



Technology Transition Workshop | *Paul Chamberlain*

Probability Software and Fingerprint Comparison

Introduction

- **We've introduced some ideas of how probability can help in forensic science**
- **How can any of this be applied to fingerprints?**

Fingerprint Examination – The Objective

- **In a fingerprint examination we are trying to establish if the latent print and the known print came from the same individual**
- **We are comparing a partial and distorted area of friction ridge detail with an area taken under controlled conditions**

Analysis

- **First, let's consider how we arrive at our conclusions now**
- **In the analysis phase we select individual features and configurations of features to use in our comparison**
- **Why do we select those features?**

Analysis

- We select on the basis of the knowledge we have that these features are
 - Consistently reproducible
 - Have a high degree of specificity

Analysis

- **Specificity**
 - You shouldn't expect the particular features and their configuration to appear in another random fingerprint
- **If you could show that they don't appear in any other fingerprint at all then you could call this uniqueness**
 - You can only show uniqueness by considering all fingerprints

Evaluation

- We can say that in our evaluation we are calculating the **likelihood that the features and configurations appearing in the latent and print have the same source**

Evaluation

- **We are talking about a single event**
- **You will recall that to consider the probability of a single event we can use the concept of **subjective probability****

Evaluation

- You will also recall that we need to be careful with that word **subjective**
 - Does not imply that our observations are unfounded
- They are based on empirical observations and belief

Evaluation

- In fingerprints, we call this **experience**
- Our current approach to fingerprints does have a logical basis
 - Provided that the features and configurations we select **truly have a high level of specificity**
 - The basis has **some scientific validity**

Evaluation

- **We identified issues**
 - **Consistency**
 - **Transparency**
 - **Reproducibility**
 - **Etcetera**
- **What constitutes sufficient experience?**

How Will Probability Help?

- **We can use ideas from probability to develop an understanding of how we currently reach our conclusions**
- **We can do more than this**

How Will Probability Help?

- We can **model** features in a fingerprint and produce data to assist
- This data is:
 - Consistent to the input
 - Transparent: the underlying theories, databases, etc. can be demonstrated
 - Reproducible
- We can say it is more “objective”

Introducing Probability Software

- This is the aim of software such as ***FSS***
Fingerprint Dactsys™
- It generates an output based on the minutiae configuration

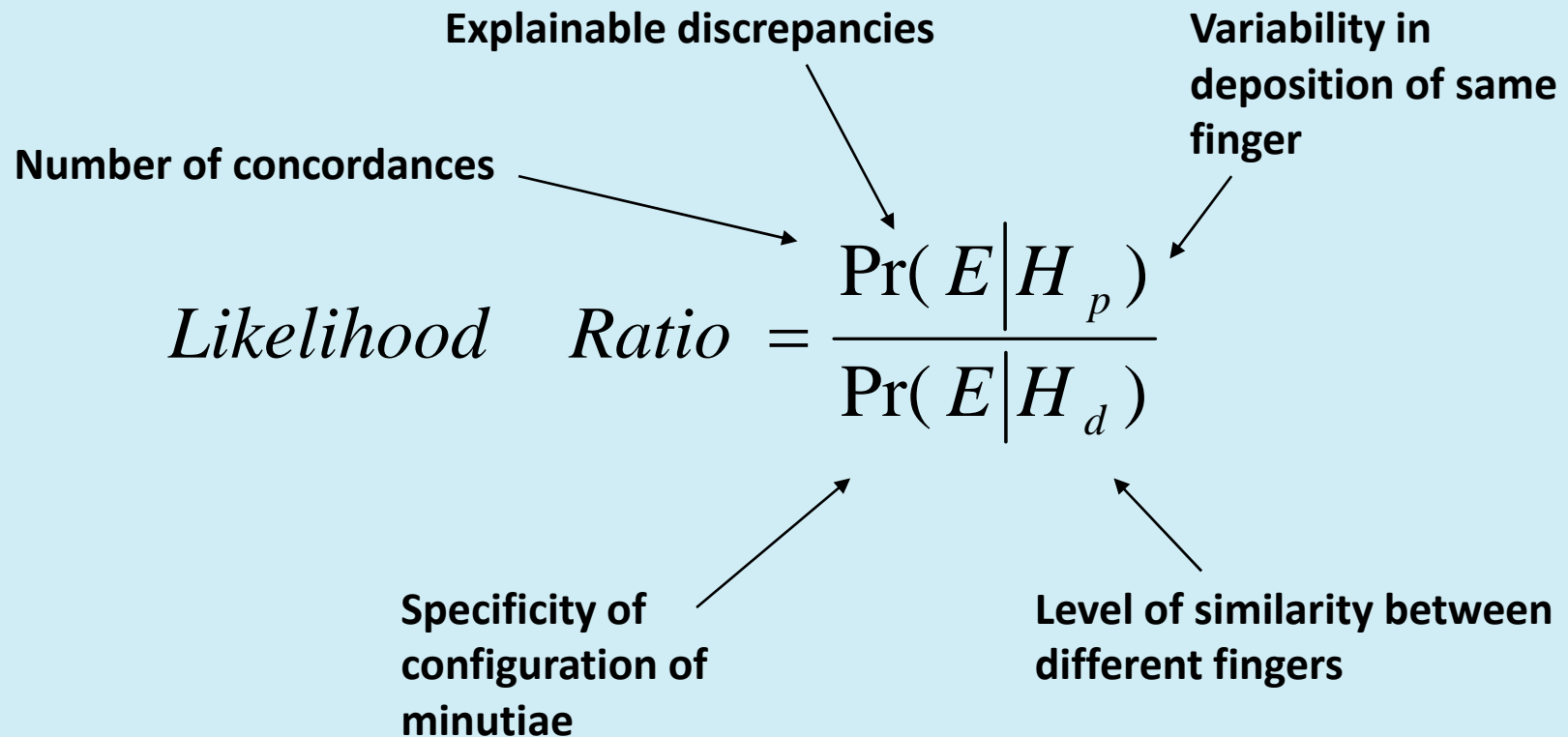
Introducing Probability Software

- **Why only minutiae?**
 - They are the universally accepted features
 - Used in almost all comparisons
 - Start simple

Introducing Probability Software

- **The output of Dactsys™ is a Likelihood Ratio (LR)**
- **What we are providing is a measure of the weight of evidence of a corresponding configuration of minutiae**
- **How is this achieved?**

Introducing Probability Software



Introducing Probability Software

- **Specificity of the configuration of minutia**
 - **Minutiae type, direction and relative spatial relationships**

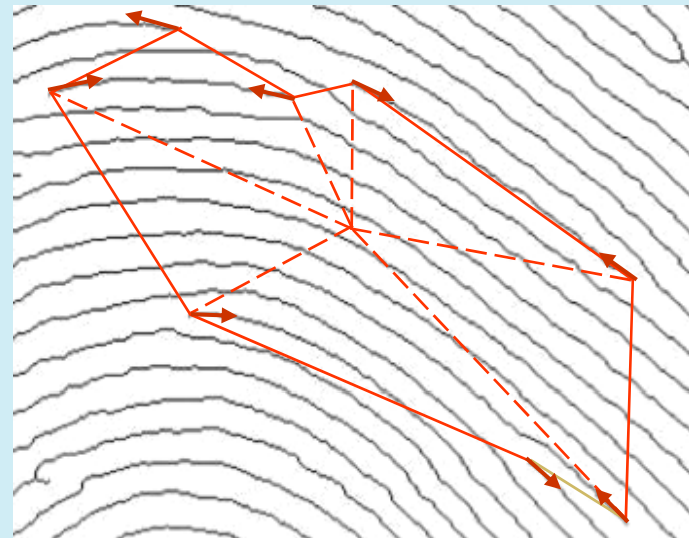


Image courtesy of Paul Chamberlain

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Introducing Probability Software

- **The model takes an objective, data-driven approach**
- **It provides a calculation based on the actual latent print and known match**
 - **It is case specific**

Introducing Probability Software

- **There are other factors that need to be considered**
 - **Database needs to be representative**
 - **Relevant population**
 - **Size**

Introducing Probability Software

- **Different areas of fingers and thumbs**
 - Differing distributions of minutiae
- **Research on palms and phalanges**
- **Distortion during deposition**
 - Probabilistic distortion model

Elements of Validation

- Addressing these and other aspects of the model and the software constitutes **validation**
 - Differences in deposition of same finger
 - Measurement of errors
 - Accuracy

Validation and Adoption

- We will not discuss validation further here and assume for the purpose of this discussion that the model and software are validated
- FSS sets the highest standards of validation
- Until both a validation and any **adoption** criteria are met, this software cannot be used

First Generation Software

- **Of course, minutiae form only part of the examination**
- **Does software with such a limitation have value?**

First Generation Software

- **Let's look at those criteria from the first session**
 - **Scientific validity**
 - **Sufficiency**
 - **Consistency**
 - **Transparency**
 - **Reproducibility**
 - **Training**

First Generation Software

- **Scientific validity**
 - **Contributes to the basis of fingerprint examination**
- **Sufficiency**
 - **Can provide a guide to defining sufficiency**
- **Consistency**
 - **Same output from same observations**

First Generation Software

- **Transparency**
 - Helps show how some of the observations were evaluated
- **Reproducibility**
 - Same output regardless of time
- **Training**
 - “Captures” experience of examiners

First Generation Software

- **We can identify some value in using this type of software to support our current process**
- **Does this software challenge the ability to individualise?**

Probability and Individualisation

- **What do we mean by individualisation?**
 - “Conclusive match”
- **Exclude *any* likelihood of another source**
- **Such certainty cannot be supported from a scientific / mathematical viewpoint**

Probability and Individualisation

- It is now becoming more accepted that it is unnecessary to attempt to exclude all other sources
- We need to think only about **relevant populations**

Probability and Individualisation

- **Let's consider another definition:**
 - **The findings of the examination are such that the likelihood of another person in the relevant population being the source of the latent is so diminishingly small that it can be discounted**
 - **This is an expert opinion**

Probability and Individualisation

- **What is the fundamental objective of a latent print comparison?**
 - **To associate an individual with a latent recovered from a scene or item**
- **The probative value of that association is dependent on the case circumstances**

Probability and Individualisation

- **The expert opinion based on the definition provided here has the same evidential value as we are currently expressing**
- **What about those matches for which we are unable to make this opinion?**
 - **We will consider this situation later in the workshop**

Scope of First Generation Software

- **The Dactsys™ software you will use today only calculates LR for configurations of 12 minutiae or less**
- **Research has shown that LR for higher numbers of corresponding minutiae are extremely high**

Scope of First Generation Software

- **The specificity of minutiae configurations above 12 is such that the likelihood of another source can be assumed to be diminishingly small**
- **The opinion of individualisation is therefore supported**

Scope of First Generation Software

- **This finding is of interest to our colleagues involved in the biometric uses of fingerprints**
- **Does this finding indicate a return to a point standard?**
- **The simple answer is no, but we will return to this topic later**

Scope of First Generation Software

- **Below 12 minutiae, the software may be considered as providing a sort of baseline measure**
- **Individualisation would therefore be based on the examiner's calculation of the specificity of the other features observed, etc.**
- **To do this we will develop an **Evaluative Framework****

Scope of First Generation Software

- We will now introduce you to a demonstration version of ***FSS Fingerprint Dactsys™***
- We will investigate how the software performs and explore its use

Questions?

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