

# Biometrics for Forensics:

*A few words with examples in Fingerprint, Face and Handwriting*

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Julian Fierrez – Winter School on Biometrics, Shenzhen, CHINA – Jan. 2019 – Slide 1 / 16

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## Funding Acknowledgements

### Public (EU)

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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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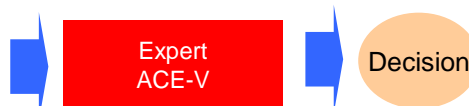
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## Forensic Biometrics App 1: Candidate ID

Biometric A



Biometric B



- 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

Database (with additional features)

Step 1: Best N (Highest scores)

Step 2: Manual ACE-V

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

Confiscated document

SCANNER

Text

Manually segmented and labelled characters

PDF computation

Similarity

N-MOST SIMILAR

Ranked list

CODEBOOK

WRITER IDENTIFICATION

Model 1

Model 2

Model K

DATABASE

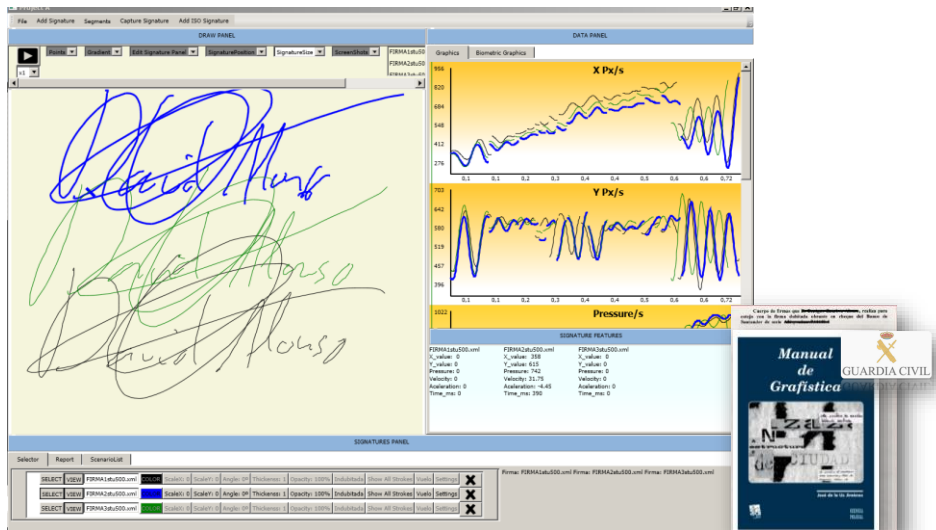
GUARDIA CIVIL

Biografo

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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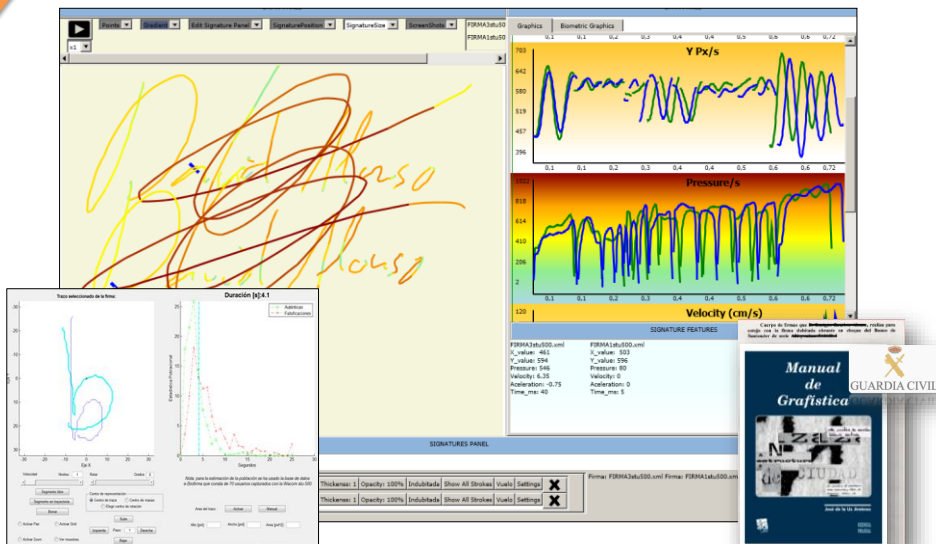
## Forensic Biometrics App 2: Tools for the Expert



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



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Original image

Face normalization

14 Facial landmarks

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Face ISO

IPD = 75 pixels  
(300x400)

15 Facial regions

Face ISOV

Right middle face

Left middle face

Forehead

Right eyebrow

Both eyebrows

Left eyebrow

Right eye

Both eyes

Left eye

Right ear

Nose

Left ear

Mouth

Chin

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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Identity claim

SYSTEM  
(Facial Soft Biometrics)

Face Input

Facial Landmarks Extraction

Pre-Processing

Feature Extraction

Continuous Features

Discrete Features

Enrolment

Enrolled Templates

Similarity

Score Normalization

Similarity

Score Normalization

Similarity

Score Normalization

Fusion

System performance

Face verification rate

False acceptance rate

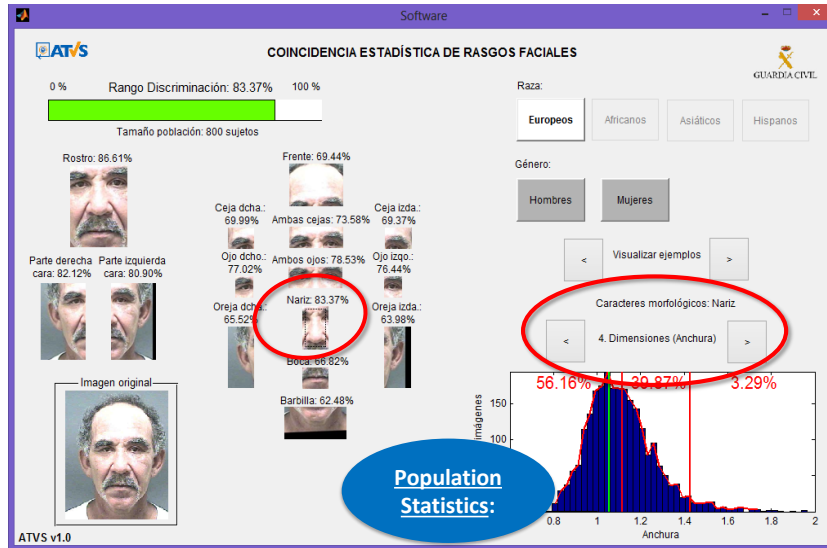
GUARDIA CIVIL  
CONVIVIO CLAIT

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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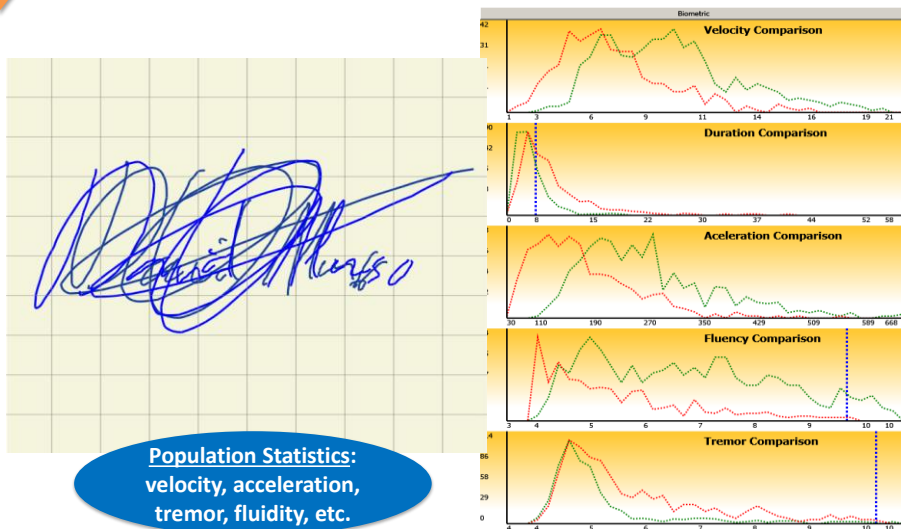
## Forensic Biometrics App 3: Improving the Reports



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



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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 (Likelihood Ratio)

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

Posterior probability ratio

=

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

Likelihood Ratio

\*

$$\frac{\text{Pr (Hp, I)}}{\text{Pr (Hd, I)}}$$

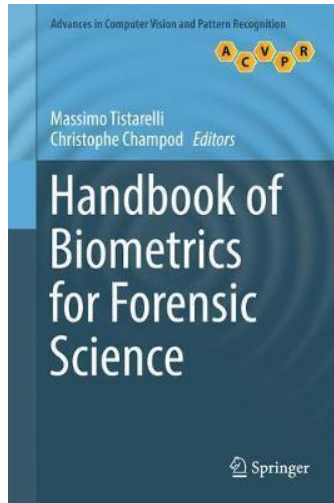
Prior probability ratio

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



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

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