Biometrics for Forensics:
A few words with examples in Fingerprint, Face and Handwriting

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Funding Acknowledgements

Public (EU)

Public (Spain)

SEVENTH FRAMEWORK PROGRAMME

MARIE CURIE ACTIONS

COST Action IC1106

∑M
La Suma de Todos
AGENCIA REGIONAL PARA LA INMIGRACIÓN Y LA COOPERACIÓN
Comunidad de Madrid

MINISTERIO DEL INTERIOR

GUARDIA CIVIL

MINISTERIO DE DEFENSA

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4 PhD Positions available in Madrid, SPAIN!!

- Topics: **Smartphone Biometrics** (Face and Gesture), Human Behavior, Privacy, Security

- **Extraordinary Salary**: around **50.000 €/year** (gross) x **3 years** + **additional research funding for Travels/Conferences/Equipment**

- **2 EU Projects:** work together with another 14 intl. PhD students + **Research Visits all Around EU**

- **See:** http://atvs.ii.uam.es/fierrez > Careers

  julian.fierrez@uam.es; WeChat: **Julian Fierrez**

- **Interviews:** Today, Hotel Reception from 17:30

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Applications of Biometrics in Forensics

1. **Candidate identification*** in large DBs

2. **Tools for improving/accelerating manual work**** (forensic comparisons)

3. **Improving Forensic Reports** with biometric systems:

   – With **population statistics**** from biometric systems

   – With the **output of biometric systems***** (similarity scores)

EXAMPLES in Handwriting:

* J. Galbally, S. Gonzalez-Dominguez, J. Fierrez et al., "Biografo: An integrated tool for forensic writer identification", in *Proc. Intl. Workshop on Computational Forensics*, Springer LNCS-8915, Nov. 2015.

** R. Vera-Rodriguez, J. Fierrez et al., "Dynamic Signatures as Forensic Evidence: A New Expert Tool Including Population Statistics", M. Tistarelli et al.(Eds.), *Handbook of Biometrics for Forensic Science*, Springer, 2017.

*** J. Gonzalez-Rodriguez, J. Fierrez-Aguilar, D. Ramos-Castro and J. Ortega-Garcia, "Bayesian analysis of fingerprint, face and signature evidences with automatic biometric systems", *Forensic Science International*, Vol. 155, n. 2-3, pp. 126-140, December 2005.

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Forensic Biometrics App 1: Candidate ID

Biometric A

Biometric B

Expert ACE-V → Decision
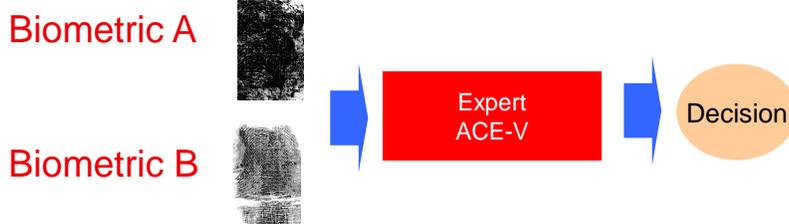
- A = Analysis = Validity & Quality
- C = Comparison = Mark & Compare Biometric Characteristics
- E = Evaluation = Identification/Exclusion/Inconclusive
- V = Verification = Independent re-examination

R. P. Krish, J. Fierrez, D. Ramos, J. Ortega-Garcia and J. Bigun, "Pre-Registration of Latent Fingerprints based on Orientation Field", *IET Biometrics*, June 2015.
R. P. Krish, J. Fierrez, D. Ramos, F. Alonso-Fernandez and J. Bigun, "Improving Automated Latent Fingerprint Identification using Extended Minutia Types", *Information Fusion*, October 2019.

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Forensic Biometrics App 1: Candidate ID

Latent
Unknown ID

Expert Marking

AFIS

Step 1:
Best *N*
(Highest scores)

Step 2:
Manual ACE-V

Database
(with additional features)
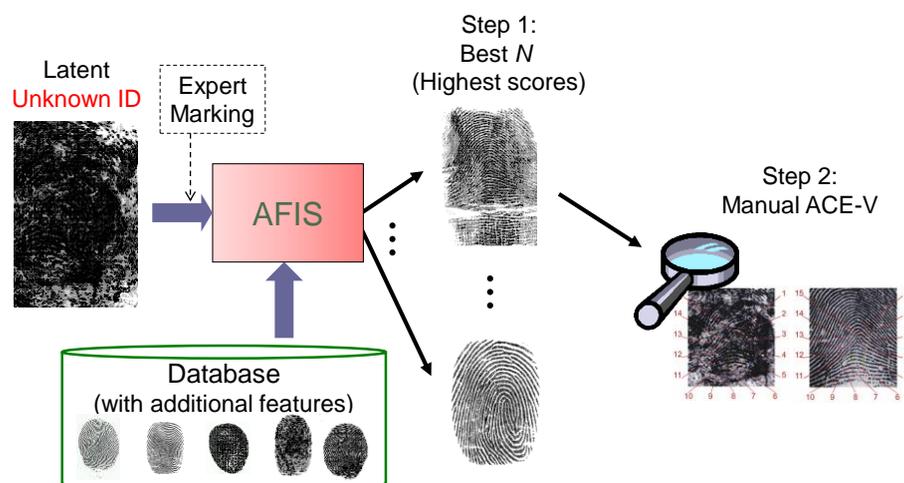
M. Puertas, D. Ramos, J. Fierrez, J. Ortega-Garcia and N. Exposito, "Towards a Better Understanding of the Performance of Latent Fingerprint Recognition in Realistic Forensic Conditions", in *Proc. Intl. Conf. on Pattern Recognition*, ICPR, pp. 1638 -1641, August 2010.

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Forensic Biometrics App 1: Candidate ID
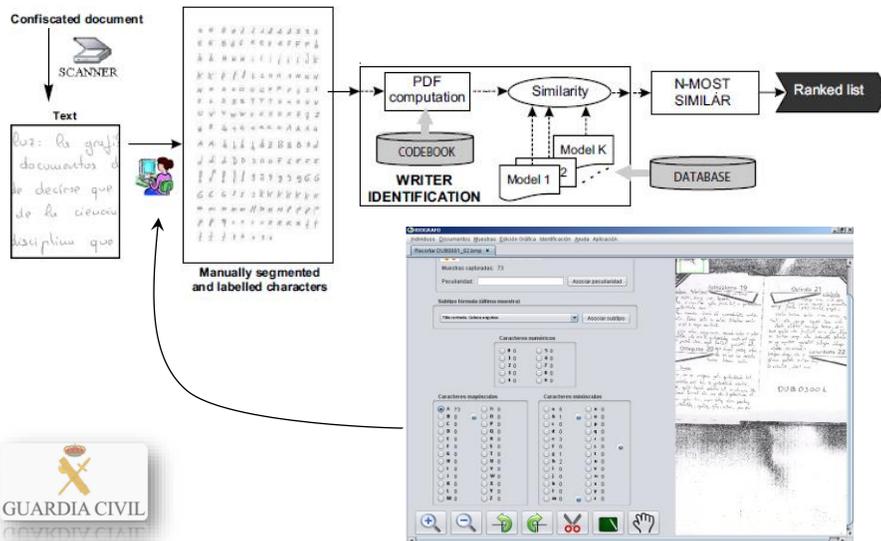
J. Galbally, S. Gonzalez-Dominguez, J. Fierrez and J. Ortega-Garcia, "Biografo: An integrated tool for forensic writer identification", in *Proc. Intl. Workshop on Computational Forensics*, Springer LNCS-8915, Nov. 2015.

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Forensic Biometrics App 2: Tools for the Expert
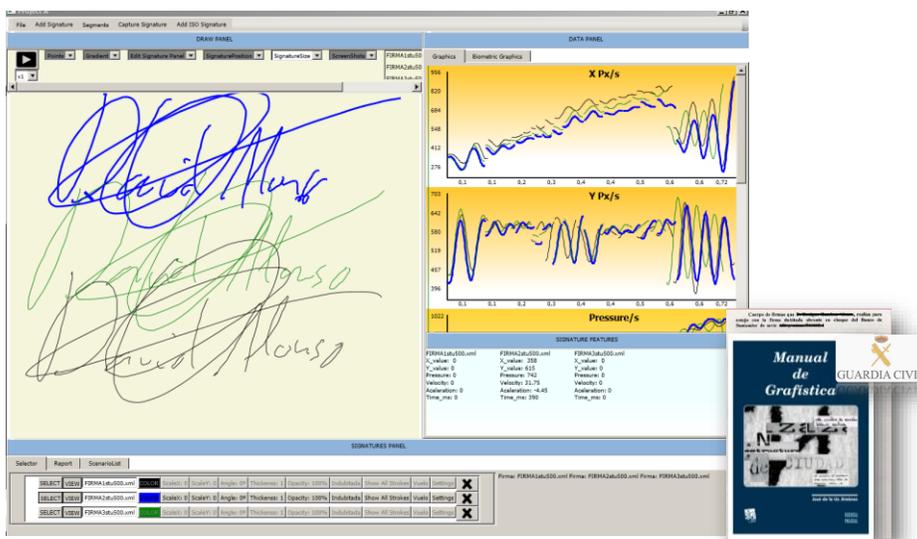
R. Vera-Rodriguez, J. Fierrez et al., "Dynamic Signatures as Forensic Evidence: A New Expert Tool Including Population Statistics", M. Tistarelli et al.(Eds.), *Handbook of Biometrics for Forensic Science*, Springer, 2017.

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Forensic Biometrics App 2: Tools for the Expert
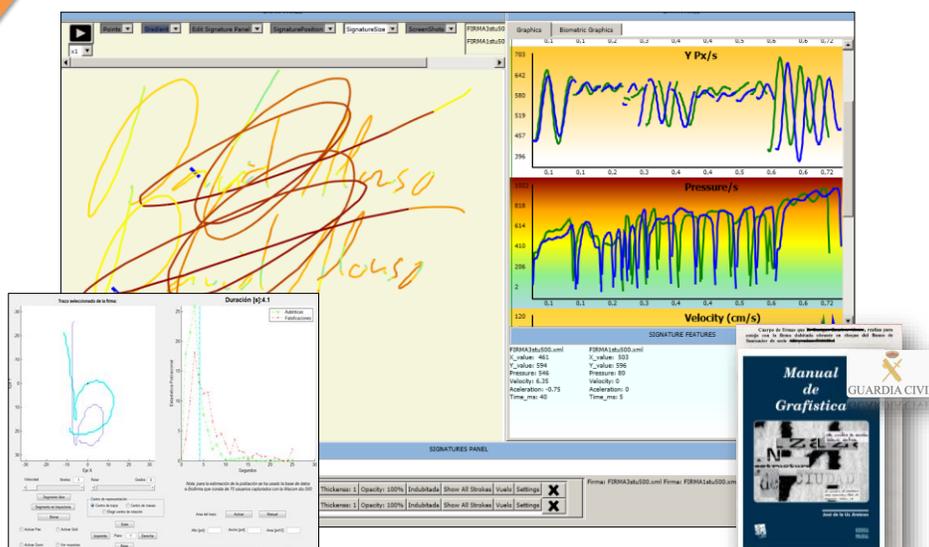
R. Vera-Rodriguez, J. Fierrez et al., "Dynamic Signatures as Forensic Evidence: A New Expert Tool Including Population Statistics", M. Tistarelli et al.(Eds.), *Handbook of Biometrics for Forensic Science*, Springer, 2017.

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Forensic Biometrics App 2: Tools for the Expert
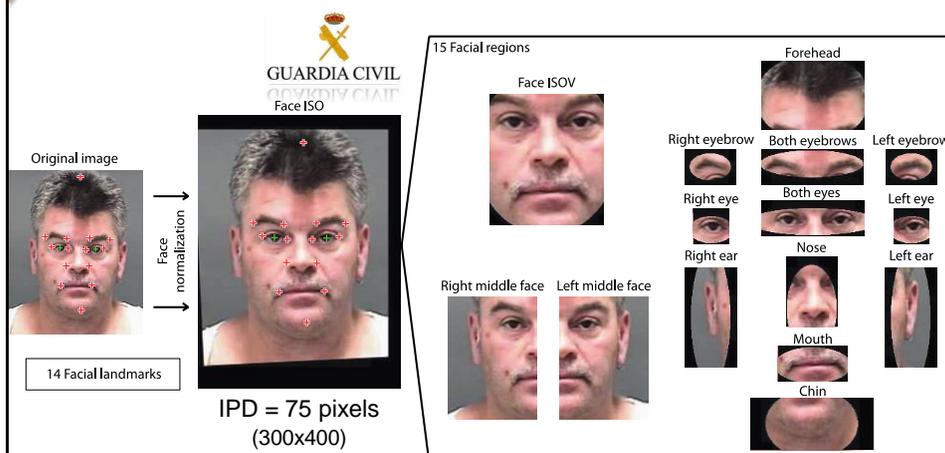
P. Tome, J. Fierrez, R. Vera-Rodriguez and D. Ramos, "Identification using Face Regions: Application and Assessment in Forensic Scenarios", *Forensic Science International*, 2013.

P. Tome, J. Fierrez, R. Vera-Rodriguez and J. Ortega-Garcia, "Combination of Face Regions in Forensic Scenarios", *Journal of Forensic Sciences*, 2015.

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Forensic Biometrics App 2: Tools for the Expert

P. Tome, R. Vera-Rodriguez, J. Fierrez and J. Ortega-Garcia, "Facial Soft Biometric Features for Forensic Face Recognition", *Forensic Science International*, December 2015.

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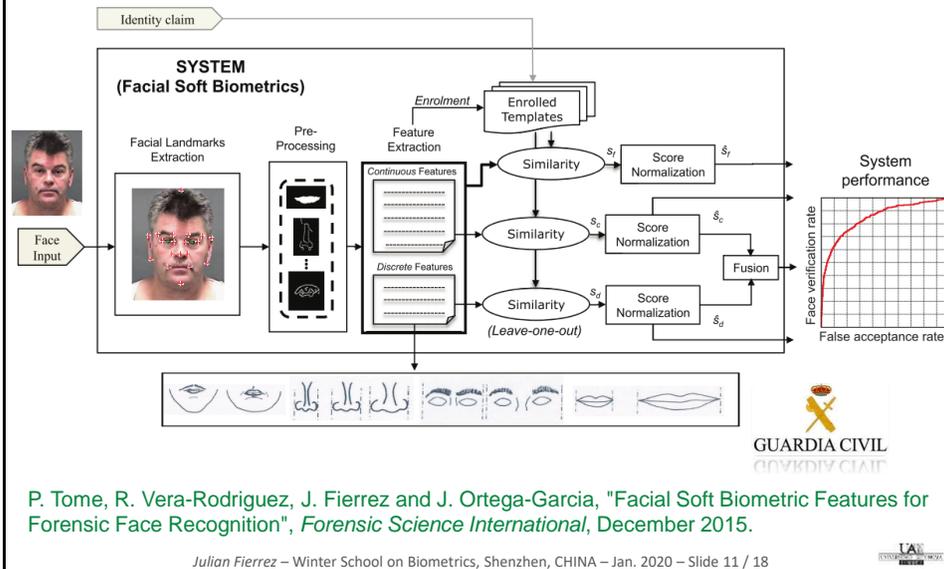
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Forensic Biometrics App 3: Improving the Reports
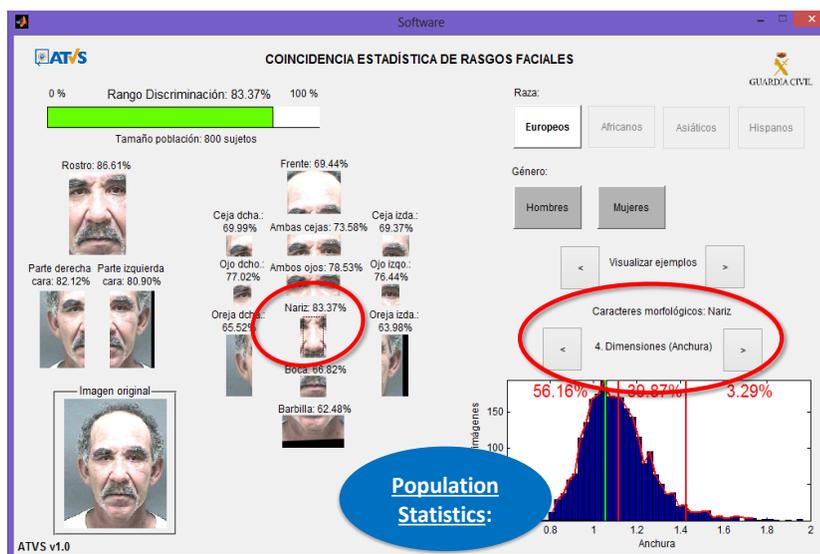
P. Tome, J. Fierrez, R. Vera-Rodriguez and D. Ramos, "Identification using Face Regions: Application and Assessment in Forensic Scenarios", *Forensic Science International*, 2013.

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Forensic Biometrics App 3: Improving the Reports

Population Statistics: velocity, acceleration, tremor, fluidity, etc.

R. Vera-Rodriguez, J. Fierrez et al., "Dynamic Signatures as Forensic Evidence: A New Expert Tool Including Population Statistics", M. Tistarelli et al.(Eds.), *Handbook of Biometrics for Forensic Science*, Springer, 2017.
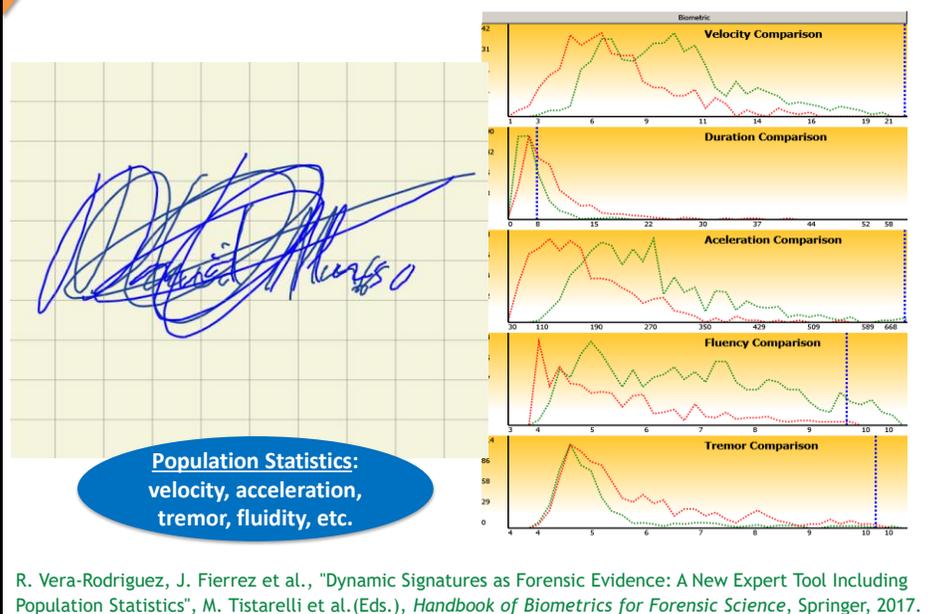
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Forensic Biometrics App 3: Improving the Reports

Assign the strength of evidence (Likelihood Ratio)

Hp	The trace and reference have a common origin
Hd	The trace and reference have different origins
Score (S)	Degree of correspondence between trace and reference
I	Background information
Pr (s | Hp, I)	Similarity factor - intra / within-source variability
Pr (s | Hd, I)	Typicality factor - inter / between-source variability
LR	Strength of evidence Likelihood Ratio

J. Gonzalez-Rodriguez, J. Fierrez-Aguilar, et al., "Bayesian analysis of fingerprint, face and signature evidences with automatic biometric systems", *Forensic Science Intl.*, December 2005.
D. Ramos, R. P. Krish, J. Fierrez and D. Meuwly, "From Biometric Scores to Forensic Likelihood Ratios", Massimo Tistarelli and Christophe Champod (Eds.), *Handbook of Biometrics for Forensic Science*, 2017.

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Forensic Biometrics App 3: Improving the Reports

Forensic evaluation method

Assign the strength of evidence (**L**ikelihood **R**atio)

$$\frac{Pr(Hp|s,I)}{Pr(Hd|s,I)} = \frac{Pr(s|Hp,I)}{Pr(s|Hd,I)} * \frac{Pr(Hp,I)}{Pr(Hd,I)}$$

Posterior probability ratio   **L**ikelihood **R**atio   Prior probability ratio

Duty of the Forensic Expert

J. Gonzalez-Rodriguez, J. Fierrez-Aguilar, et al., "Bayesian analysis of fingerprint, face and signature evidences with automatic biometric systems", *Forensic Science Intl.*, December 2005.

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More on Biometrics for Forensics
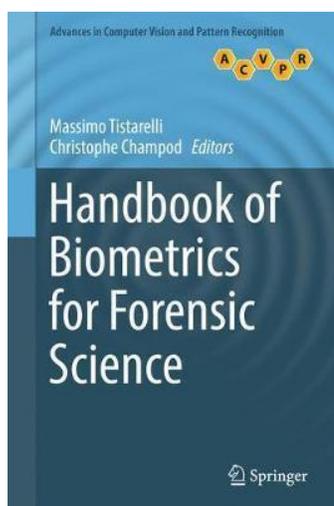
Advances in Computer Vision and Pattern Recognition
A C V P R

Massimo Tistarelli
Christophe Champod *Editors*

Handbook of
Biometrics
for Forensic
Science

Springer

J. Gonzalez-Rodriguez, J. Fierrez-Aguilar, et al., "Bayesian analysis of fingerprint, face and signature evidences with automatic biometric systems", *Forensic Science Intl.*, December 2005.

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