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6th IAPR International Conference on Biometrics (ICB-2013)

Madrid, 6th of June 2013

Prof. Christophe Champod

Forensic Science and Biometric Systems: an Impossible Mix?

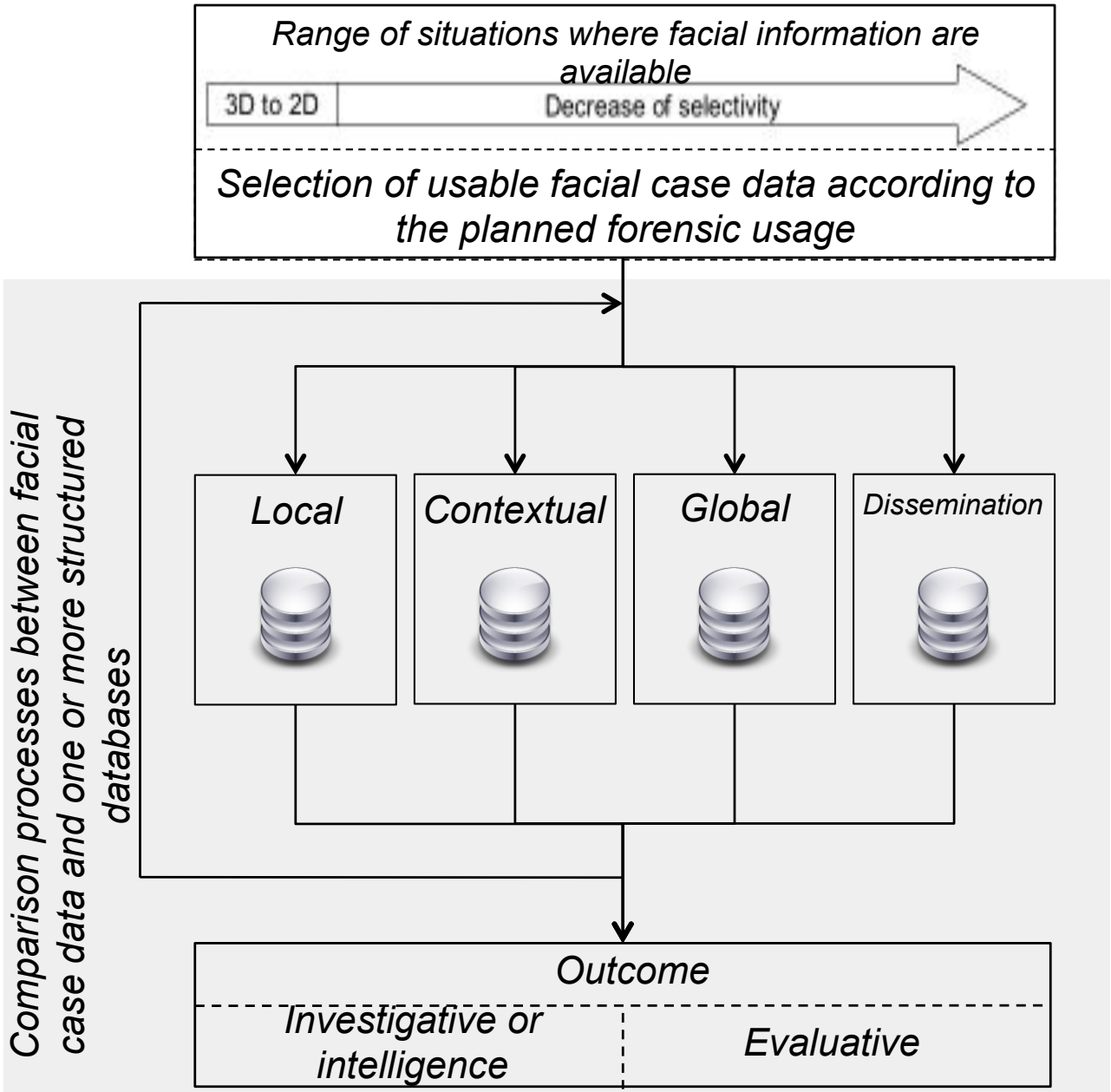
IC 1106

| le savoir vivant |

With contributions from Flore Bochet and Damien Dessimoz

Challenge 1: To have a shared understanding of the concept of operations

(e.g. face recognition in police operations with a COTS system)



Local: *against a limited set of individuals (even 1:1)*

Contextual: *against a set of individuals known for activities in a given context (aka metadata binning)*

Global: *against all putative sources (similar to DNA or fingerprints)*

Dissemination: facial images distributed to the press or target groups

Different customers and expectations
Different attitude towards risk
Different metrics for performance

Courtesy: Damien Dessimoz

HOLD-UP À VISAGE DÉCOUVERT

06 février 2012 16:46; Act: 06.02.2012 17:10

Le même braqueur a-t-il encore frappé?

Mi-janvier, un homme braquait l'UBS de Delémont a visage découvert. Lundi matin, c'était la Banque Coop a Bienne. Les polices bernoise et jurassienne pensent qu'il s'agit de la même personne.

Global: Gallery 60k, ranked 32

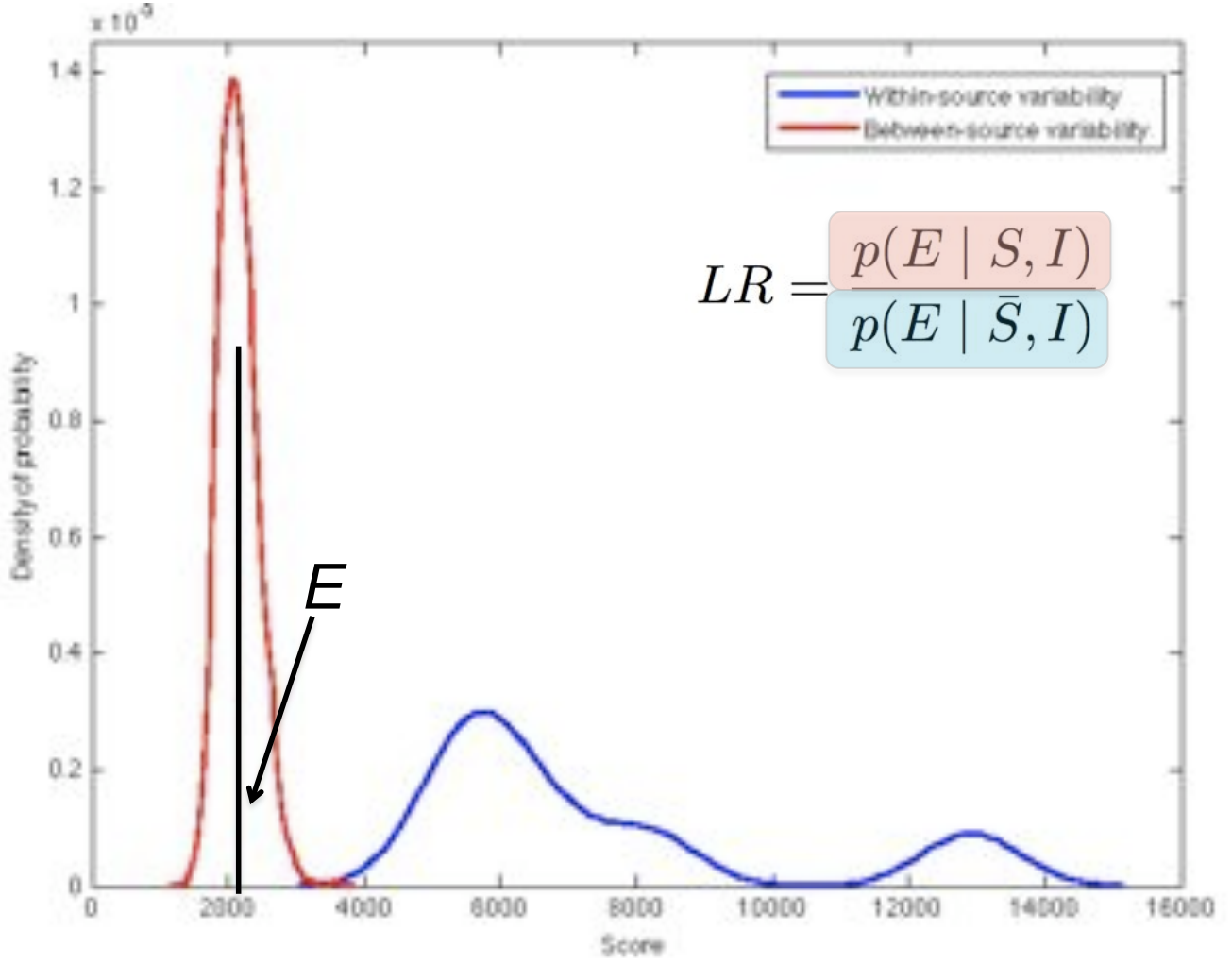
Contextual Gallery selected based on MO, ranked 5. Not in a reasonable hit list with a gallery of 60k

Local: ID documents: Gallery: 60k, ranked 3

Towards an evaluative report?

- To get a likelihood ratio for the forensic findings (E, here the score), we need two probability densities

The within-source variability is unknown in most cases



Towards an evaluative report?

- Does it all come down only to a judgment based on the training and experience of the expert applying the recommended methods?

- Without data on the within-source variability, how can an expert robustly assign a likelihood ratio?

Challenge 2: To have a clear definition of the respective role of technology and forensic experts

(e.g. lights-out ID)

Lights-out Decisions

- Results of Flore Bochet on a set of 1818 marks
- Auto-encoded without any other user input
- Searched against a COTS AFIS system (background database of about one million fingerprints)

Auto-encoding and Search

Rank [1]: 69%

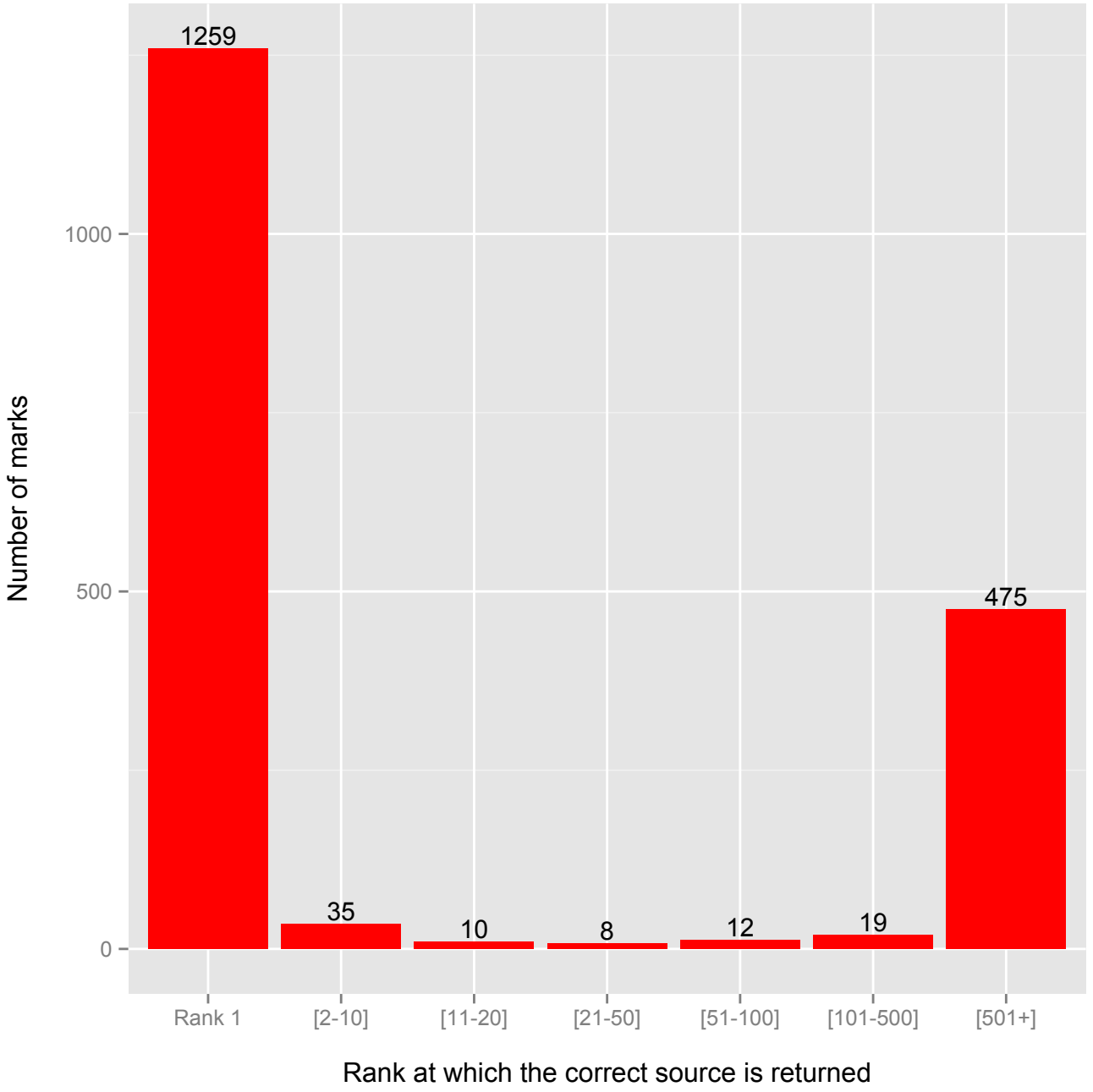
Ranks [1:10]: 71%

Ranks [1-20]: 72%

Ranks [1-50]: 72%

Ranks [1-100]: 73%

Ranks [1-500]: 74%



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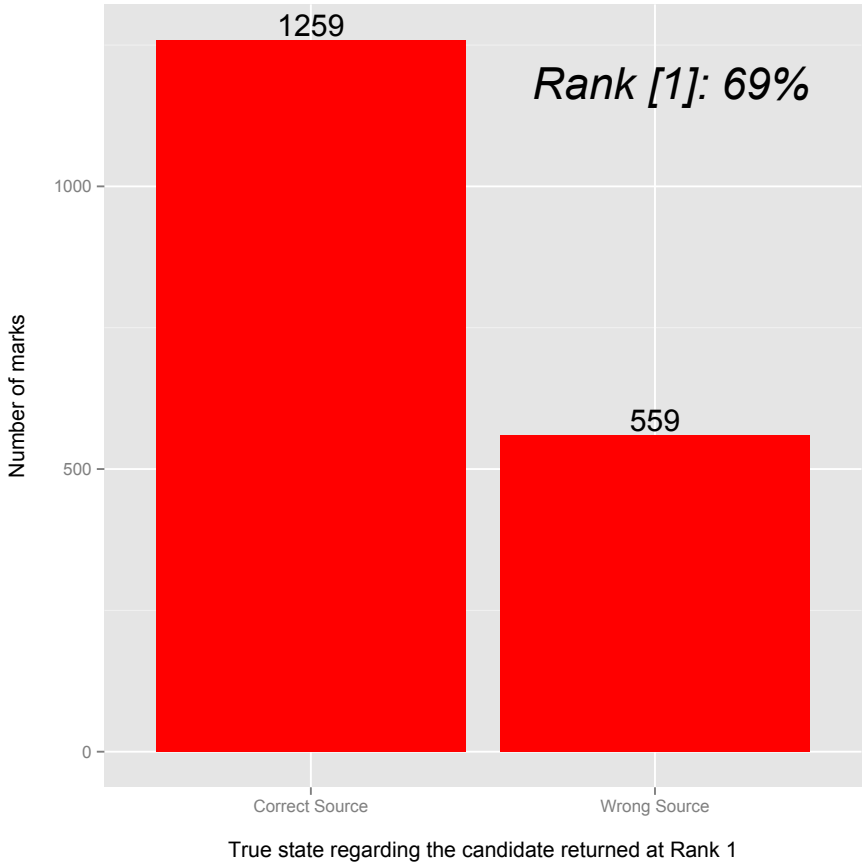
Auto-encoding and Search

- In about 70% of the cases, the identification will be made after checking (verifying) only rank [1] without any manual encoding.
- Allow to concentrate the efforts on the remaining 30%.
- Gain obtained allows to increase the number of submissions.

Providing intelligence ?

- Could we use an AFIS in lights-out mode to provide intelligence information in the form of investigative leads delivered in a timely manner?

- **Latent fingerprint image quality (LFIQ)** Yoon S., Liu E. & Jain A.K. "On Latent Fingerprint Image Quality", In Proceedings of the 5th International Workshop on Computational Forensics, Tsukuba, Japon, 2012.
- ***Each transaction comes with a set of variables directly from the COTS AFIS system***
  - *Score at rank 1*
  - *Score for the candidate at rank 2*
  - *The number of encoded minutiae*
  - *Measures of quality (global and for minutiae)*
  - *The general patterns (mark and print)*
  - *The finger number of the print*



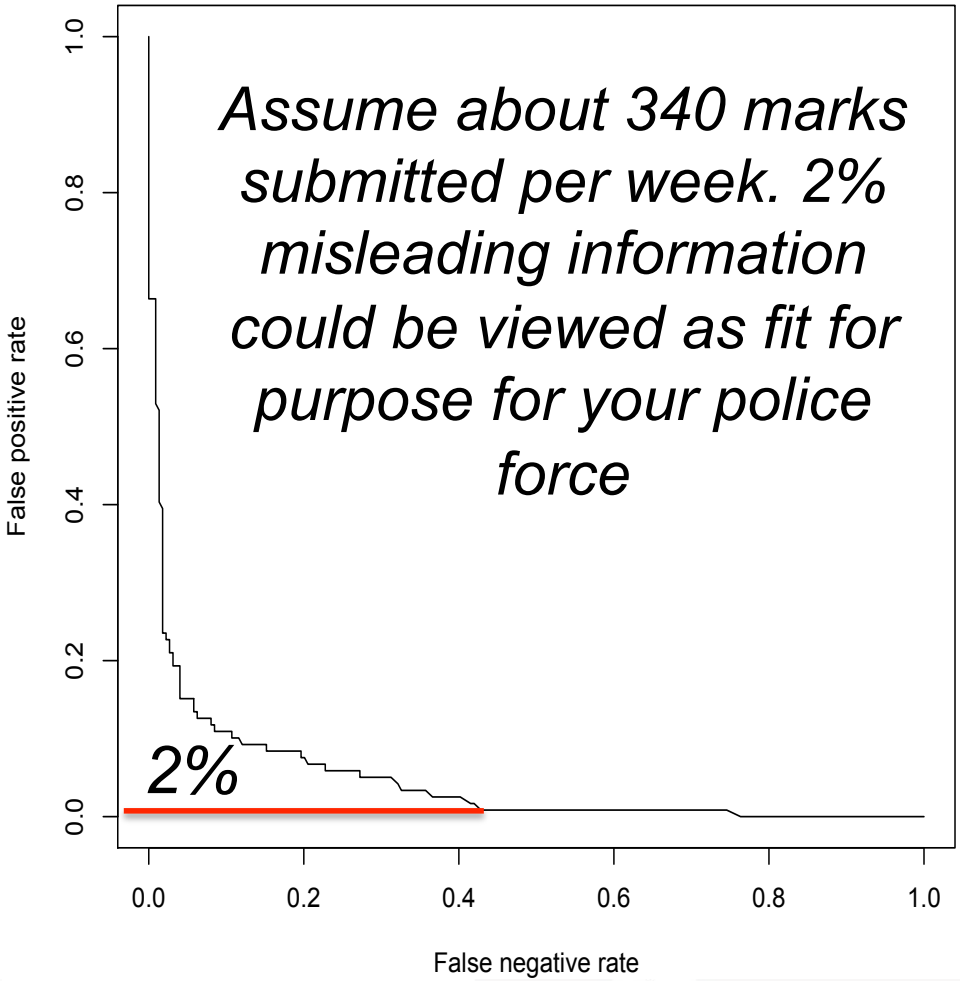
Random Forest classification

Breiman L. "Random Forests", Machine Learning, 45(1), pp. 5-32, 2001

	Importance	**Error when added to the model**	**Drop of the error with the addition of each variable**
Difference between score @Rank 1 and @Rank 2	180	0.16	0.34
Score @Rank 1	168	0.11	0.06
LFIQ (Yoon & Jain 2012)	60	0.10	0.01
All other variables	<33	<0.10	≈ 0

Balancing risks

How many misleading leads the police force is ready to cope with?



About 130 instant IDs per week for free

True state	Predict tate	
	Correct source	*Wrong source*
Correct source	134	90
Wrong source	3	116

For 3 misleading info per week

Challenge 3: To understand how biometric systems can help with forming evaluative opinions

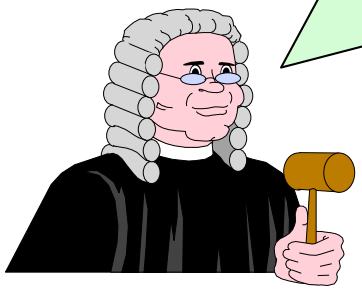
(e.g. LR systems made available to the fingerprint community)

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"

SWGFAST Document #10 Standard for Examining Friction Ridge Impressions and Resulting Conclusions, Ver. 2.0,
http://www.swgfast.org/documents/examinations-conclusions/121124_Examinations-Conclusions_2.0.pdf

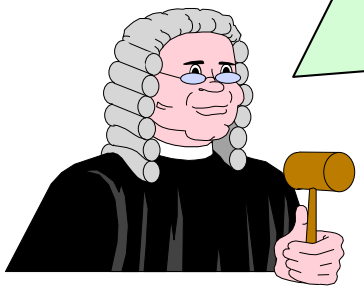
Just an Opinion ?



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.

A. Campbell, The Fingerprint Inquiry Report. Edinburgh: APS Group Scotland, 2011.

Just an Opinion ?



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.

A. Campbell, The Fingerprint Inquiry Report. Edinburgh: APS Group Scotland, 2011.

Transparent decision process

All fingers on Earth

Decision

"Leap of faith"
(D. Stoney)

Weight of the forensic findings (MP < 10^{-15})

ID decision – An adventitious match is a practical impossibility

1. Who left the mark? (priors)

2. Fingermark Evidence (LR)

3. Who left the mark? (posteriors)

Utility

1/all fingers

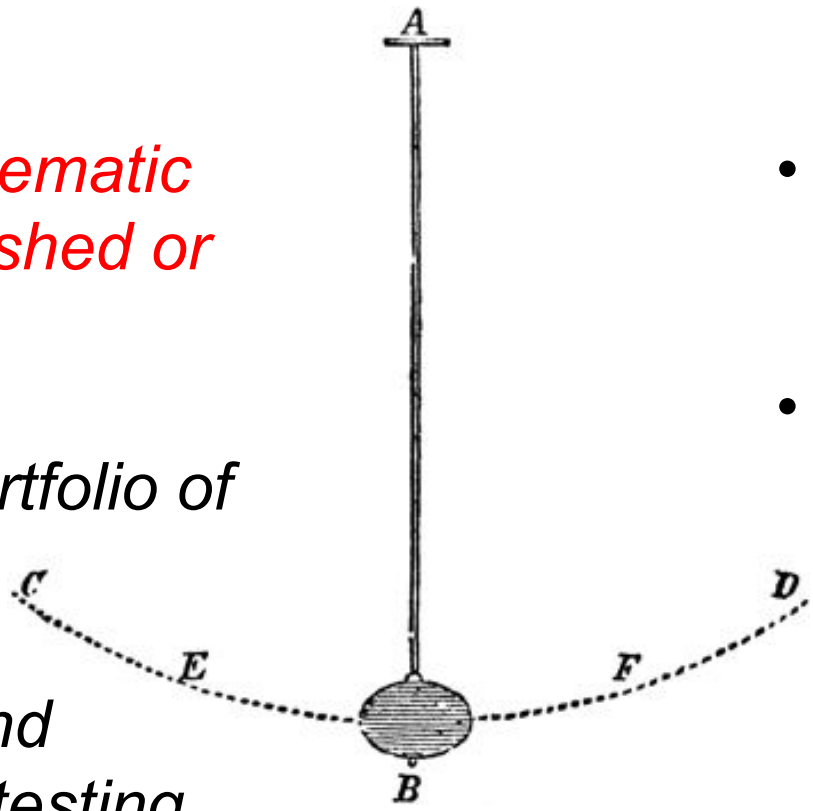
LR for FP comparison

99.99…%

A. Biedermann, S. Bozza, and F. Taroni, "Decision theoretic properties of forensic identification: Underlying logic and argumentative implications," Forensic Science International, vol. 177, pp. 120-132, 2008.

Equilibrium in the *spectrum* of knowledge

- *Relevant systematic studies (published or documented)*
- *Structured portfolio of cases*
- *Proficiency and collaborative testing*



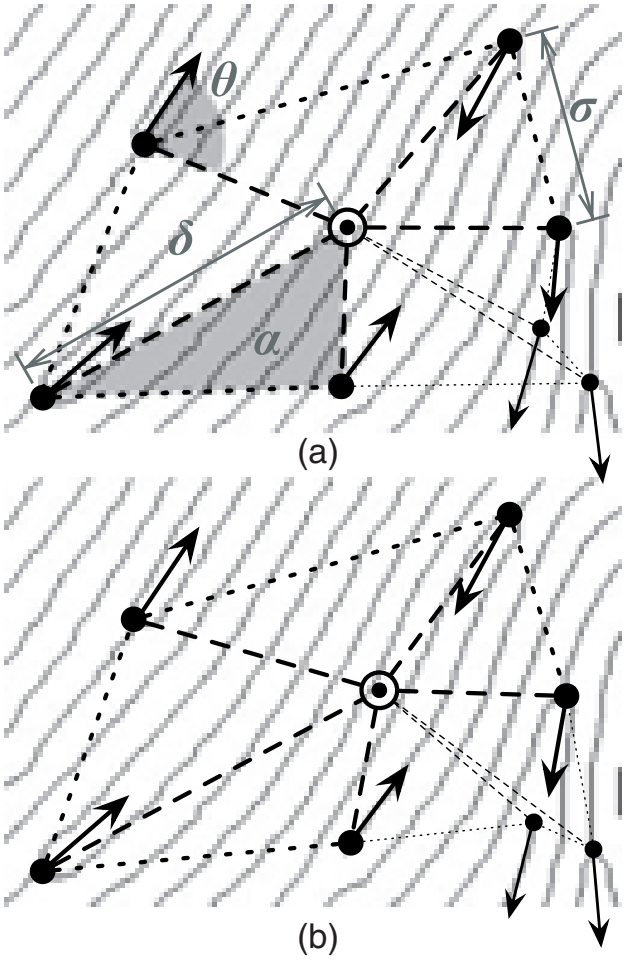
- *Years of experience*
- *Unstructured data collection from uncontrolled casework*

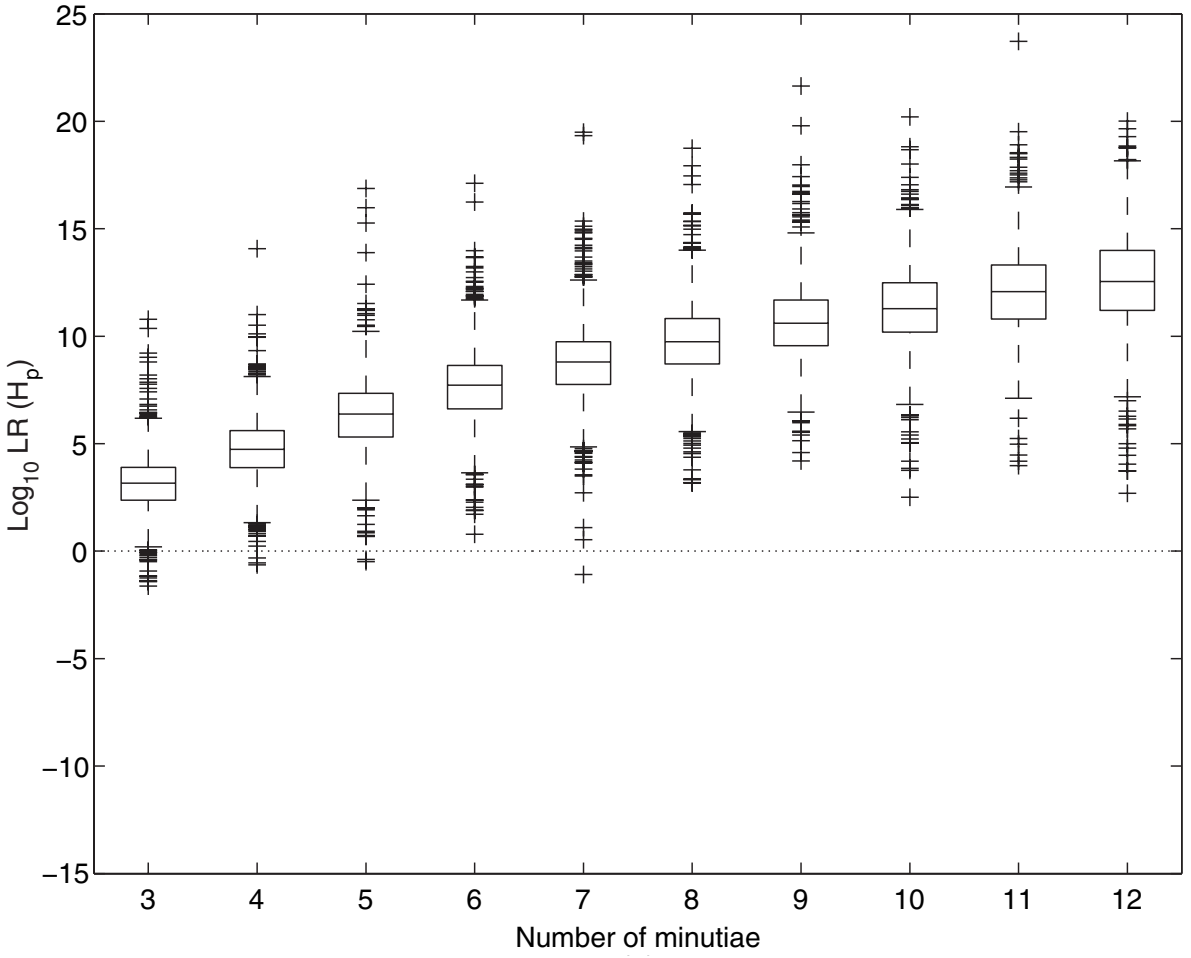
Probabilistic *vs* *unfettered opinions*

Arrival of probabilistic models

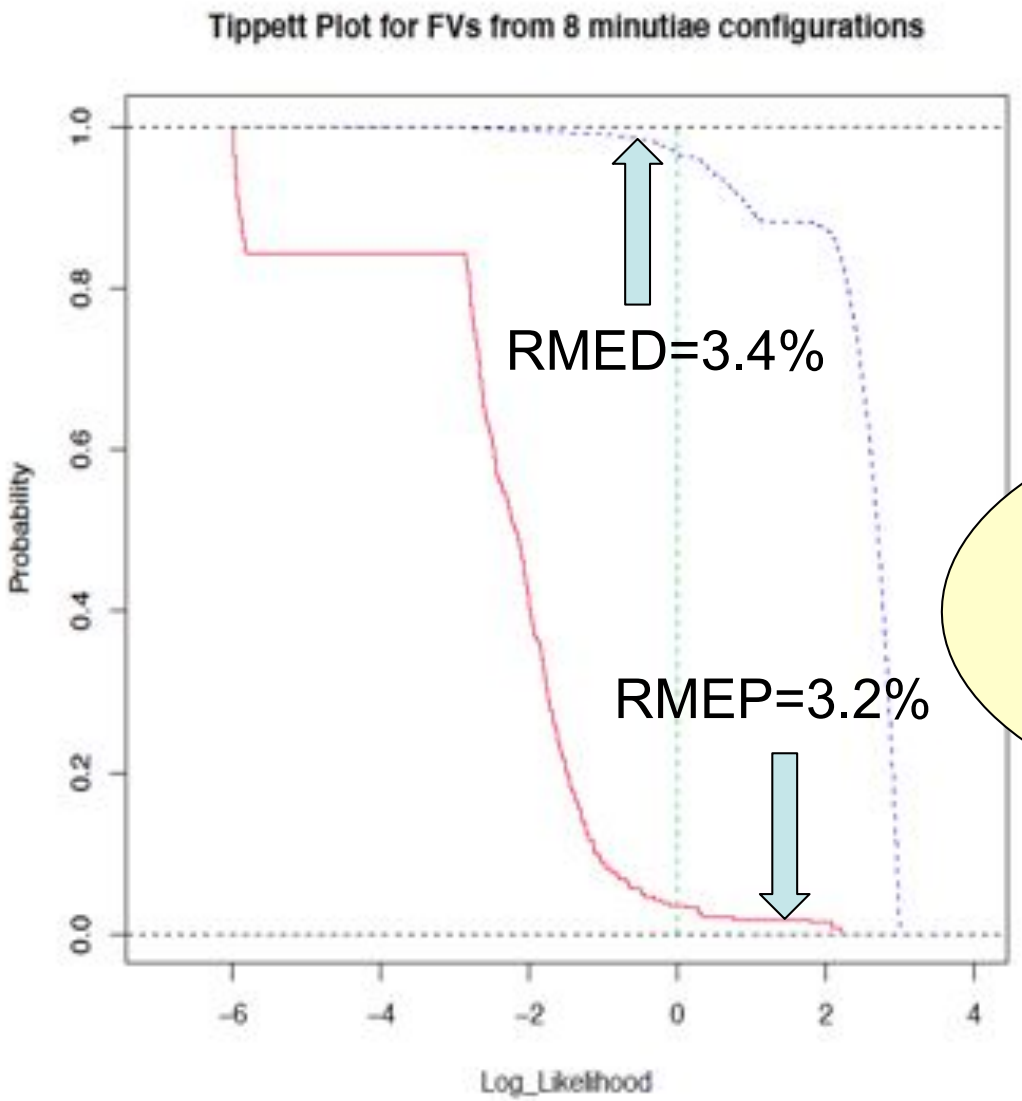
- Help assign the weight of evidence to the whole configuration without decomposing the contribution of its individual minutiae.
- The more recent efforts have been successfully presented to the Royal Statistical Society: C. Neumann, I. W. Evett, and J. Skerrett, "Quantifying the weight of evidence from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

Neumann & al. (2012)





Forensic Error Rates

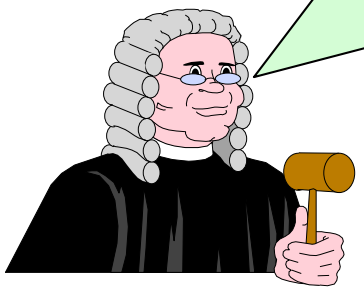


What is an acceptable error rate?

We should confirm them through an operational validation

J. Abraham, C. Champod, C. Lennard, and C. Roux, "Spatial Analysis of Corresponding Fingerprint Features from Match and Close Non-Match Populations," Forensic Science International, in press.

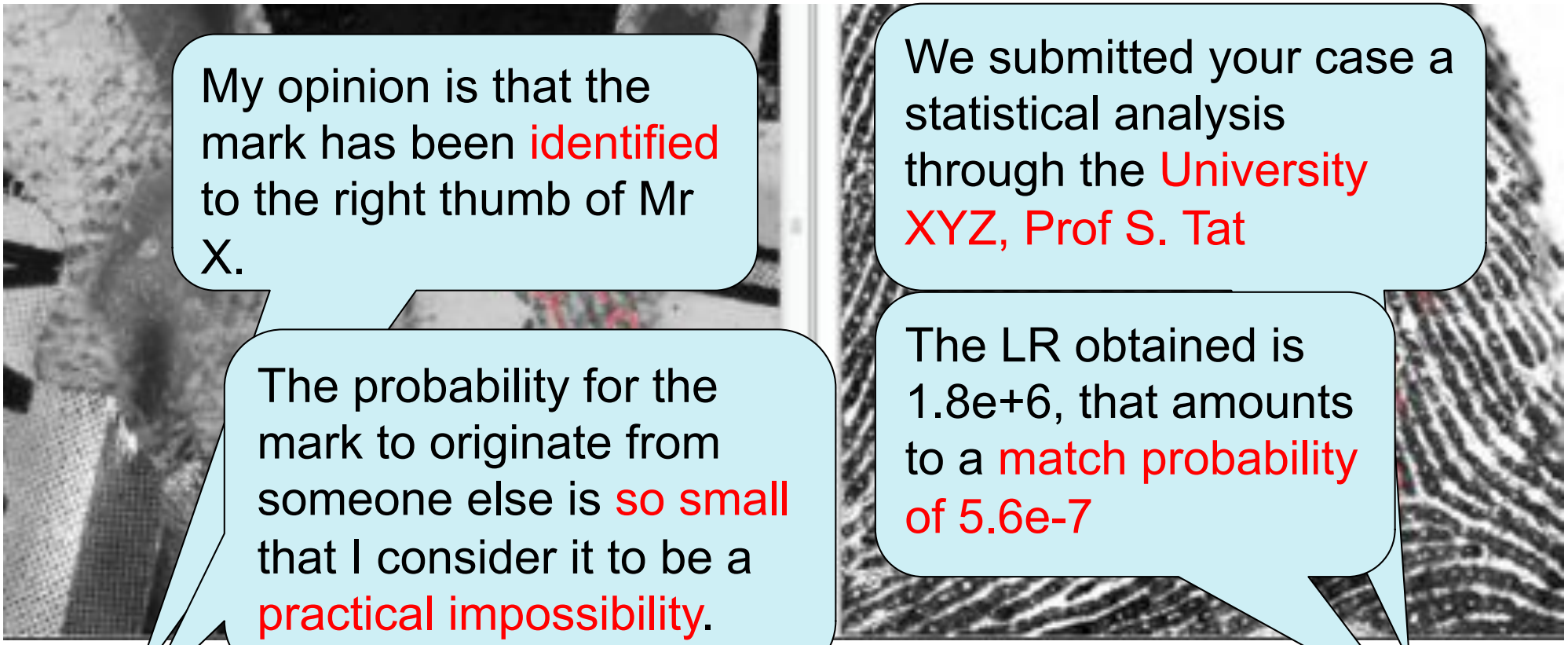
Models can be used ..



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.

A. Campbell, The Fingerprint Inquiry Report. Edinburgh: APS Group Scotland, 2011.

The *situation* we want to handle



My opinion is that the mark has been identified to the right thumb of Mr X.

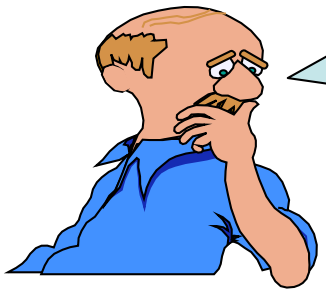
The probability for the mark to originate from someone else is so small that I consider it to be a practical impossibility.

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*?

Backing up examiners ?



We need to precisely define how these "experts" will operate.

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

Examiners' feedback

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

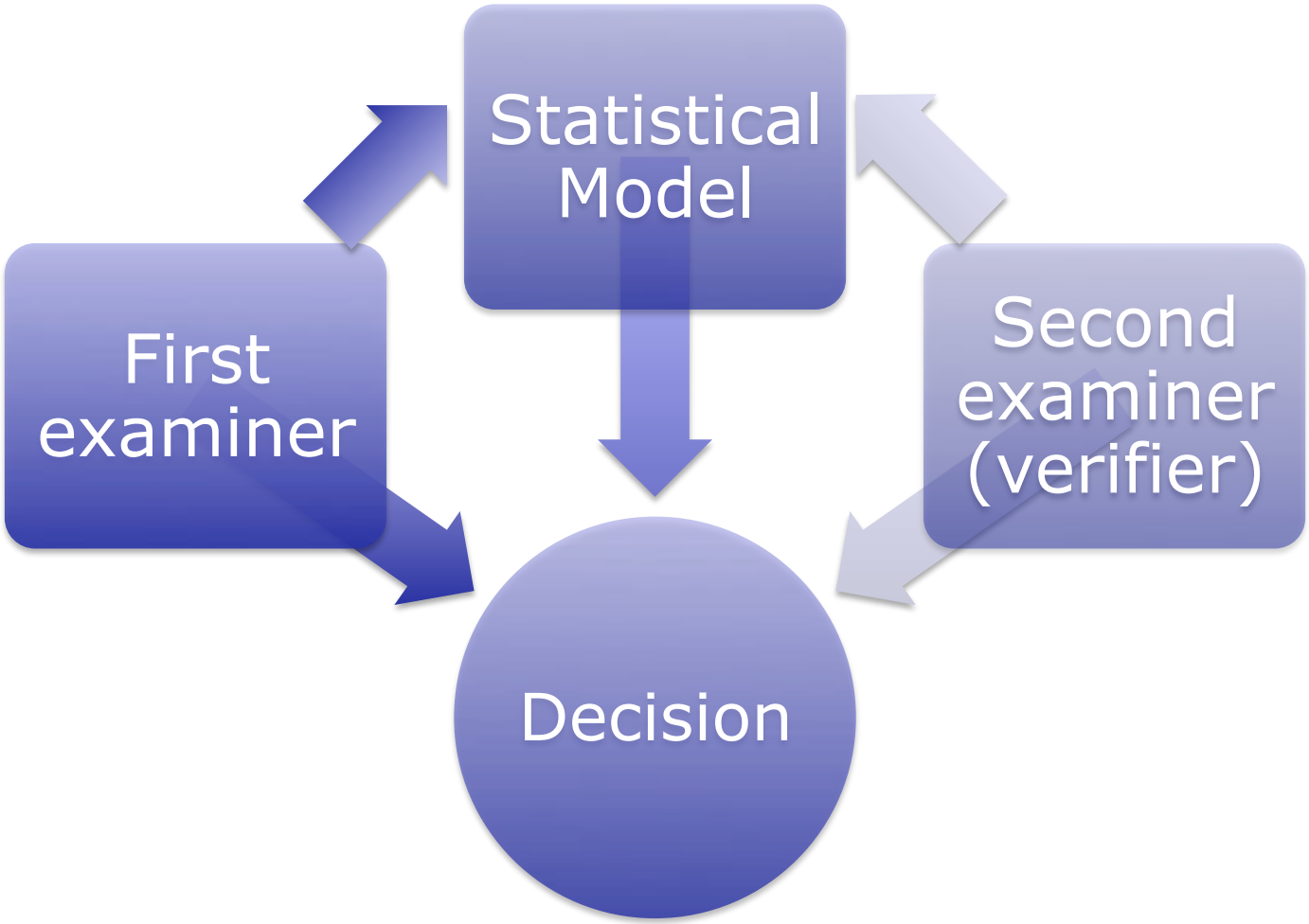
I need to be able to explain its meaning and limitations

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

Conflict resolution procedures



Understanding Our Decisions

- Understanding the concept of "sufficiency" in friction ridge examination

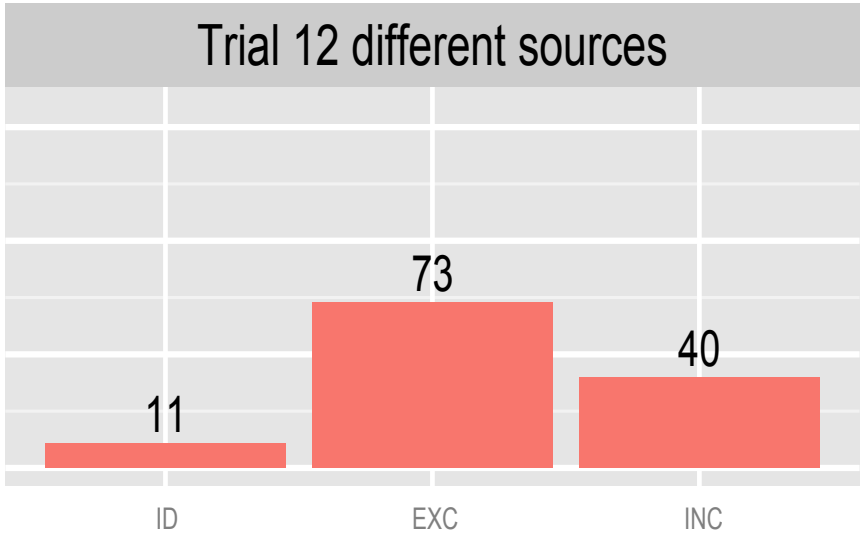
  C. Neumann, C. Champod, M. Yoo, G. Langenburg, T. Genessay, NIJ award - 2010-DN-BX-K267

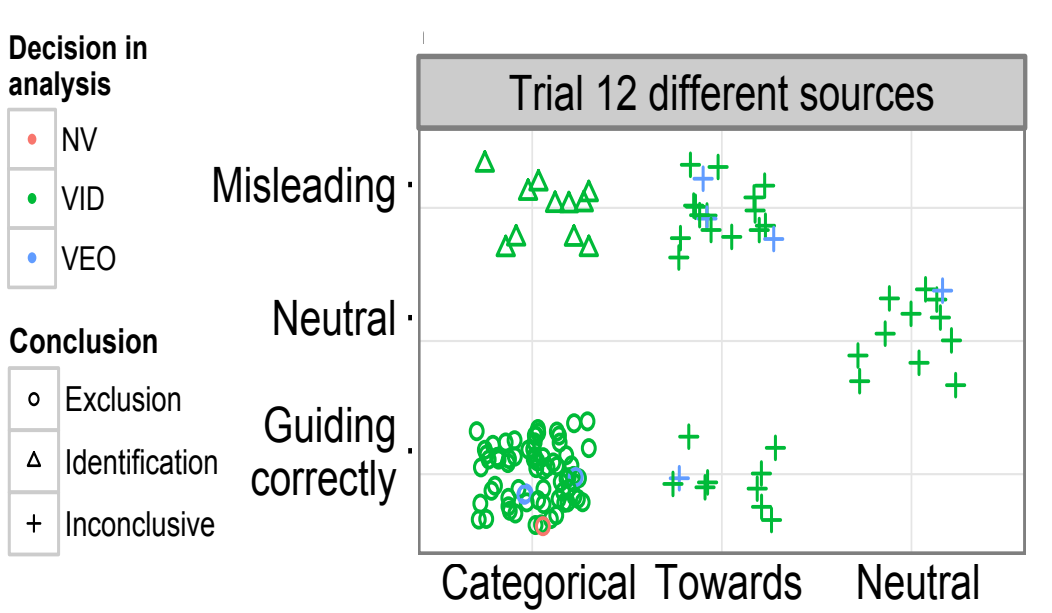
- Results presented at the annual meeting of the American Academy of Forensic Science, Feb 2013

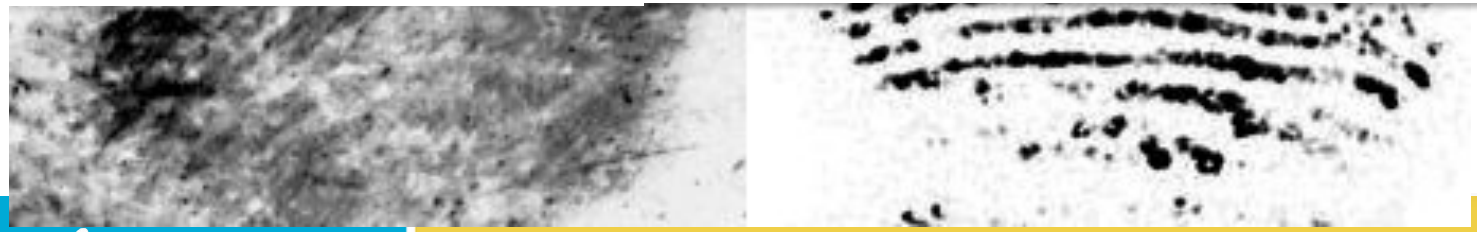
- 15 comparisons (chosen to highlight decision boundaries)
  - 12 pairs latent/control prints from same source
  - 3 pairs latent/control prints from different sources
- All nnotations captured through a web-based software designed to support the ACE process (Picture Annotation Software – PiAnoS – https://ips-labs.unil.ch/pianos/index.html)
- Approximately 600 examiners contacted
  - 145 completed first comparison
  - 123 completed all 15 comparisons

Data from C. Neumann, C. Champod, M. Yoo, G. Langenburg, T. Genessay, Understanding the concept of “sufficiency” in friction ridge examination NIJ award - 2010-DN-BX-K267

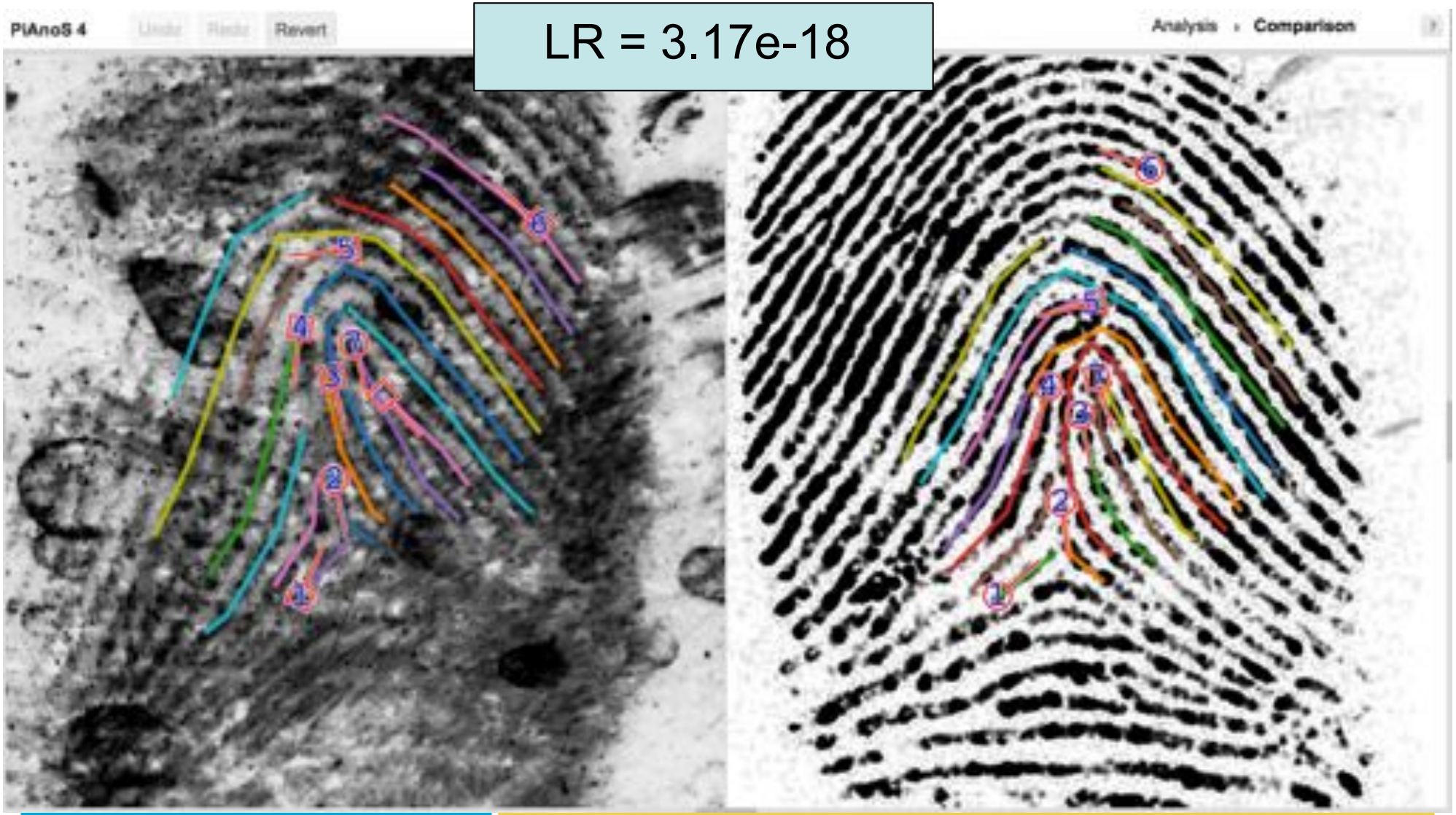
Trial 12





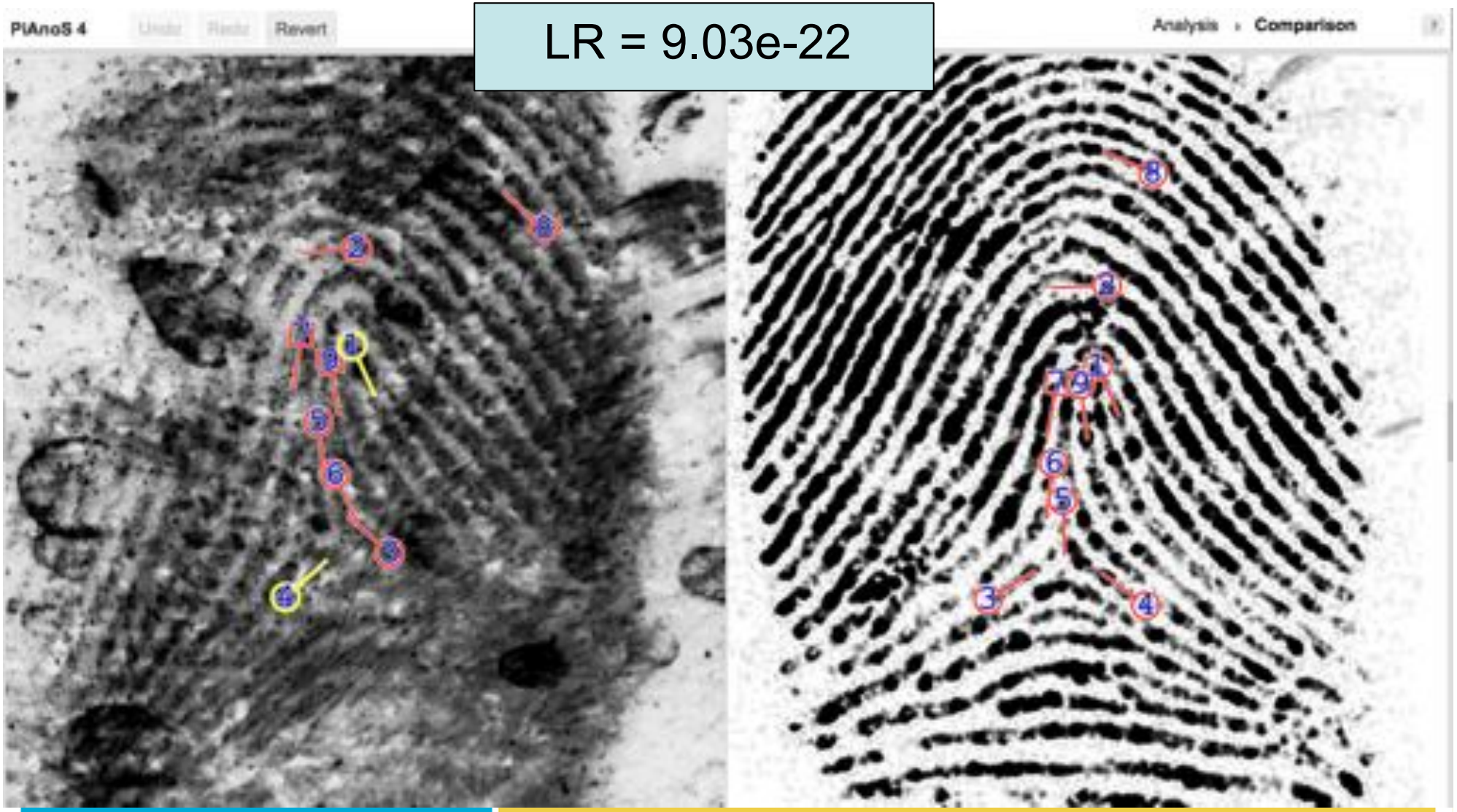


User 342 (ID) – not certified (3 years)



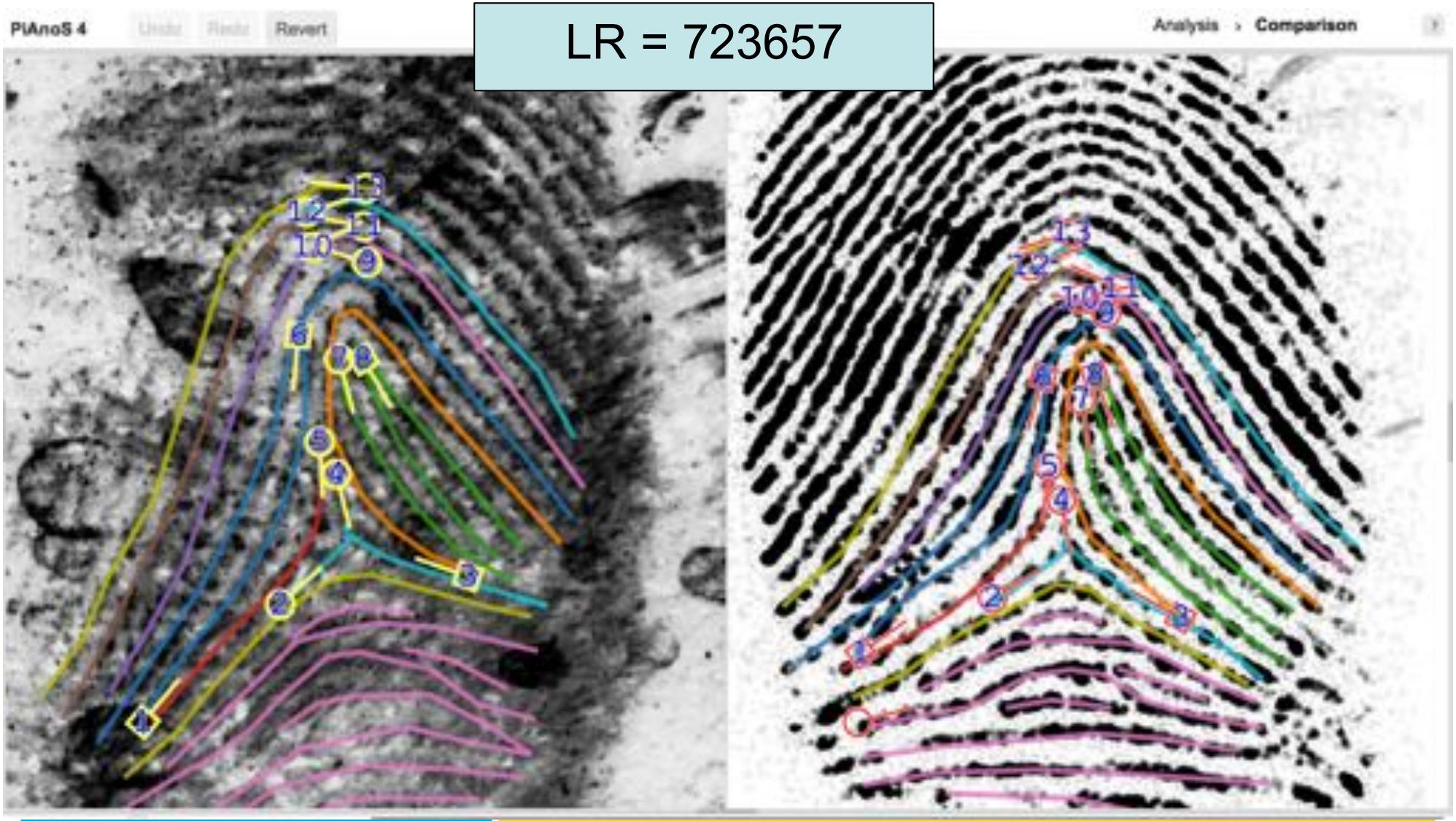
User 436 (ID) – Certified (5 years)

LR = 9.03e-22

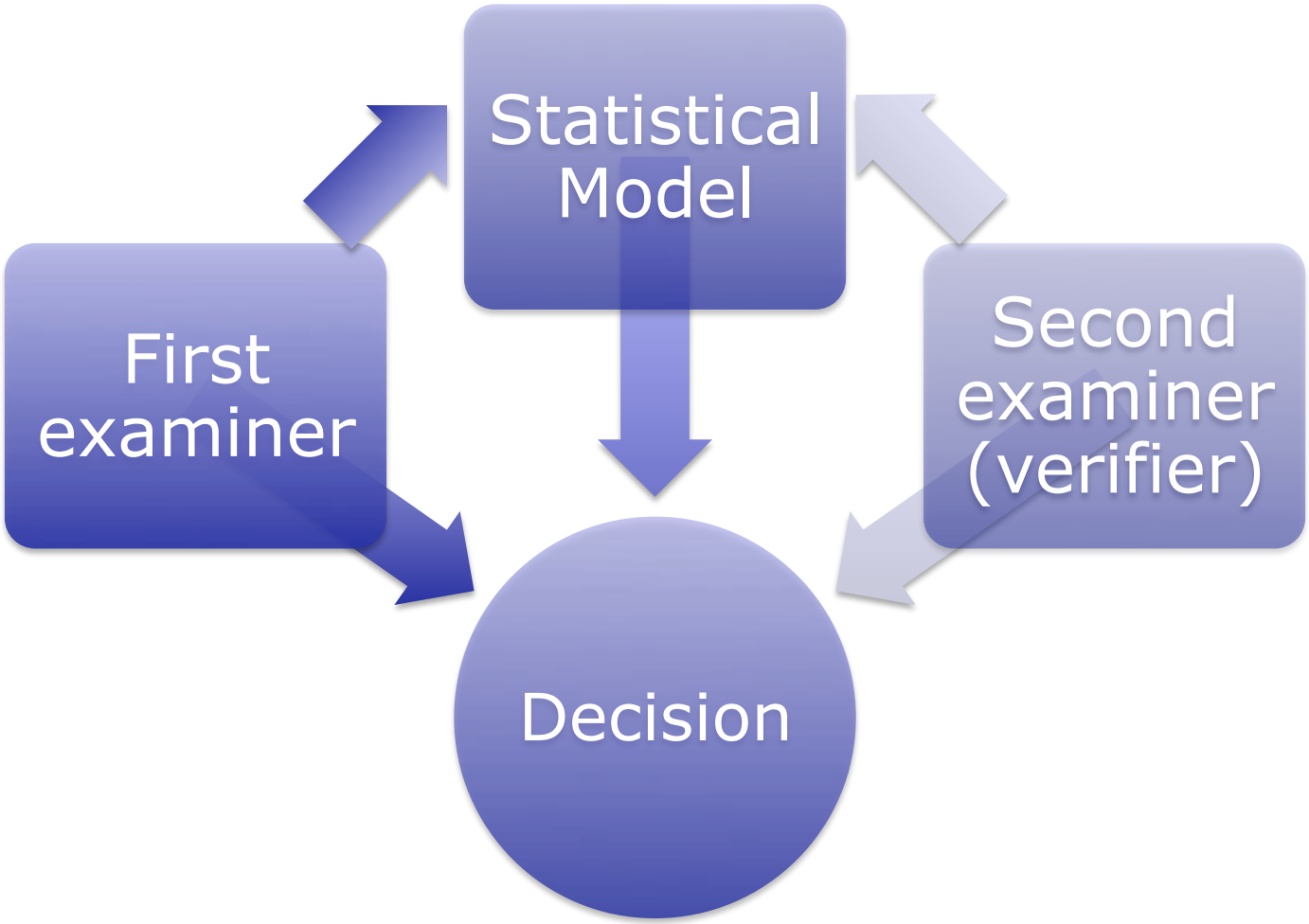


User 481 (ID) – Certified (7 years)

LR = 723657



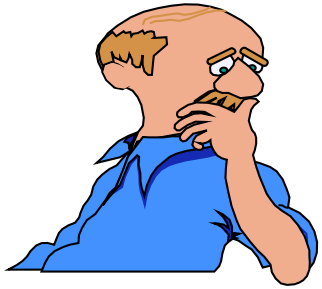
Conflict resolution procedures



Outlook

Holistic expert		LR-based biometric system	
Level 3 features (pores and ridge edges) (scars, creases)	Level 1 features (general flow/pattern)		Level 2 features (Minutiae)
Their contributions must be articulated through an argumentative discourse used to assign the numerator and denominator of the likelihood ratio associated with the features not covered by the biometric system. To the very least an error rate obtained from task-relevant proficiency tests should be disclosed.		Likelihood ratios assigned following a documented and systematic account of the *within* source and *between* sources variations.	

Saying more than “inconclusive”



Again, we need to precisely define the scope of usage

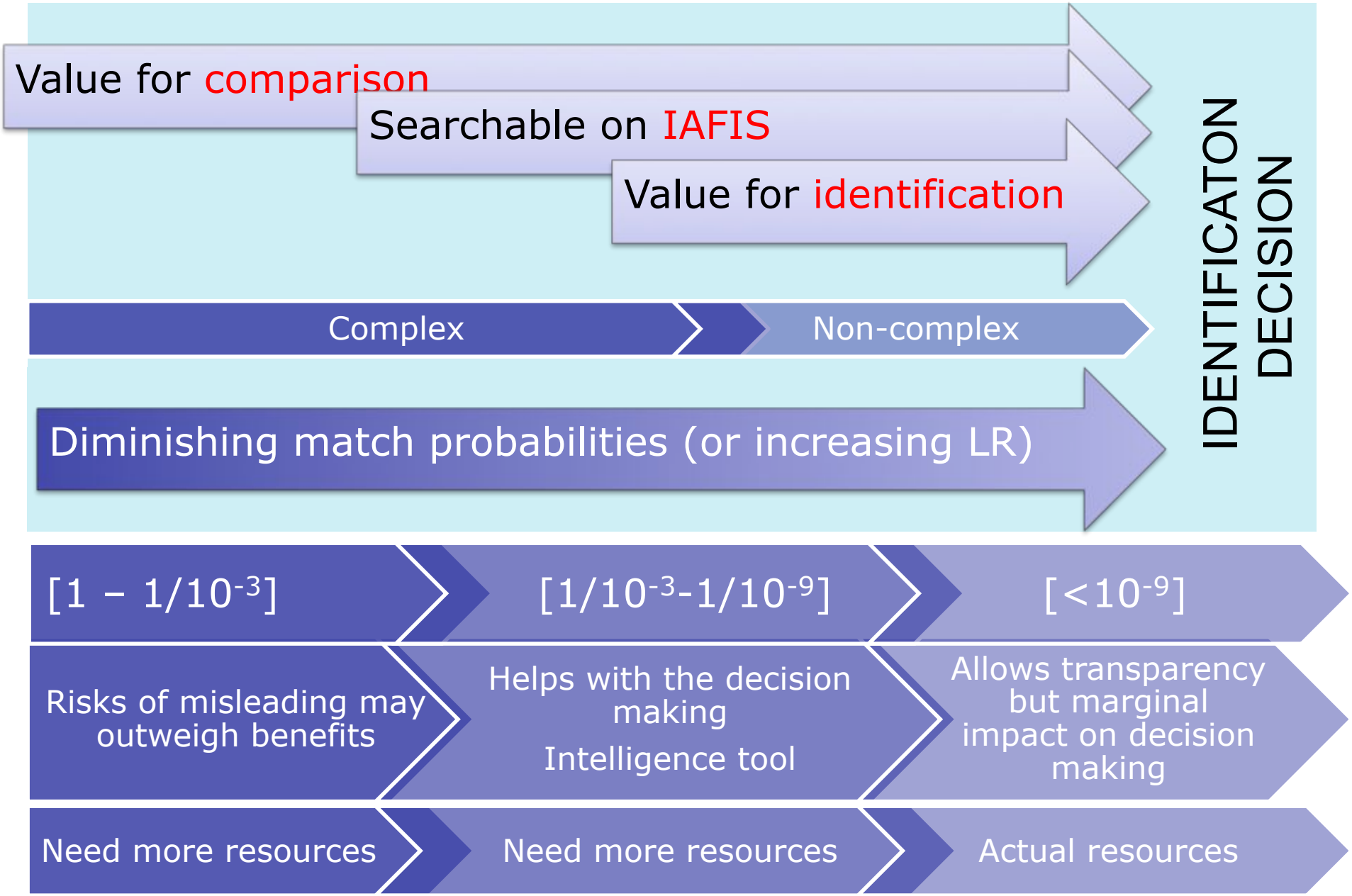
Examiners’ feedback

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
IDENTIFICATON DECISION
Complex
Non-complex
Diminishing match probabilities (or increasing LR)
[1 – 1/10-3]
[1/10-3-1/10-9]
[<10-9]
Risks of misleading may outweigh benefits
Helps with the decision making
Intelligence tool
Allows transparency but marginal impact on decision making
Need more resources
Need more resources
Actual resources

Biometric (Mars) and forensic (Venus) wedding ?

① Friendly visit to the other clubs/planets

② Suggested elements of the *prenuptial agreement*:

- Jointly define the use cases that address the needs of forensic investigation.
- Jointly agree on the territories of excellence (lights-out versus manual operations).
- Jointly identify the mutual benefits in relation to the production (the birth) of evaluative reports.

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