Biometrics 1
Intro & fingerprints

PV181 Laboratory of security and applied cryptography
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Lecture structure

Seminar 1

1. Introduction
2. Fingerprints
3. Seminar activity
   - Fake fingerprints
4. Homework
   - Report on selected biometric system

Seminar 2

1. Face recognition
2. Seminar activity
   - Face biometric SWOT analysis
3. Homework
   - Age estimation

Project Citizen K.

- 2010 “art” project by ZTOHOVEN
- 12 people had their Czech ID cards re-issued with morphed photographs
  - Similar haircut & style
  - Photos 50% themselves, 50% someone else
  - In 2010 you brought your own photo for the ID card

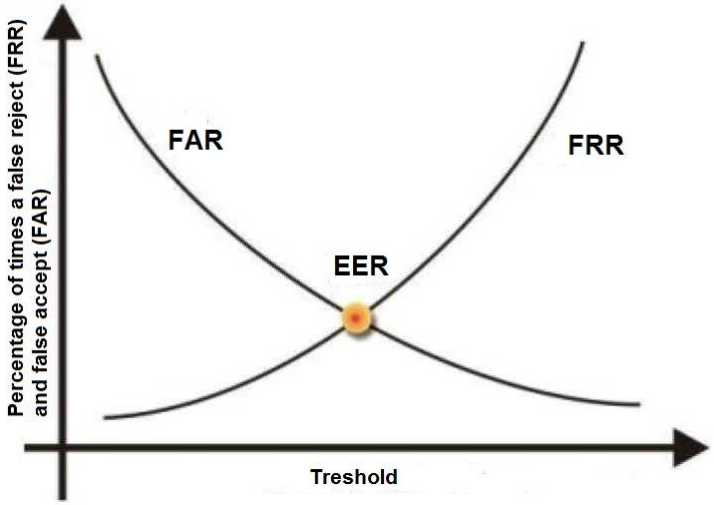
- Using someone else's identity for several months
  - Wedding, gun licence, pilot licence, bank operations, out-of-Schengen travel, elections, ...

PS: Czech documentary can be legally streamed for 60 Kč

Biometrics – introduction

- Authentication based on:
  - something I know (e.g. password)
  - something I have (e.g. access card)
  - **something I am (e.g. fingerprint)**

- Never 100% match
  - FAR (false acceptance rate)
  - FRR (false rejection rate)



Basic criteria for biometrics

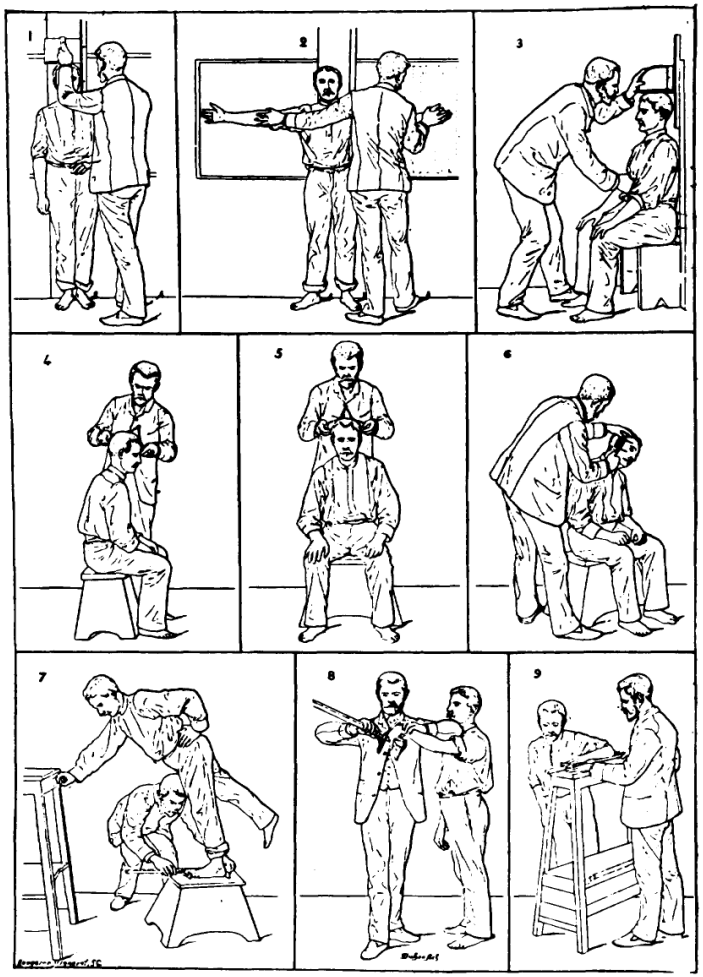
- Uniqueness (sufficiently different across population)
- Universality (everybody has it)
- Permanence (invariant in the period of time)
- Collectability (possible to measure and digitalize it)
- Performance (recognition accuracy should good)
- Acceptability (individuals should be OK to present it)
- Circumvention (hard to fake)

Biometrics – introduction – discussion

- Physiological
  - Face
  - Fingerprint
  - Palm geometry
  - Hand vein pattern
  - Eye iris
  - Eye retina
  - Ear shape
  - DNA
- Behavioral
  - Keystrokes
  - Signature dynamics
  - Voice
  - Walking dynamics

The beginning of anthropometry

- The Bertillon system (1882)
- 5–9 stable body features
  - Head length & breath
  - Middle finger & foot length
  - Cubit length
- Categorization
  - small/medium/large
  - In total: 243 bins



Mugshots

BUDDSJD_10

CAUGHMANMD_3

CLYMANNS_1

DELAROSAJ_2

CHEWEYSR_22

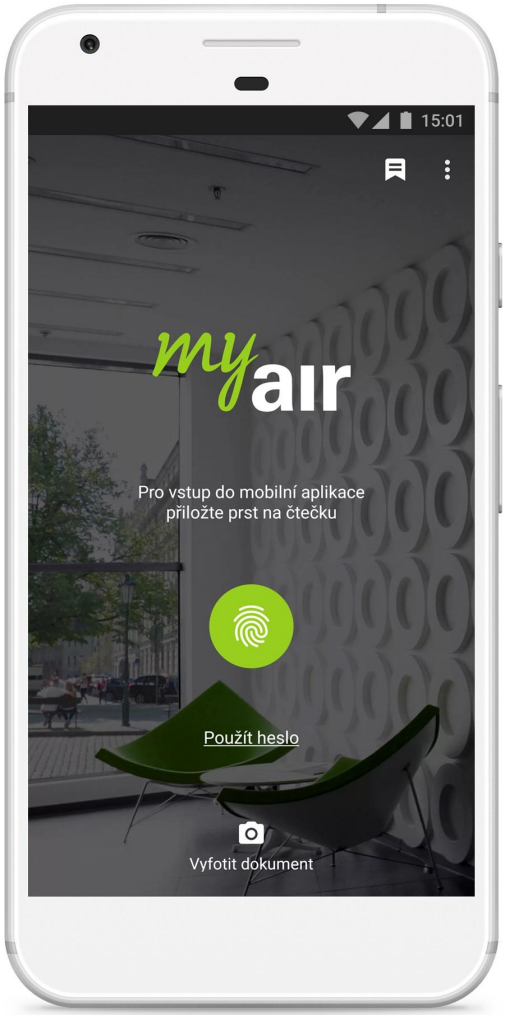
CLARKJ_6

DELOACHAM_1

GILLEYNK_1

Biometrics now (optimistic)

- Smartphones
  - Fingerprints, face
- Passports
  - Fingerprints, face
- Contract signing
  - Signature
- Nuclear power plants :-)
  - Dukovany use hand geometry



Biometrics now (pessimistic)

- Fingerprint reader EULA:

  *The biometric (fingerprint reader) feature in this device **is NOT a security feature** and is intended to be used **for convenience only**. It should not be used to access corporate networks or protect sensitive data, such as financial information.*

- Other problems
  - Unencrypted transfer, liveness detection, ...

Biometrics soon (maybe?)

- MasterCard's Identity Check Mobile
  - Prove holder's identity by fingerprint/selfie
  - Blinking/nodding as liveness testing.
  - Being introduced in 12 EU countries
  - Supported by Alibaba e-shop
- *"Selfies to kill off passwords 'in five years'"* says MasterCard in 2015.
- Still not broadly used.

http://newsroom.mastercard.com/eu/press-releases/mastercard-makes-fingerprint-and-selfie-payment-technology-a-reality/

Biometrics in the future (combined?)

Biometrics – basic problem?

Biometrics are not secret!

And cannot be changed...

It’s not so easy (math everywhere!)

- Image quality checking
- Feature detection and extraction
- Storage format (irreversibility!)
- Feature comparison (performance)
- Matching (accuracy, threshold)
- Liveness detection

Authentication types

Verification

- One to one.
- Determines if person is who he claims to be.

Identification

- One to many
- Search entire database.
- Determine identity of person.

What could go wrong?

Commercial vs. forensic use

Commercial

- Low precision
- Enrollment can be repeated
- Only extracted characteristics saved
- Fast and automatic

Forensic

- High precision
- Enrollment just once
- Full biometric data saved
- Slower, expert interventions may be necessary

How much do you trust biometrics?

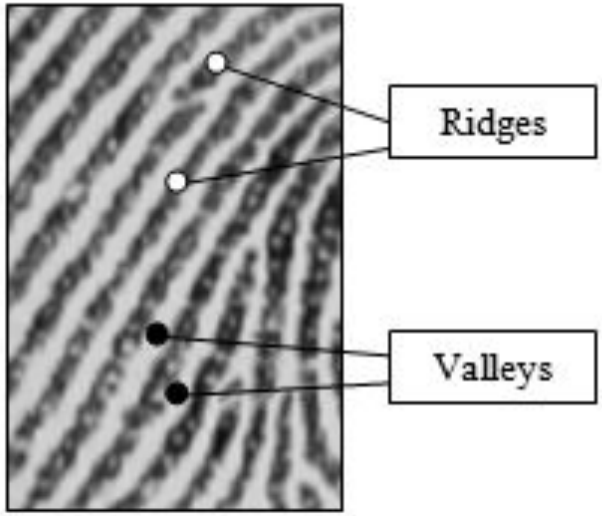
Would you use biometric authentication

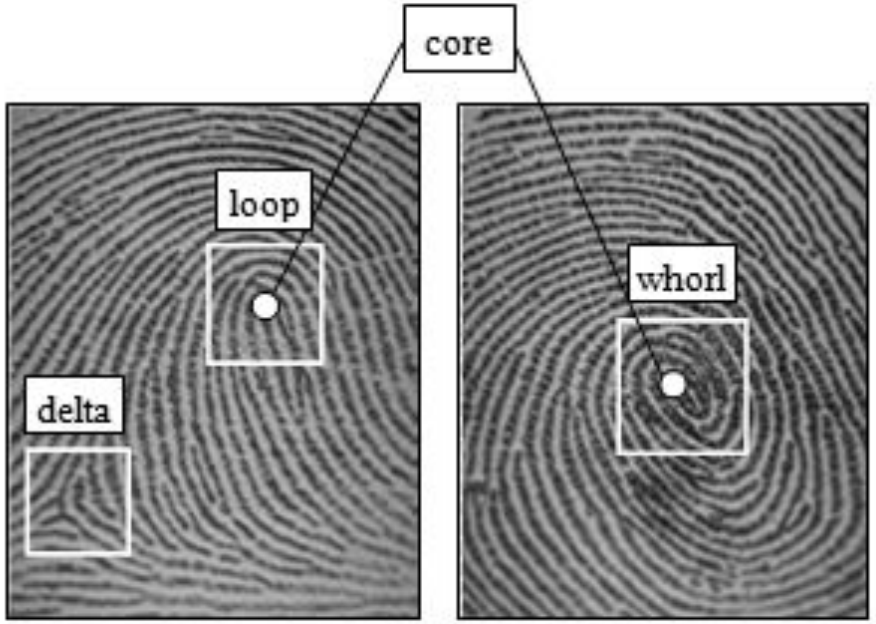
- … to access the library?
- … to log in to your work computer?
- … to do money transactions?
- … to secure the Declaration of Independence?

Fingerprints

Theory, technology, news, ...

Fingerprint characteristics

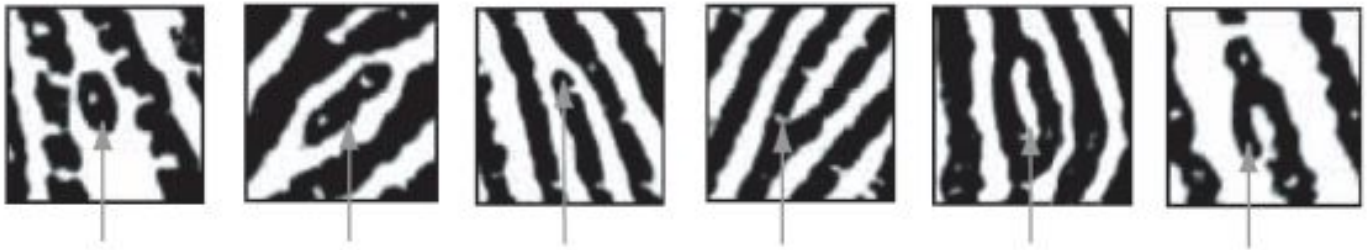




LEVEL 1 FEATURES

ARCH TENTED ARCH LEFT LOOP RIGHT LOOP DOUBLE LOOP WHORL

LEVEL 2 FEATURES

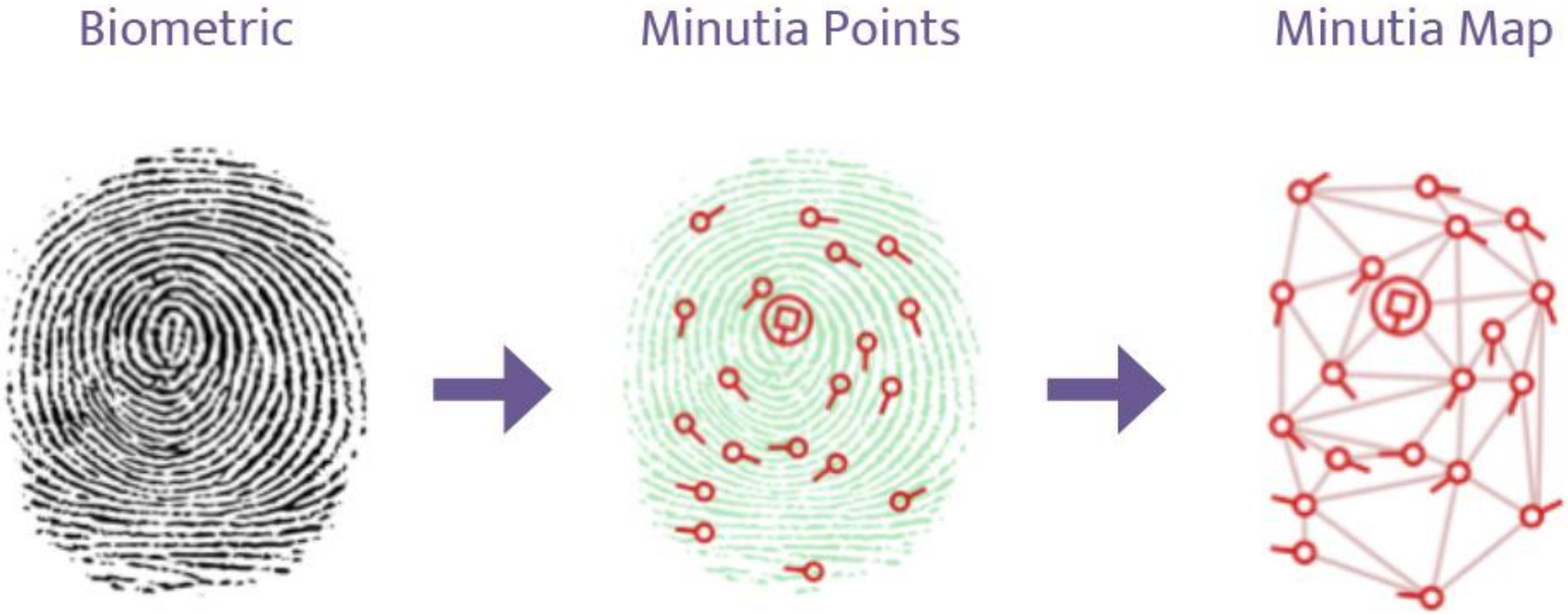


LINE-UNIT LINE-FRAGMENT ENDING BIFURCATION EYE HOOK

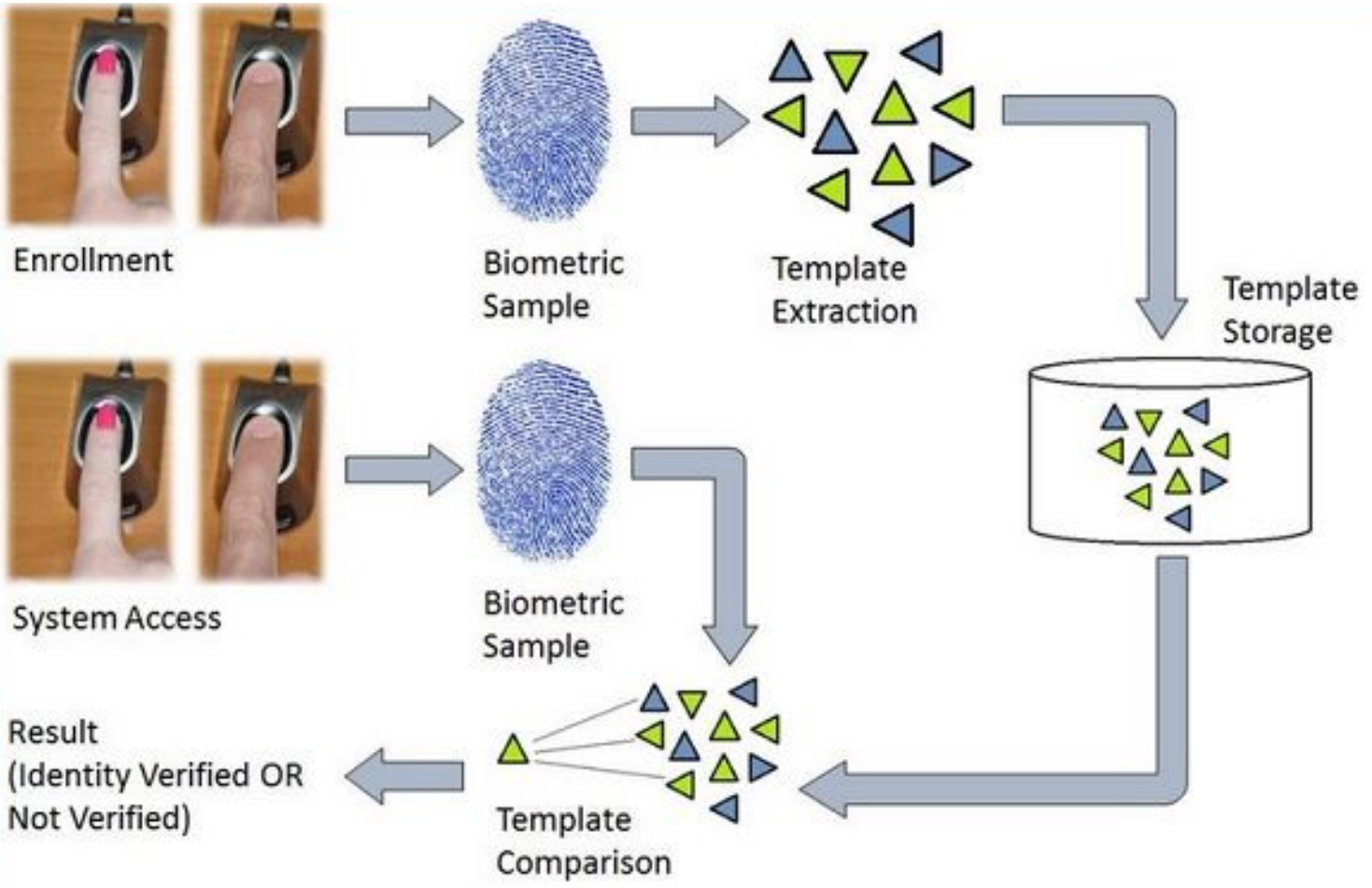
LEVEL 3 FEATURES

PORES LINE SHAPE INCIPIENT RIDGES CREASES WARTS SCARS

Fingerprint minutiae



Fingerprint authentication



Fingerprint classification

Different approaches:

- based on singular points
- structure-based
- frequency-based
- mathematical models
- machine learning methods
- hybrid models
- ...

Fingerprint readers

- Various sensor types
  - optical, capacitive, thermal, …
- Smartphone readers
  - Partial scanning (fewer unique features)
  - Liveness still an issue
- iPhoneX
  - Only Face ID (no more the Touch ID)

News: TAPS

- Touchscreen Sticker with TouchID (KickStarter)
- *Something I have* instead of *something I am*

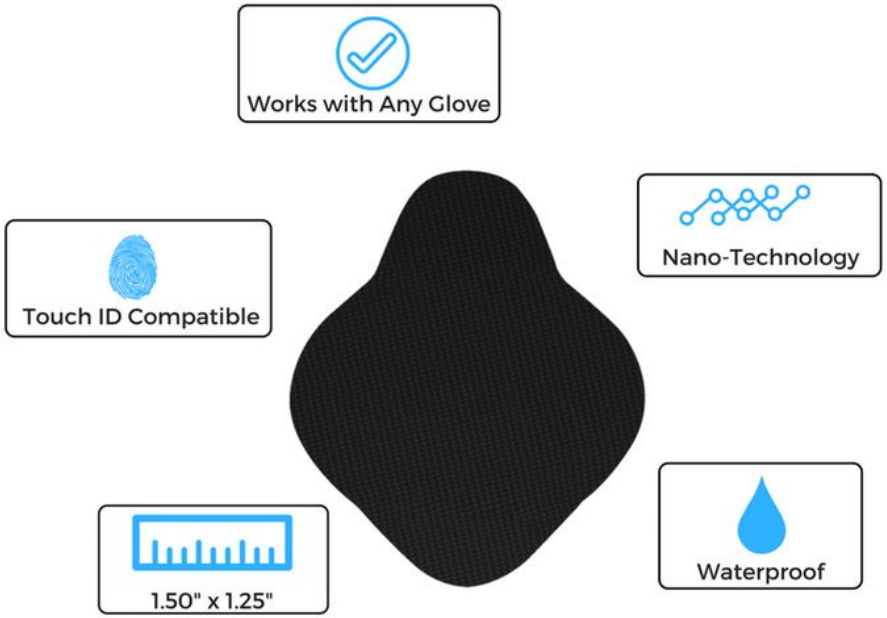


Photo © 2016 TAPS Kickstarter campaign

Latent fingerprints

Attacks and liveness detection

- Attacks
  - latent fingerprints, replay attacks, fake features, ...
- Liveness detection (!)
  - testing the finger reaction to sensor stimuli
  - temperature measurement
  - skin resistance measurement
  - pulse/blood flow measurement

Homework: Faking other biometrics

Write a short report (2+ pages) summarizing current usage and current faking techniques for a biometric system of your choice (but not fingerprint nor face).

- Deadline: 13. 12. 2018 23:59
- Submit a single PDF file to IS MUNI
- Cite all your references properly! (blogs, news, ...)
- Cite at least 2 reasonably current research papers
- Be concise using mostly your own words
  (Do not copy-paste Wikipedia!)

Seminar task: Faking fingerprints

The task has several bottlenecks, so please adhere to the following:

I. Listen to the overview of the whole process.

II. Open the slides and follow the instructions.

III. Consult us if you have not found it elsewhere.

Creating fake fingerprints I.

- Create visible fingerprint
  - Imprint finger
    onto photographic paper
  - Try multiple times
  - If you have dry fingers,
    Touch some greasy place
    (e.g. behind your ears)
- Make ridges visible
  - Use brush & carbon powder
  - Handle the powder carefully

Creating fake fingerprints II.

- Scan the fingerprint
  - Have the photopaper scanned
  - Have it scanned
  - You can find it in the IS study materials
- Clean the image
  - Create **inverted 1-bit B/W image** With clear ridges (see right)
  - See GIMP basics later
  - Foil needs to have ridges When printed! (that's why B/W)

Creating fake fingerprints III.

- Upload the **PNG(s)** image to IS folder
  - We'll print it for you on foil
- Cover in glue
  - The glue will form a copy of your finger
  - Cover a bigger area
    (it will shrink when drying)
  - Thin enough layer
    to dry out completely
  - Thick enough to hold
  - Avoid bubbles in glue

Creating fake fingerprints IV.

(next week, when the glue is dry)

- Peel the glue off the foil
  - Be extra careful!
  - Printing ink should peel off
- Try to verify the fingerprint on the reader
  - Read the finger and fake
  - Do visual comparison

GIMP basics

- Colors > Levels/Curves
  - Adjust the contrast
- Paintbrush
  - Clean the surroundings
- Image > Mode > Indexed
  - Convert to 1-bit B/W (not grayscale!)
- Crop as necessary
- Others as you see fit...