of the engineer/computer scientist.

A few themes

1. Managing the change from “fact” to “opinion”.
2. Managing the arrival of probabilistic models, backing up expert’s opinion and conflict resolution.
3. Q/A tools and saying more from “inconclusive” cases.

From fact to opinion


“The 100 percent certainty expressed by Mr. Meagher in this case, as well as in other forum, and others has been persuasively questioned by some academics and defense counsel. The absolute certainty has been proved to be wrong in the past.”
Individualization: NAS report

• Difficult to report?
  – p.112: Rather than claiming absolute truth, science approaches truth either through breakthrough discoveries or incrementally, by testing theories repeatedly.
  – P. 142: Although there is limited information about the accuracy and reliability of friction ridge analyses, claims that these analyses have zero error rates are not scientifically plausible.
  – P.184: The concept of individualisation is that an object found at a crime scene can be uniquely associated with one particular source. By acknowledging that there can be uncertainties in this process, the concept of “uniquely associated with” must be replaced with a probabilistic association, and other sources of the crime scene evidence cannot be completely discounted.

The challenge

“Radical skepticism of all possible assertions of uniqueness is not justified, and the optimal format for explaining the logical impact of a match is not self-evident. But it is clear that one way or another, a less absolutist and more nuanced theory of identification is essential if forensic scientists are to adhere to scientific precepts and to contribute to the just resolution of criminal cases.”

Recent changes in reporting

“Individualization of an impression to one source is the decision that the likelihood the impression was made by another (different) source is so remote that it is considered as a practical impossibility”

Just an Opinion?

2.45 - The decision whether or not a mark can be individualised is potentially a complex one calling for a series of subjective judgments on the part of the examiner. The decision is one of opinion, not fact.
**Opinionization**

“We should require more than mere *ipse dixit*”

“*To begin with, there is a sense in which ‘opinion’ can become an all-encompassing shield that deflects all accountability.*”

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**Recent changes in reporting**

“*Individualization of an impression to one source is the decision that the likelihood the impression was made by another (different) source is so remote that it is considered as a practical impossibility*”

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**That opens a brand new door on...**

*probabilities*

Greener grass, blue sky, really?

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**What do you mean by**

- A Decision?
- A likelihood so remote?
- Practical impossibility?
- I would not expect this on another individual?
- Your statement never mention that adverse probability, why?
38.24 - What matters more than the choice of language (whether the witness says that he is ‘confident’, ‘sure’, ‘certain’ or ‘in no doubt’) is the transparency of the opinion.


How that decision is taken?

Framework (priors)   Evidence   Update (posterior)   Decision on the ID or Exclusion
Earth population paradigm   Two generic questions forming a likelihood ratio   Require both the priors and the evidence   Based on the posterior probabilities and an utility function


What do you know about:

Relative frequencies of level 1 features (general pattern) and their use?

And it goes beyond that… (minutiae)

Level 3 (pores)
Requirement for training

Regardless of the availability of statistical models to assess fingerprint comparison, there is an urgent need for fingerprint experts to understand and to be able to articulate in court and in their statements the probabilistic nature of their decisions.

Arrival of probabilistic models

- Help assign the weight of evidence to the whole configuration without decomposing the contribution of its individual minutiae.
- The more recent efforts have been successfully presented to the Royal Statistical Society: C. Neumann, I. W. Evett, and J. Skerrett, “Quantifying the weight of evidence from a forensic fingerprint comparison: a new paradigm,” Journal of the Royal Statistical Society, vol. 175, pp. 371-415 (with discussion), 2012.

Equilibrium in the spectrum of knowledge

- Relevant systematic studies (published or documented)
- Structured portfolio of cases
- Proficiency and collaborative testing
- Years of experience
- Unstructured data collection from uncontrolled casework

Neumann & al. (2012)

To be part of the accreditation scope, regardless of its scientific merits, it will require operational validation
How LRs are assigned (generic)

The conditioning propositions are not so trivial as Genuine and Impostor.

LR = \frac{P(s | \text{Genuine})}{P(s | \text{Impostor})}

Forensic Error Rates

What is an acceptable error rate?

RMED = 3.4%
RMEP = 3.2%

We should confirm them through an operational validation.

Independent sets of marks and prints of known sources are required for an operational validation.

Models can be used in two ways:

41.32 [...] to provide background data to assist fingerprint examiners with their evaluation of marks and to enable them to express the strength of their conclusion in a transparent and verifiable manner.

Models are inevitable in the future.


Back up examiners?

We need to precisely define how these “experts” will operate.

A set of SOPs need to be drafted before any operational implementation.

To embrace it, I need to understand and trust the model.

I need to be able to explain its meaning and limitations.

Models are inevitable in the future.

I may want to identify regardless of the number given by the model.

As in DNA, probabilities will be asked by both prosecution and defence.

04.04.13
Pilot joint project

The situation we want to handle

My opinion is that the mark has been identified to the right thumb of Mr X. The probability for the mark to originate from someone else is so small that I consider it to be a practical impossibility.

We submitted your case a statistical analysis through the University XYZ, Prof S. Tat. The LR obtained is 1.8e+6, that amounts to a match probability of 5.6e-7.

How do you get from a match probability of 5.7e-7 to an identification?

Expert 1 (LR = 5.8e10⁵)

Expert 2 (LR = 9.6e10¹⁰)
A quick look at the task complexity

Understanding the concept of "sufficiency" in friction ridge examination

C. Neumann, C. Champod, M. Yoo, G. Langenburg, T. Genessay, NIJ award - 2010-DN-BX-K267

Results presented at the annual meeting of the American Academy of Forensic Science, Feb 2013.

Understanding “Sufficiency”

- 15 comparisons:
  - 12 pairs latent/control prints from same source
  - 3 pairs latent/control prints from different sources

- Information captured through a web-based software designed to support the ACE process (Picture Annotation Software – PiAnoS – https://ips-labs.unil.ch/pianos/index.html)

- Approximately 600 examiners contacted
  - 145 completed first comparison
  - 123 completed all 15 comparisons

PiAnoS

- Certified Latent Print Examiner (p/c): 100 certified, FBI certified, or other governmental certified
- Latent Print Examiner: trained in competency and actively working cases
- Latent Print Examiner: trained in competency but no longer actively working cases (e.g., manager, crime analyst, or other duty that no longer requires handling latent prints)
- Latent Print Examiner: currently in training and not responsible for reporting case results
- Other, please explain

- Years of experience performing latent print examinations (you may include your training period)
- Familial status
- Approximately how many hours per week would you estimate that you spend conducting and comparing latent prints?
- If you assist, please indicate

- Approximately how many latent print cases per month would you estimate that you consider?
PiAnoS

Minutiae annotated
Change of size of displayed minutiae markers

PiAnoS

PiAnoS

“Sufficiency” after the Comparison stage

Number of respondents

Decisions following comparison

Trial 01 same source
Trial 02 different sources
Trial 03 same source
Trial 04 same source
Trial 05 same source
Trial 06 same source
Trial 07 same source
Trial 08 same source
Trial 09 different sources
Trial 10 same source
Trial 11 same source
Trial 12 different sources

Sufficiency after the Comparison stage

ID
EXC
INC
ID
EXC
INC
ID
EXC
INC

04.04.13
### Reliability of Conclusion

<table>
<thead>
<tr>
<th>Trial</th>
<th>Same Source</th>
<th>Different Sources</th>
<th>Categorical</th>
<th>Neutral</th>
<th>Misleading</th>
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<tbody>
<tr>
<td>08</td>
<td>same source</td>
<td></td>
<td>Correctly</td>
<td>Guiding</td>
<td>Misleading</td>
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<tr>
<td>12</td>
<td>different sources</td>
<td></td>
<td></td>
<td></td>
<td>Correctly</td>
</tr>
</tbody>
</table>

### Conflict Resolution Procedures

1. **Statistical Model**
2. First Examiner
3. Second Examiner (Verifier)
4. Decision

### Other Usage: Q/A Tool?

Figure 6: A close non-match found in [36]. The respective log LH value is log(L[H]) = -1.53.
Other usage: Suitability tool?

The expected LR associated with the 5-6 level 2 features is 12,540.

Is the mark suitable for further comparison, for identification? Is that a complex case?

Models can be used in two ways:

41.33 [...] the possible application of probabilistic analysis to comparisons that examiners would otherwise consider to be inconclusive, the objective being to produce evidence that could be used in court of the probability of a match.

“Unable to exclude” cases

38.84 - Before a finding of ‘unable to exclude’ is led in evidence, careful consideration will require to be given to (a) the types of mark for which such a finding is meaningful and (b) the proper interpretation of the finding. An examiner led in evidence to support such a finding will require to give a careful explanation of its limitations.

Saying more than “inconclusive”

Again, we need to precisely define the scope of usage

Very useful source of additional information, either as evidence or for intelligence purposes

The statistics may convey more weight than it deserves

We don’t want to mislead anyone

Already a reality for the Dutch NFI
**Value for comparison**

**Searchable on IAFIS**

**Value for identification**

**Complex** ➔ **Non-complex**

**Diminishing match probabilities (or increasing LR)**

**[1 \( \rightarrow \) \( 1/10^3 \rightarrow 10^{-9} \)**

**Risks of misleading may outweigh benefits** ➔ **Helps with the decision making** ➔ **Intelligence tool**

**Needs more resources** ➔ **Actual resources**

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**Managing the change**

- Define the exact scope
- Train fingerprint examiners
- Agree on acceptable error rates
- Educate Judiciary and field officers
- Conduct operational validation
- Define the SOPs
- Conflict resolution procedures

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