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Fingerprint Science

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Abstract

Outline 1. What fingerprint analysts do. 2. Fingerprint Uniqueness a) Biology b) Empirical c) Persistence

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Outline

1. What fingerprint analysts do.

2. Fingerprint Uniqueness

   a) Biology
   b) Empirical
   c) Persistence

Research funded by the Center for Statistics and Applications in Forensic Evidence (CSAFE) - forensicstats.org

3. AFIS (Automatic Fingerprint Identification Systems)
4. The identification decision
5. Conclusions

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1. What fingerprint analysts do

a) Examine the mark from a crime scene to determine whether it is of such quality that it can be analyzed.

b) Note the Level 1 (gross characteristics) and Level 2 (minutiae) on the mark.

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c) Run the mark thru an AFIS (Automatic Fingerprint Identification System) with respect to a database.

d) Examine the most similar prints identified by AFIS to determine whether each can be excluded, or whether one can be said to be a (match, identification, etc.)

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2. Fingerprint uniqueness

a) Biology – twin studies
development of fingerprints in the fetus

b) Empirical – we've never seen a duplication

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There are about 7.3 billion people in the world. Thus there are $10(7.3 \text{ billion})^2/2$ comparisons to be made, which works out to 2.67×10^{20}.

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For example, fingerprint analysis in its current form started with Galton [1892], say roughly 130 years ago. Since that time the number of seconds that have elapsed is $(60)^2$ (24) (365.25)(130) = 4.1 10^9. Therefore, it would require over 10^{10}, i.e. 10 billion, comparisons every second since 1892 to verify the hypothesis empirically.

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3. AFIS (Automatic Fingerprint Identification System)

Assumption A: The AFIS system is unerringly accurate in finding that member of the database of fingerprints most similar to the mark found at the crime scene, and returns real-valued similarities without ties.

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Assumption B: The database of fingerprints used by the AFIS system is a random sample of the relevant population's fingerprints.

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Suppose the results are $x_1 < x_2 < \ ... < x_n$, similarities from a database of size *n*.

Results:

Then only the fingerprint most similar to the mark (with similarity x_n) is a possible match. It's probability of being correct is n/N where N is the size of the population.

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Table 1: Probability that the person found most similar by AFIS is the person who left the mark.

Description	N	n	Probability that x_n is the culprit
World comparison national database	7.3 billion	70 million	9.589×10^{-4}
World comparison local database	7.3 billion	10,000	1.37×10^{-6}
US population national database	324 million	70 million	2.16×10^{-1} (=21.6%)
US population local database	324 million	10,000	3.09×10^{-5}

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Critique of Assumptions

A. (perfection of AFIS)

1. Several, and they're different.

2. All proprietary, so analyst doesn't know what similarity measure they use.

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B. Database

1. National has persons arrested, those who have sensitive jobs, and those who fly. (So perhaps those most and least likely to offend.)

2. Analyst is not an expert on the inclusiveness of the database.

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4. The identification decision

Suppose an analyst has found a print with identical Level 1 characteristics, and several minutiae that correspond and none that do not.

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There is no scientific basis on which to estimate the number of people whose fingerprints share these characteristics. As a consequence there is no scientific basis for concluding that this is the only person who could have such a fingerprint.

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5. Conclusions

a. Testimony concerning ‘identification,’ ‘match,’ etc.

b. Usefulness of fingerprint analysis.

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