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Predicting the First Recorded Set of Identical Fingerprints

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Abstract
Fingerprints have been used to identify criminals in the UK since the beginning of the 20th century, with 1901 marking the initial development of Scotland Yard's fingerprint database. Since this time the UK database has continued to grow and now has approximately 7 million sets of fingerprints on record. Sir Francis Galton's 1982 calculations stated that there is a 1 in 64 billion chance that two fingerprint sets are identical. Using these match probability calculations and the average yearly growth of the database, this paper shows that it will be at least 1,042,277 years before the British database will contain two sets of identical fingerprints.

Introduction
A fingerprint is an impression left by a special type of skin found on the tips of a person's fingers. This skin, known as friction ridge skin, forms in the womb during pregnancy and leaves a distinctive ridge pattern that is unique to an individual. Due to this individuality and the fact that they remain constant throughout a person's life [1] - providing the individual's fingertips are not subjected to deep scarring [2] - fingerprints can be used as a means of identification [1].

Fingerprints are classed as identical if a significant number of the ridge patterns minute details match up. The evaluation of these details and the determination of fingerprint matches is left to highly trained fingerprint experts who are the only ones with the power to declare a fingerprint match within a criminal trial [1]. While this is common global practise, it is important to note that different countries have different standards of what constitutes a fingerprint match. Until 2001 the UK used a 16 point match standard (now a match is left to the discretion of the expert) where as other countries have different standards, e.g. Australia uses a 12 point standard [3].

Fingerprints started to be become a recognised means of criminal identification towards the end of the 19th century. While many historical figures contributed to their eventual worldwide use, Sir Francis Galton was the first person to publish mathematical evidence that fingerprints were unique to an individual. In his 1982 publication "Finger Prints" Galton's calculations showed that there was a 1 in 64 billion chance of two fingerprints sets being identical [1]. His work gave mathematical proof that fingerprints were unique to individuals and lead Sir Edward Henry establishing the Henry Classification system in 1901. Henry presented this system to Scotland Yard in 1901 and this lead to the establishment of a British fingerprint database [4]. Since this time the database has continued to grow and is currently stored on the IDENT1 computer system, which to this date contains approximately 7 million sets of fingerprints [5]. This paper models the average rate at which the British fingerprint database has grown each year since 1901 and uses it to establish how long it would take for the British database to contain two sets of identical fingerprints based on Galton's original calculations.

Identifying an Identical Match
As previously stated there is a 1 in 64 billion chance of identical set of fingerprints according to Galton's probability (*P*).

$$P = \frac{1}{64 \times 10^9} \qquad (1)$$

Fingerprints have been collected and classified by the Henry classification system by Scotland Yard since 1901. If it is assumed that there have been 7 million prints collected for the British database (as

stated in 2014) [5], that no prints have been deleted from the records, and that there has been a steady collection of prints from the day they first started the records, the number of prints collected per year (*N*) can be determined for the 114 years.

$$N = \frac{7 \times 10^6}{114} \quad (2)$$
$$N \approx 61404 \text{ prints per year}$$

It is necessary to note here that that there is not an even number of prints that would have been collected per year. Since the time that print collection began many new techniques for visualising and lifting fingerprints has been found, as well as more efficient methods for print collection. It is therefore presumed that there will have been a greater number collected in the past 50 years compared to the beginning few years.

Once the value for the number of sets collected per year was defined, it could then be applied to Galton's value for the probability of finding an identical set of prints. From the probability of 1 in 64 billion it is assumed that the 64th billion set of prints will be exactly identical to one set collected prior to it. Using 61404 prints per year and the probability, it was calculated what year the first identical set of prints will appear in the database (*T*).

$$T = \frac{64 \times 10^9}{61404} \quad (4)$$

$$T = 1042277$$

As prints were not collected until 1901 this is added to the year in order to determine the final date for the first set of identical prints: 1044178 AD.

If fingerprints were collected from the moment that anatomically modern humans were present and roaming the earth – 200,000 years ago [6] – then this year would be reduced to 842277 AD.

Conclusion

The validity of using fingerprints in court trials has been questioned due to the similarities between different prints, and the difficulty with distinguishing between certain prints.

However, from our calculations here, it can be seen that using Galton's value for probability, an identical print will not be found in the British database for over a million years (1,044,178 AD).

The rates of print collection in other countries have not been accounted for in our calculation; however, it is assumed that although some countries – such as the USA – may have collected more prints due to larger populations, the raw number of prints will not differ by any order of magnitude. It can therefore still be assumed that even if all the databases were collated, it would still be many hundreds of thousands of years before an identical fingerprint set is identified.

References

[1] Jackson A.R.W. & Jackson J.M. (2011) *Forensic Science, 3rd Edition*. Pearson.
[2] Yoon, S. (2012) *Altered Fingerprints: Analysis and Detection.* Pattern Analysis and Machine Intelligence. 34, pp 451.
[3] Lynch, M. (2003) *God's signature: DNA profiling, the new gold standard in forensic science*. Endeavour, 27, 2, pp 93-97.
[4] Hawthorne, M.R. (2008) *Fingerprints: analysis and understanding*. Boca Raton: CRC Press
[5] The Scottish Government (2014) *Fingerprint Database - IDENT1.* Available: http://www.gov.scot/Topics/Justice/law/dna-forensics/scottishdnadatabase/ident1 [Accessed 16/03/2015].
[6] Barton, N., Briggs, D., Eisen, J., Goldstein, D. & Patel, N. (2007) *Evolution, 1st Edition*. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.