Biometrics for Forensics:

A few words with examples in Fingerprint, Face and Handwriting

Prof. Julian FIERREZ

Universidad Autonoma de Madrid - SPAIN

http://atvs.ii.uam.es/fierrez

Funding Acknowledgements

Public (EU)

SEVENTH FRAMEWORK PROGRAMME

MARIE CURIE ACTIONS

COST Action IC1106

Public (Spain)

La Suma de Todos

Comunidad de Madrid

MINISTERIO DEL INTERIOR

GUARDIA CIVIL

MINISTERIO DE DEFENSA

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)

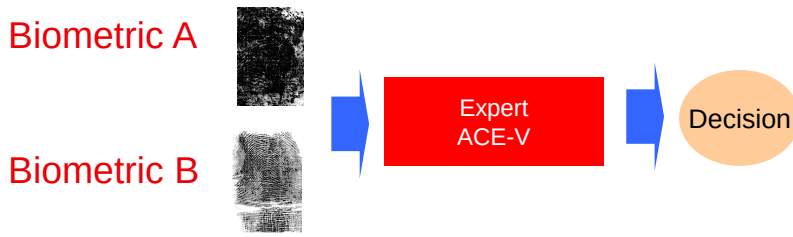
EXAMPLES in Handwriting:

* 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.

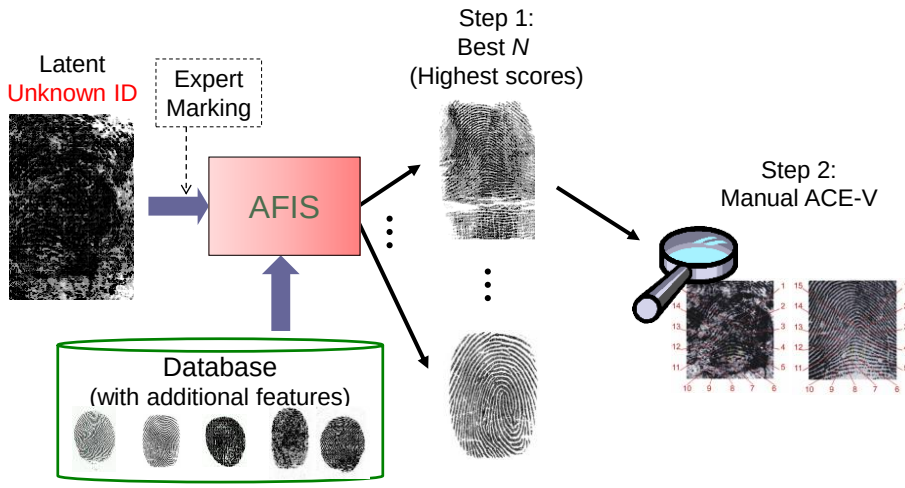
Forensic Biometrics App 1: Candidate ID



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

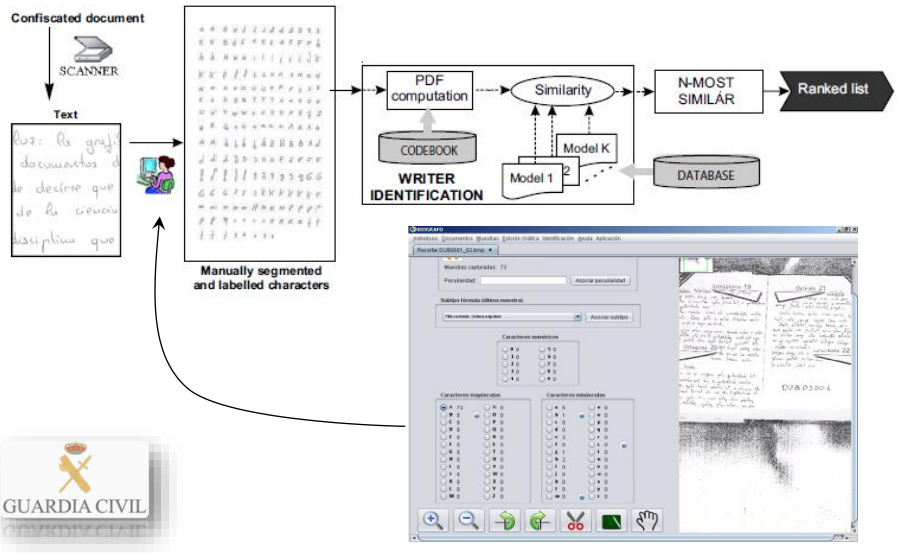
R. P. Krish, J. Fierrez, D. Ramos, J. Ortega-Garcia and J. Bigun, "Pre-Registration of Latent Fingerprints based on Orientation Field", IET Biometrics, Vol. 4, pp. 42-52, June 2015.

Forensic Biometrics App 1: Candidate ID



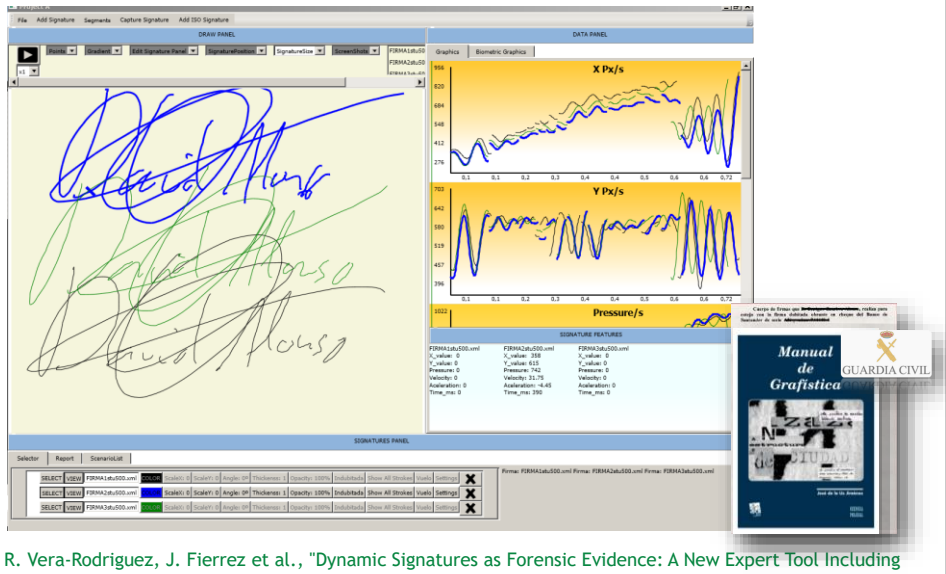
M. Puertas, D. Ramos, J. Fierrez, J. Ortega-Garcia and N. Exposito, "Towards a Better Understanding of the Performance of Latent Fingerprint Recognition in Realistic Forensic Conditions", in *Proc. Intl. Conf. on Pattern Recognition*, ICPR, pp. 1638 -1641, August 2010.

Forensic Biometrics App 1: Candidate ID



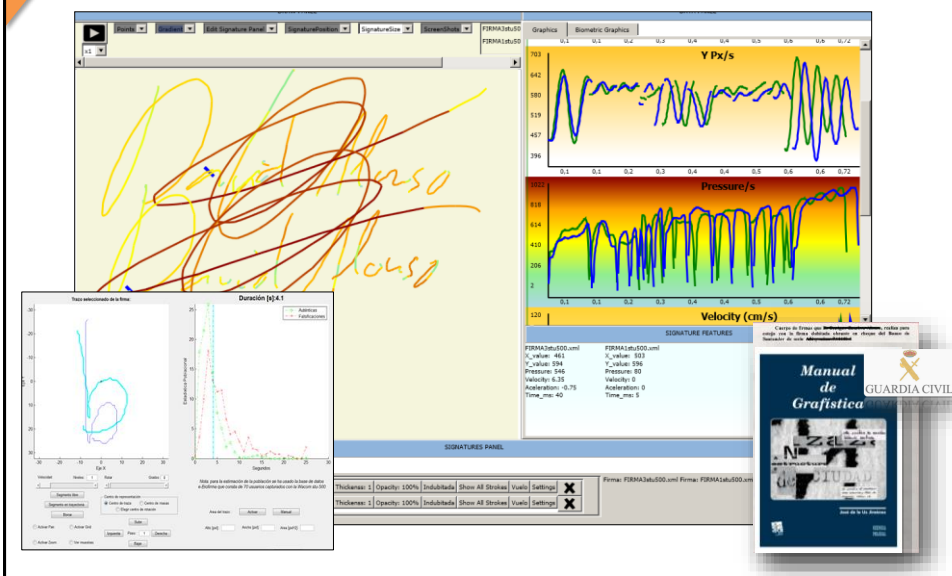
J. Galbally, S. Gonzalez-Dominguez, J. Fierrez and J. Ortega-Garcia, "Biografo: An integrated tool for forensic writer identification", in *Proc. Intl. Workshop on Computational Forensics*, Springer LNCS-8915, Nov. 2015.

Forensic Biometrics App 2: Tools for the Expert



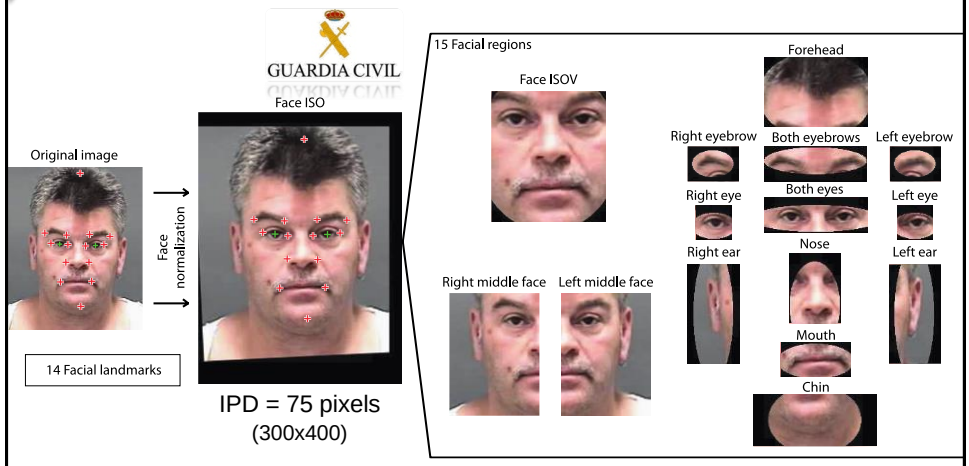
R. Vera-Rodriguez, J. Fierrez et al., "Dynamic Signatures as Forensic Evidence: A New Expert Tool Including Population Statistics", M. Tistarelli et al.(Eds.), *Handbook of Biometrics for Forensic Science*, Springer, 2017.

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.

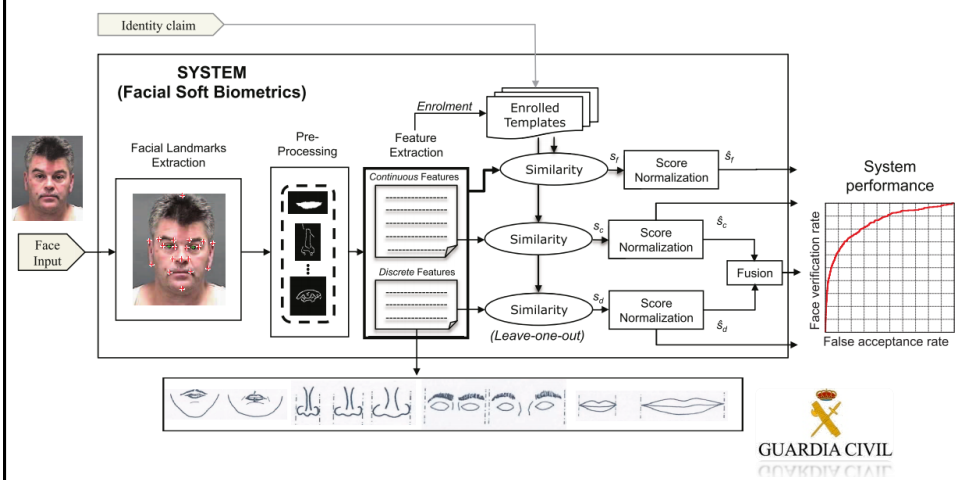
Forensic Biometrics App 2: Tools for the Expert



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

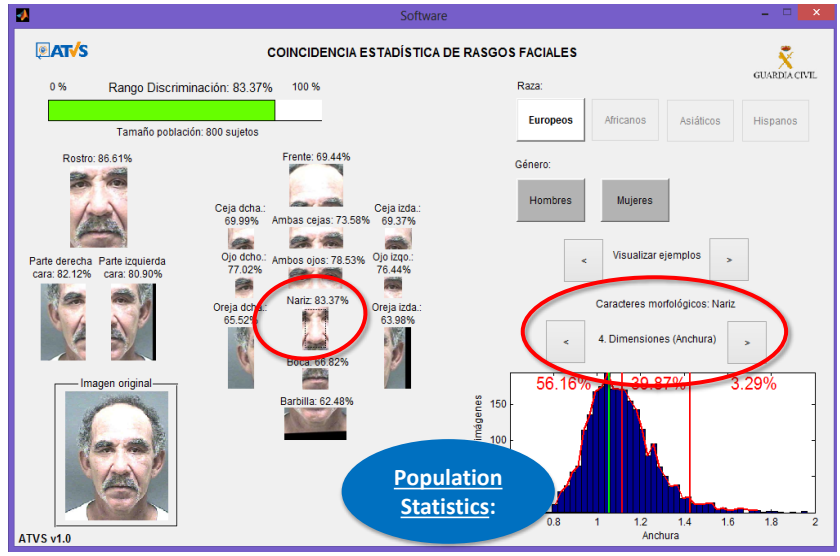
P. Tome, J. Fierrez, R. Vera-Rodriguez and J. Ortega-Garcia, "Combination of Face Regions in Forensic Scenarios", *Journal of Forensic Sciences*, 2015.

Forensic Biometrics App 2: Tools for the Expert



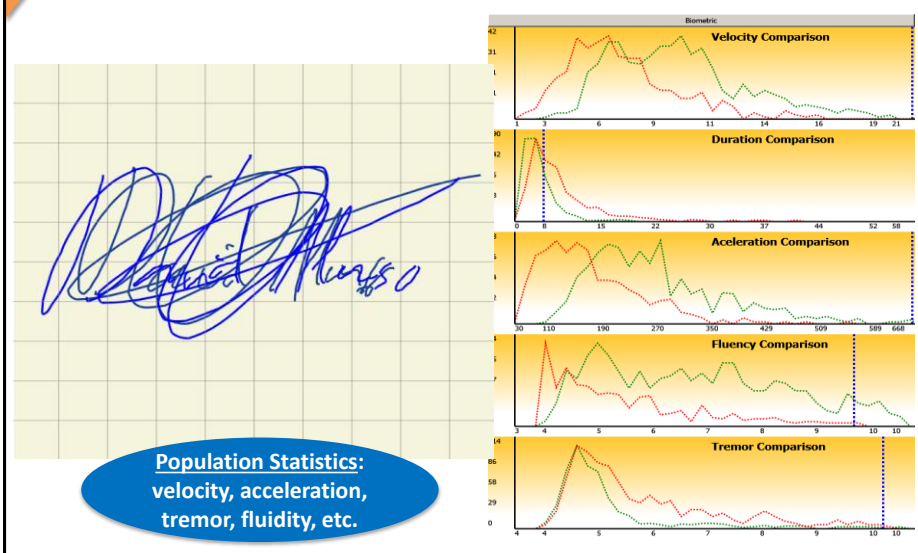
P. Tome, R. Vera-Rodriguez, J. Fierrez and J. Ortega-Garcia, "Facial Soft Biometric Features for Forensic Face Recognition", *Forensic Science International*, December 2015.

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.

Forensic Biometrics App 3: Improving the Reports



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.

Forensic Biometrics App 3: Improving the Reports

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

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.

Forensic Biometrics App 3: Improving the Reports

Forensic evaluation method

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

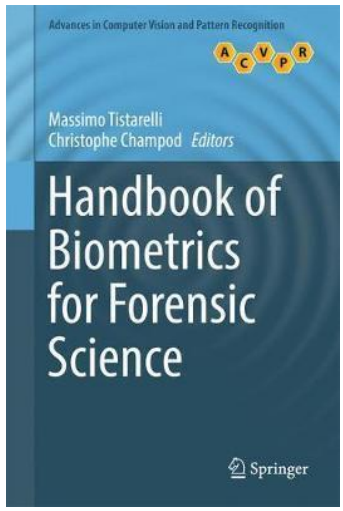
$$\frac{Pr(Hp|S,I)}{Pr(Hd|S,I)} = \frac{Pr(S|Hp,I)}{Pr(S|Hd,I)} * \frac{Pr(Hp,I)}{Pr(Hd,I)}$$

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.

More on Biometrics for Forensics



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.

Biometrics for Forensics:

A few words with examples in Fingerprint, Face and Handwriting

Prof. Julian FIERREZ

UAM UNIVERSIDAD AUTONOMA DE MADRID

Universidad Autonoma de Madrid - SPAIN

http://atvs.ii.uam.es/fierrez