

Forensic Science Lesson 3: Trace Evidence Analysis

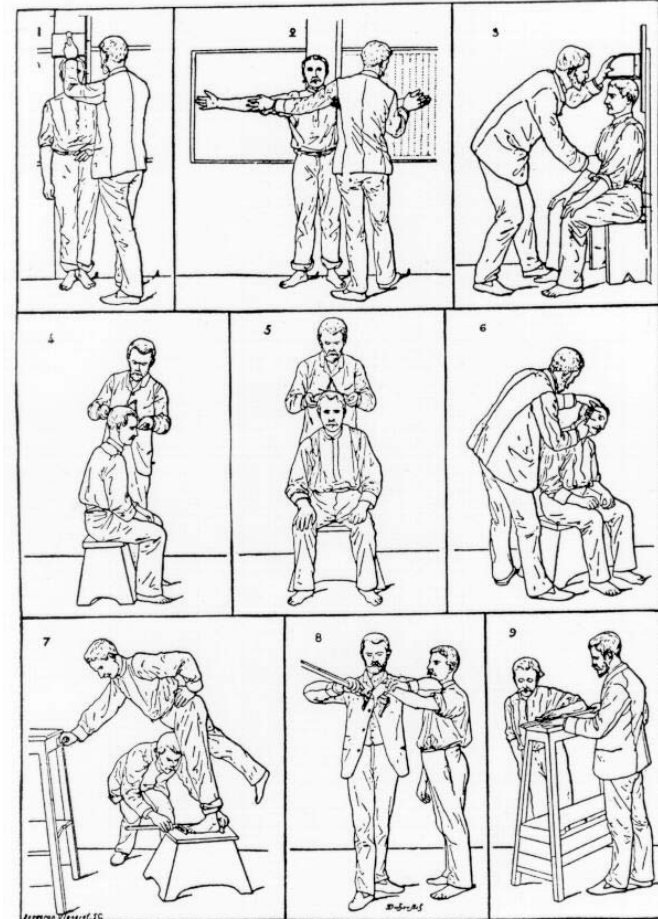


History

Alphonse Bertillon

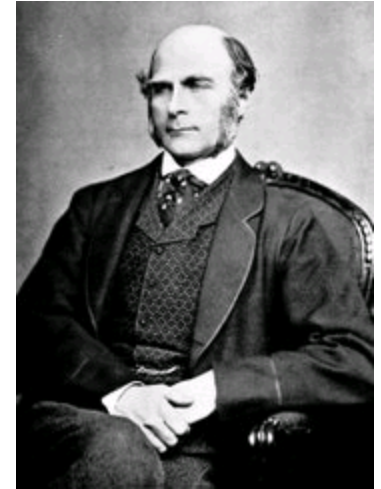


- 1883 Created the first systematic system of individual classification & identification
- Detailed description of subject, full-length & profile photographs, & a system of precise body measurements (anthropometry)



Sir Francis Galton - 1888

- Sir Francis Galton, a British anthropologist and a cousin of Charles Darwin, began his observations of fingerprints as a means of identification in the 1880's.
- In 1892, he published his book, "Fingerprints," establishing the individuality and permanance of fingerprints. The book included the first classification system for fingerprints.



http://en.wikipedia.org/wiki/Francis_Galton

Sir Francis Galton - 1888

- Galton's primary interest in fingerprints was as an aid in determining heredity and racial background.
 - He soon discovered that fingerprints offered no firm clues to an individual's intelligence or genetic history.
 - He demonstrated that fingerprints do not change over the course of an individual's lifetime, and that no two fingerprints are exactly the same.
 - According to his calculations, the odds of two individual fingerprints being the same were 1 in 64 billion.

Will West

- 1903: William West incident
 - Fort Leavenworth prison
 - New prisoner William West couldn't be distinguished from unrelated inmate with same name by anthropometry
 - Discovered that their fingerprints differed



How Fingerprints Are Formed

Fingerprints

- A fingerprint is an **INDIVIDUAL CHARACTERISTIC**
 - no two are alike and no two have yet been found to possess identical ridge characteristics.
 - Fingerprints are the product of your genes as well as the environment of the womb during development in the first trimester (nutrition, blood pressure, contact with the womb)
 - Once developed, fingerprints do not change over the course of your life, although they may be altered or scarred
- They evolved in some primates and other animals (e.g. koalas) for firmer grasp and resistance to slippage
- They are comprised of a series of lines corresponding to hills (ridges) and valleys (grooves).

Anatomy of the Fingerprint

- Skin is composed of layers of cells: Epidermis (outer portion) and dermis as inner skin.
- In a cross section a boundary of cells separating the epidermis from the dermis is made up of dermal papillae. These determine the form and pattern of ridges on the surface.
- Dermal papillae develop in the fetus and remain unchanged during life.
- Sweat glands discharge and deposit perspiration to the surface of the skin. Sweat is vital to the formation of latent fingerprints.

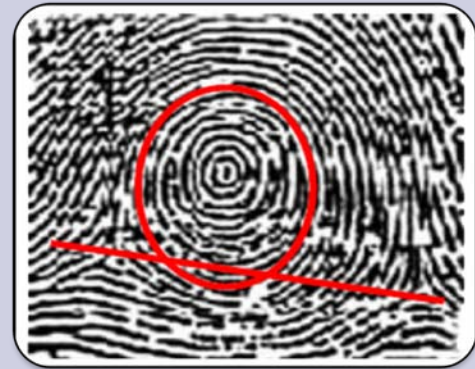
Latent Prints

- Each skin ridge is populated with a single row of pores—openings for ducts leading from sweat glands.
- There are 2 types of sweat glands – only those found on the surfaces of the hands and feet (eccrine glands) secrete perspiration that *does not* contain oil.
- Oil in fingerprints comes from the hand contacting other parts of the body (e.g. face) or other substances containing oil.
 - Perspiration from eccrine glands discharges and deposits water ($\approx 95\%$), urea, salts, and proteins on surface of skin.
 - When the finger comes into contact with another surface, the water and dissolved substances are transferred.
 - This leaves an impression of the finger's ridge pattern (fingerprint).
 - These are typically invisible to the eye and are referred to as latent fingerprints.

Fingerprint Principles

- A fingerprint is an individual characteristic; no two people have been found with the exact same fingerprint pattern. (NOT EVEN IDENTICAL TWINS!)
- A fingerprint pattern remains unchanged for the life of an individual; however, the print itself may change due to permanent scars and skin diseases.
- Fingerprints have general characteristic ridge patterns that allow them to be systematically identified.

Fingerprint Classes



Arch

Plain Arch
Tented Arch

Loop

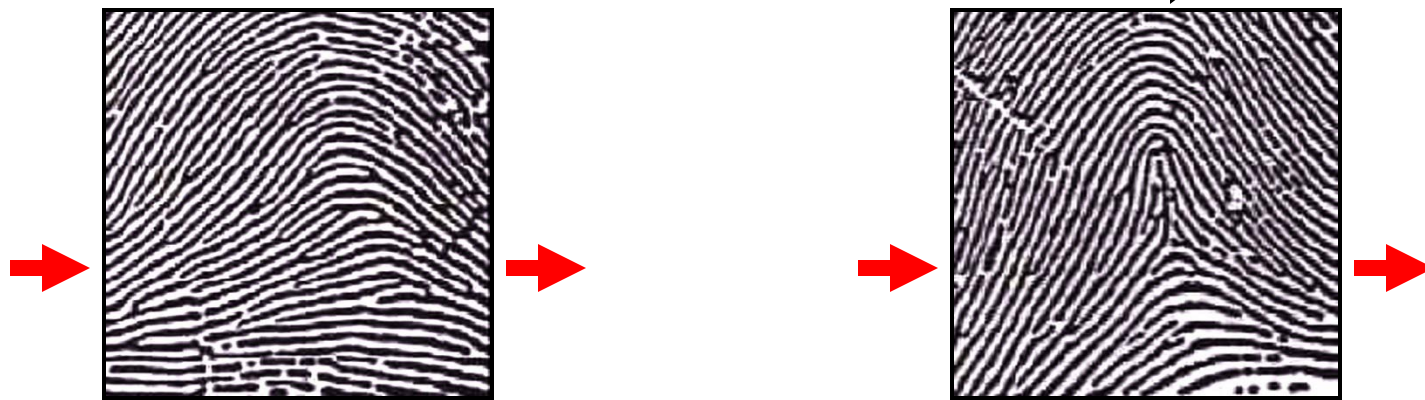
Ulnar loops
Radial loops

Whorl

Plain Whorl
Central Pocket
Whorl
Double-loop
whorl
Accidental

Arches

Arches are the simplest type of fingerprints that are formed by ridges that enter on one side of the print and exit on the other. No deltas are present.



Plain Arch

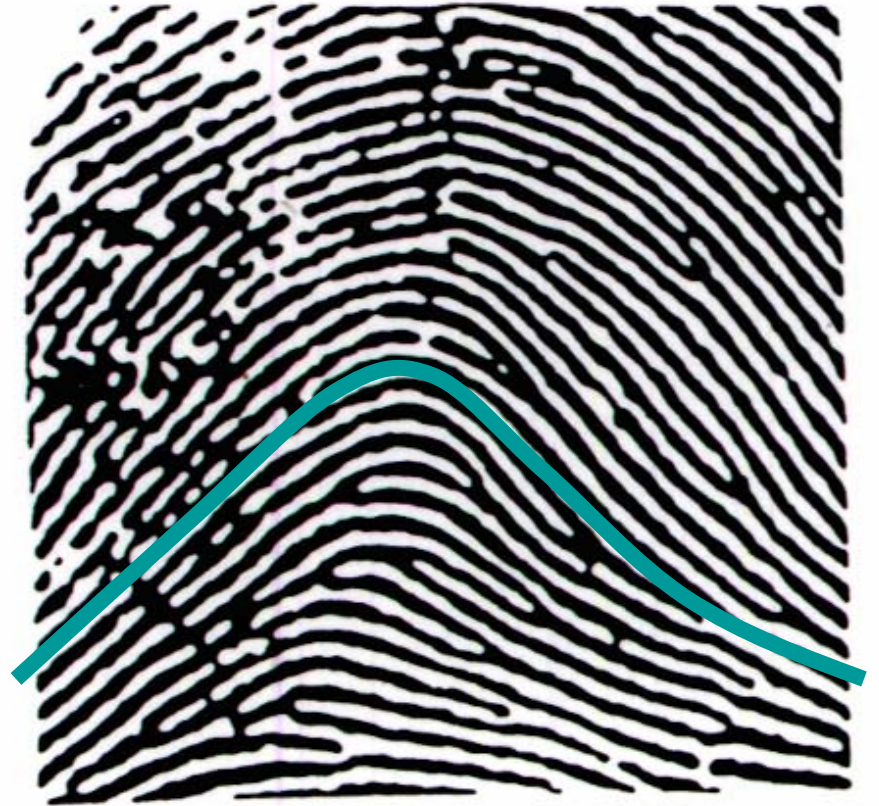
Ridges enter on one side and exit on the other side.

Tented Arches

Similar to the plain arch, but has a spike in the center.

Arches

- In one side
- Rises
- Falls
- Goes out the other side



Arches

- Plain Arch-Ridges enter, wave or rise, and exit smoothly.
- Tented Arch-Ridges in the center thrust upward to give an appearance similar to a tent. Inside angle is smaller than 90 degrees.
- Both types of arches comprise about 6% of all fingerprint patterns.



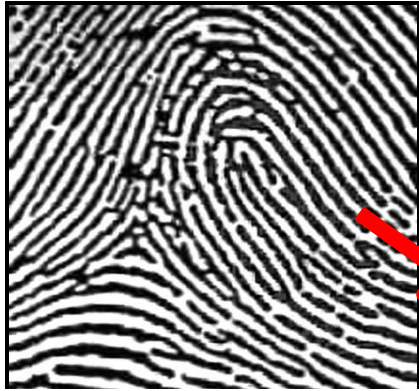
Plain Arch



Tented Arch

Loops

Loops must have one delta and one or more ridges that enter and leave on the same side. These patterns are named for their positions related to the radius and ulna bones.



Ulnar Loop (Right Thumb)

Loop opens toward right or the ulna bone.



Delta



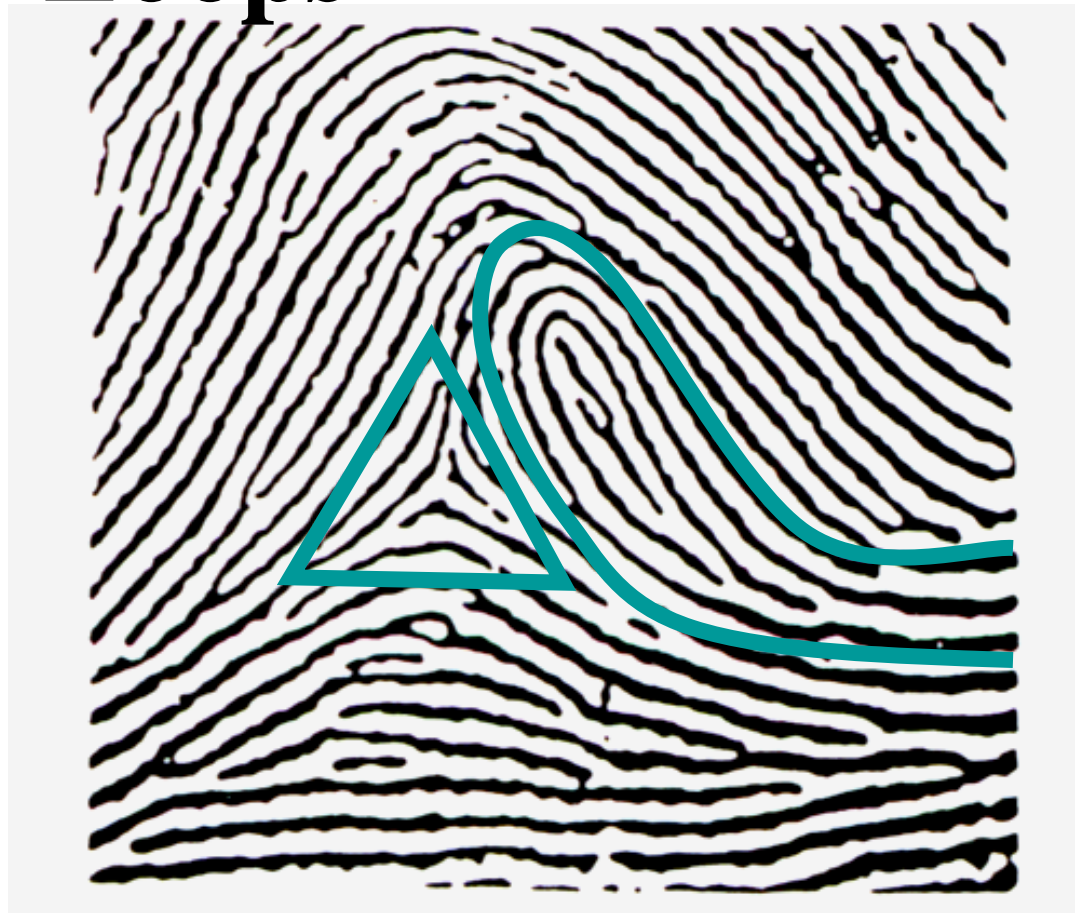
Radial Loop (Right Thumb)

Loop opens toward the left or the radial bone.

NOTE: On the left hand, a loop that opens to the left would be an ulnar loop, while one that opens to the right would be a radial loop.

Loops

- Comes in, curves, goes back out same side.
- Usually curving around a delta.

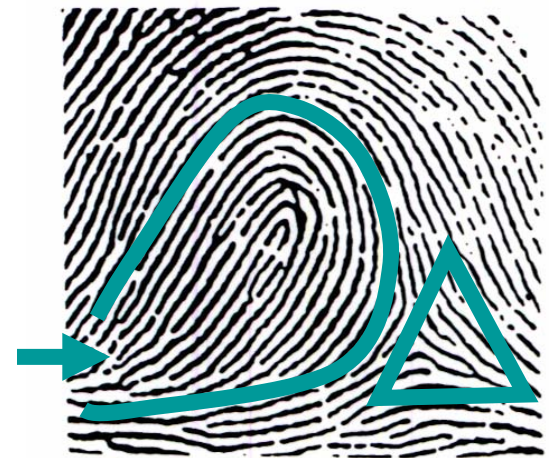


Loops

- Radial Loop – Ridges flow from the curve toward the radius or thumb side of the hand
- Ulnar Loop – Ridges flow from and curve toward the little finger side of the hand
- Radial loops are approximately 5% of fingerprint patterns while Ulnar loops are 60%.



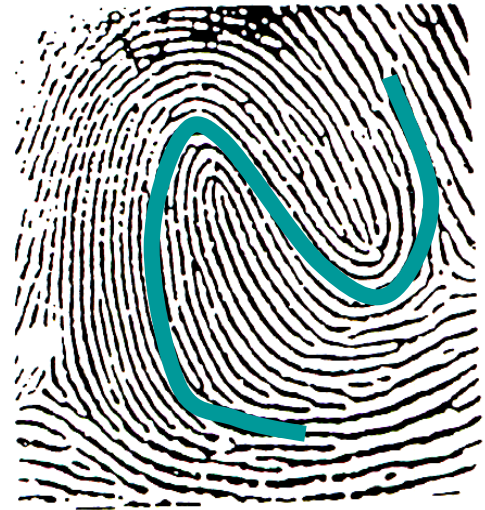
Radial Loop



Ulnar Loop

Loops

- Double Loop – Two separate loops are present, which sometimes surround each other. Sometimes called Double Loop Whorl.
- Accidental – Any pattern which does not conform to any of the previous patterns.



Double Loop

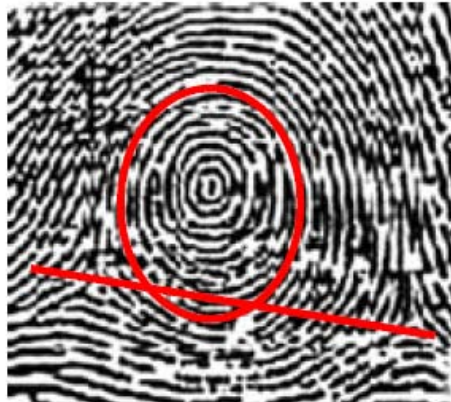


Accidental

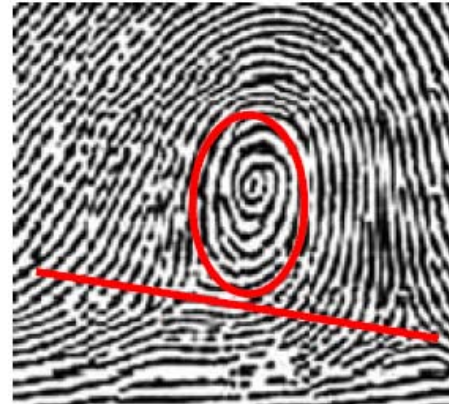
Whorls

Whorls have at least one ridge that makes (or tends to make) a complete circuit. They also have at least two deltas. If a print has more than two deltas, it is most likely an accidental.

Plain
Whorl



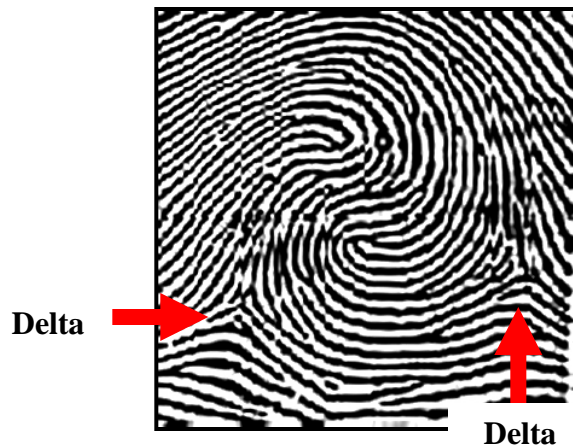
Central
Pocket
Whorl



Draw a line between the two deltas in the plain and central pocket whorls. If some of the curved ridges touch the line, it is a plain whorl. If none of the center core touches the line, it is a central pocket whorl.

Whorls

Double Loop Whorl



Double loop whorls are made up of any two loops combined into one print.

Accidental Whorl



Accidental whorls contain two or more patterns (not including the plain arch), or do not clearly fall under any of the other categories.

Whorls

WHORL:

At least two delta type divergences are present with curving ridges in front of each.

Whorls comprise approximately 29% of all fingerprint patterns.



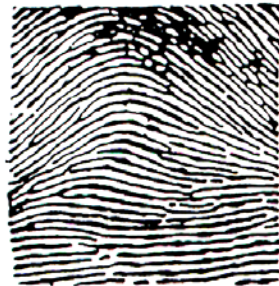
Whorls

Central Pocket Loop Whorl:
Some ridges form a
loop pattern which
curves and surrounds
a central whorl.
(1 delta)



8 Basic Patterns

Looking in depth, there are really 8 basic patterns.



I. A. Plain Arch



I. B. Tented Arch



II. A. Radial Loop



II. B. Ulnar Loop



III. A. Plain Whorl



III. B. Central Pocket Whorl



III. C. Double Loop

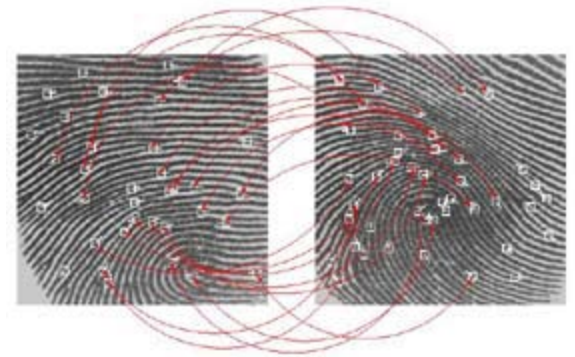


III. D. Accidental Whorl

FINGERPRINT Minutiae

Dermatoglyphics

- Individuality is not determined by general shape or pattern but by a careful study of its **ridge characteristics**
 - (also called minutiae)
- Identity = number and relative location of features that impart individuality.
 - The features should be in the same relative location to one another.
 - In court, a point-by-point comparison must be made to establish identity.



<http://cnx.rice.edu/content/m12574/latest/match.jpg>



RIDGE ENDING



BIFURCATION



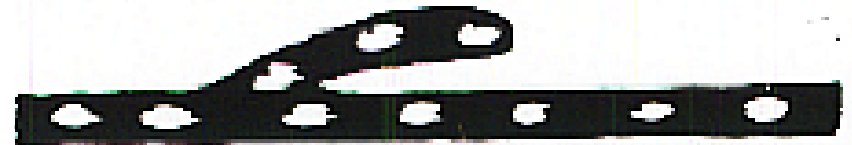
LAKE



DOT or ISLAND



INDEPENDENT RIDGE

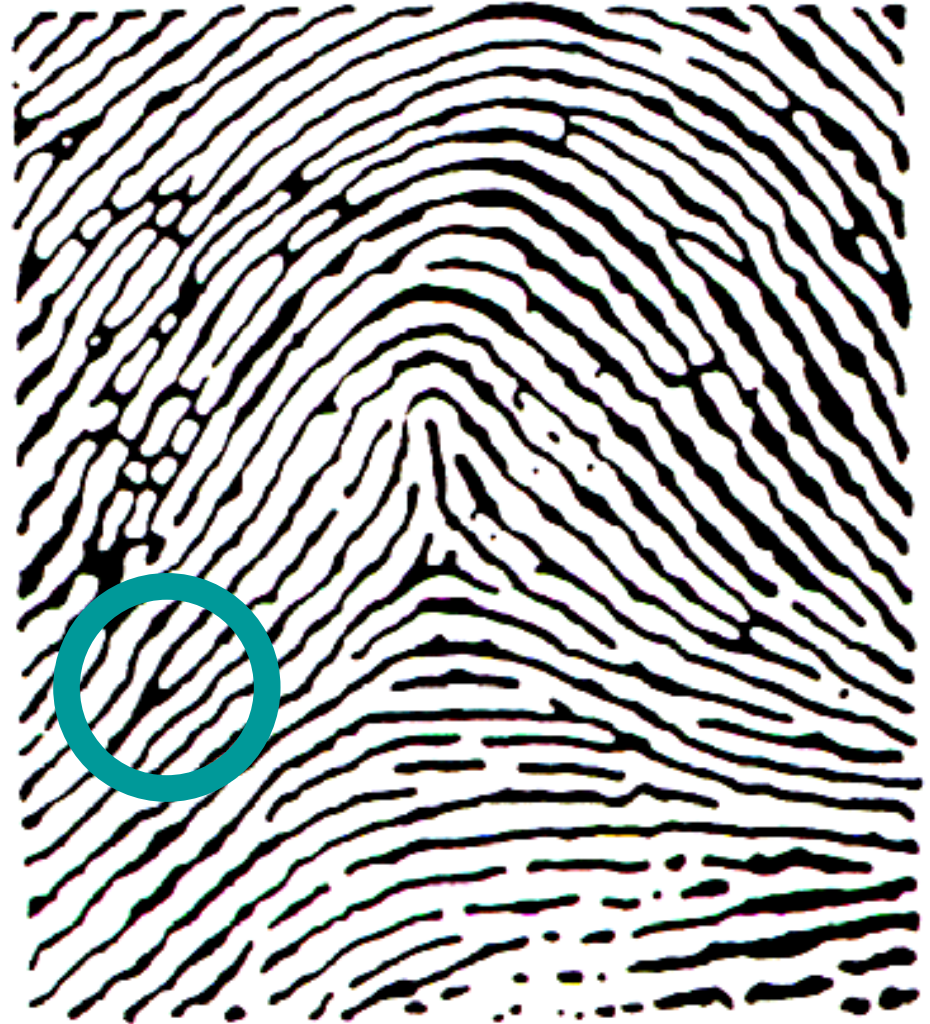


SPUR



BRIDGE

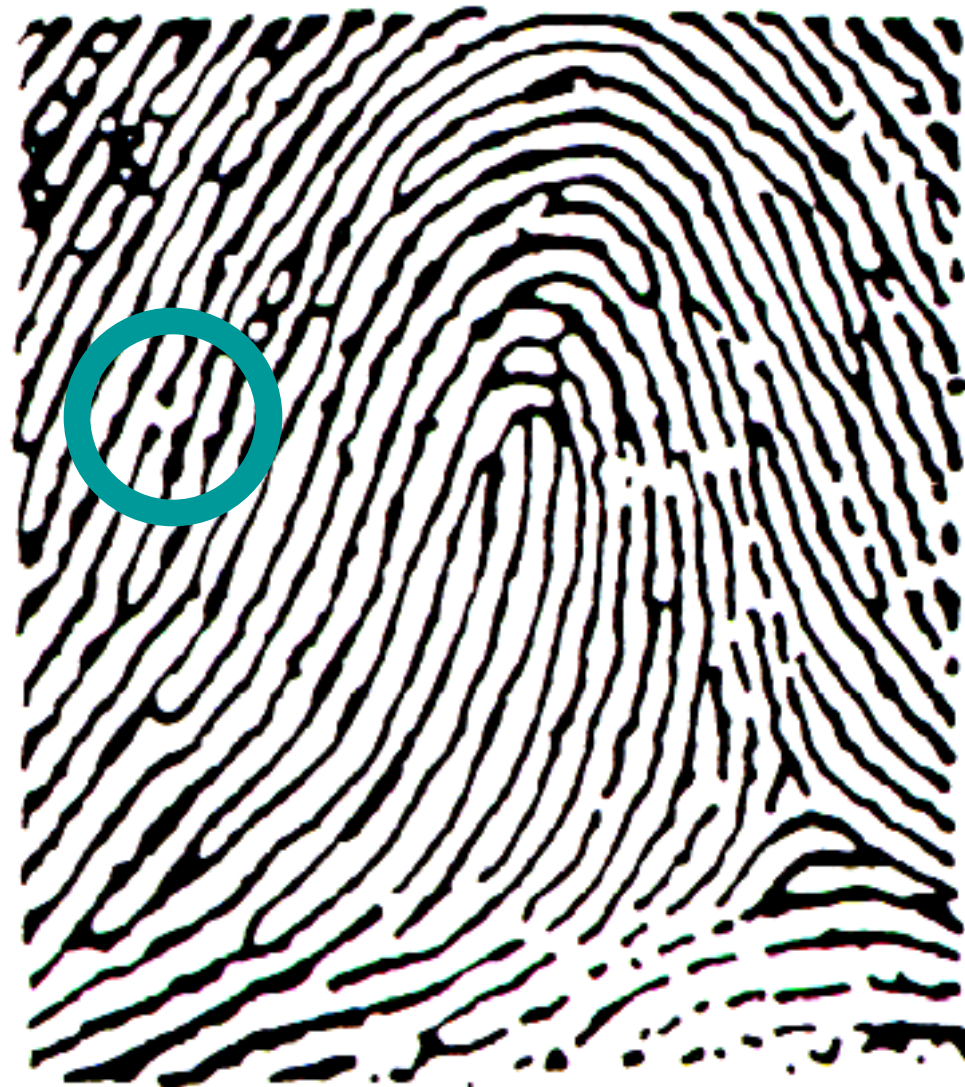
BIFURCATION



SPUR



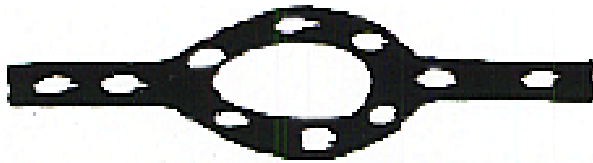
RIDGE ENDING



BRIDGE



LAKE



DOT or ISLAND



**INDEPENDENT
RIDGE**



Matching Prints

- Minutiae alone do not individualize a print – the location of and type of minutia make each fingerprint unique.
- There has never been two fingerprints found that have the exact same minutia in the exact same place.
- So, if you are comparing prints – say from a suspect and a crime scene – and the prints have the same minutiae in the same location, you can deduce that they are from the same person.

Making Comparisons

- There are as many as 150 individual ridge characteristics on the average fingerprint.
 - a vast majority of prints recovered from crime scenes are partial impressions- showing only a segment of the print.
- Experts have to compare a small number of ridge characteristics from the recovered print to the known recorded print.
- Criteria of individuality in court generally requires 8-16 matching characteristics, but often this number is not as important as the expertise of the fingerprint examiner.
- 1973 International Association for Identification concluded, “It is the responsibility of the examiner- based upon experience and knowledge to establish positive identification.”



What's the pattern and how many minutiae can you identify?

