Biometrics for Forensics:

A few words with examples in Fingerprint, Face and Handwriting

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Comunidad de Madrid

MINISTERIO DEL INTERIOR

GUARDIA CIVIL

MINISTERIO DE DEFENSA

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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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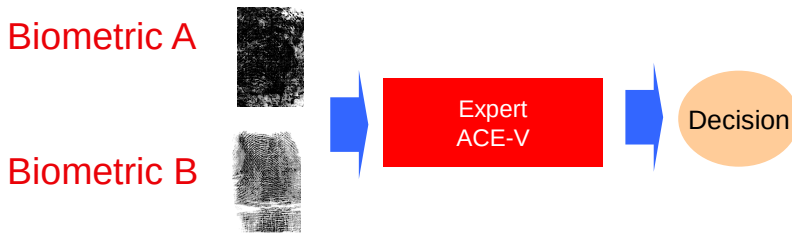
Forensic Biometrics App 1: Candidate ID



- 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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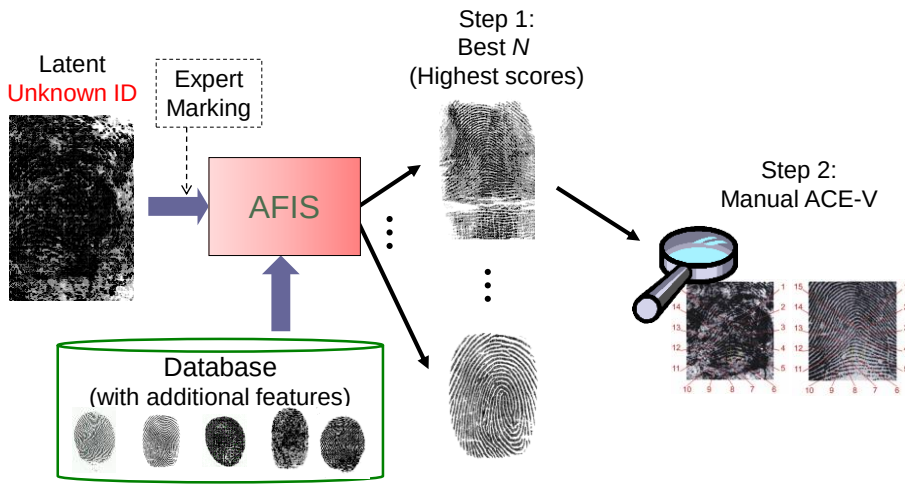

M. Puertas, D. Ramos, J. Fierrez, J. Ortega-Garcia and N. Exposito, "Towards a Better Understanding of the Performance of Latent Fingerprint Recognition in Realistic Forensic Conditions", in *Proc. Intl. Conf. on Pattern Recognition*, ICPR, pp. 1638 -1641, August 2010.

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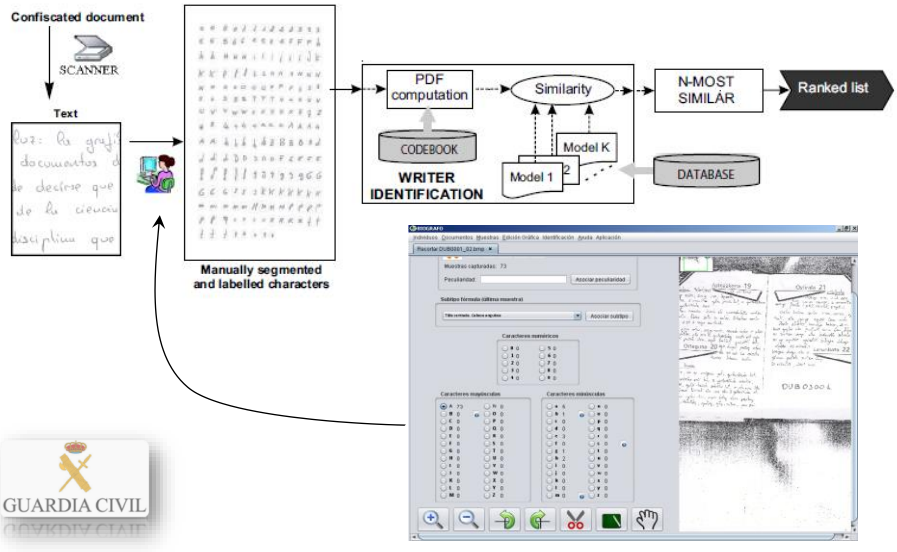

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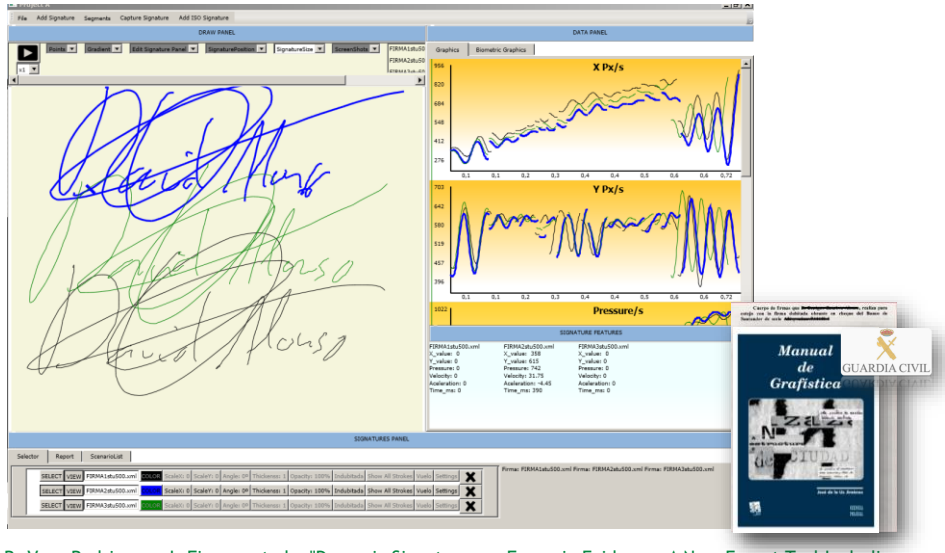
Forensic Biometrics App 2: Tools for the Expert



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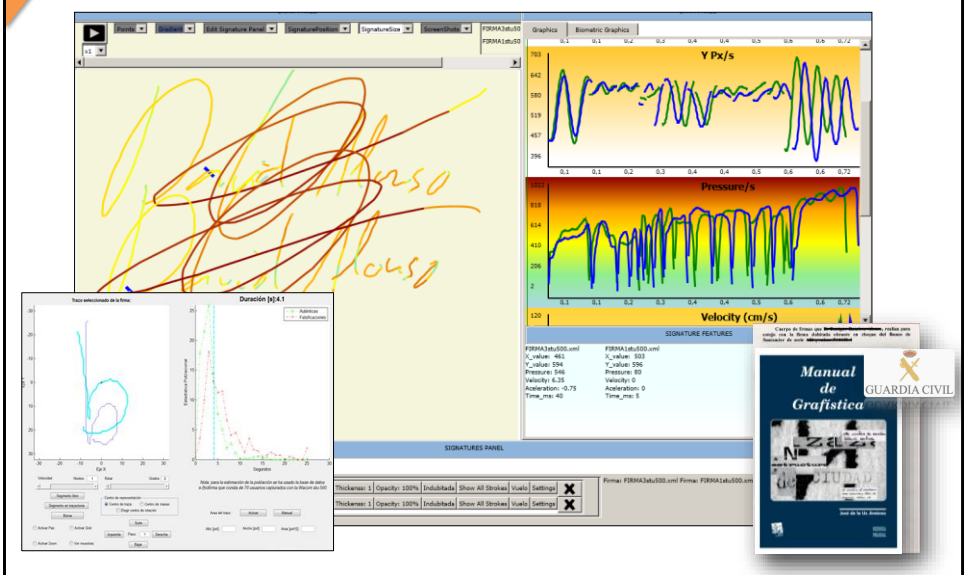

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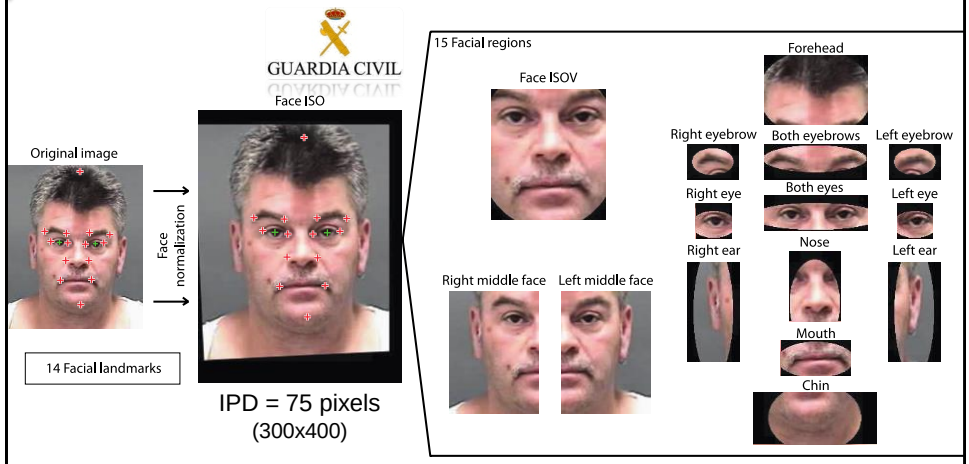

P. Tome, J. Fierrez, R. Vera-Rodriguez and D. Ramos, "Identification using Face Regions: Application and Assessment in Forensic Scenarios", *Forensic Science International*, 2013.

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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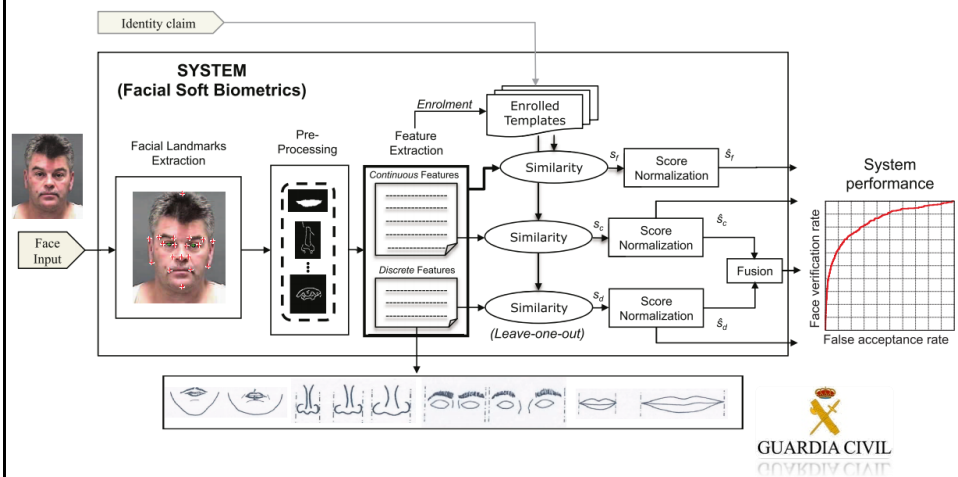
Forensic Biometrics App 2: Tools for the Expert



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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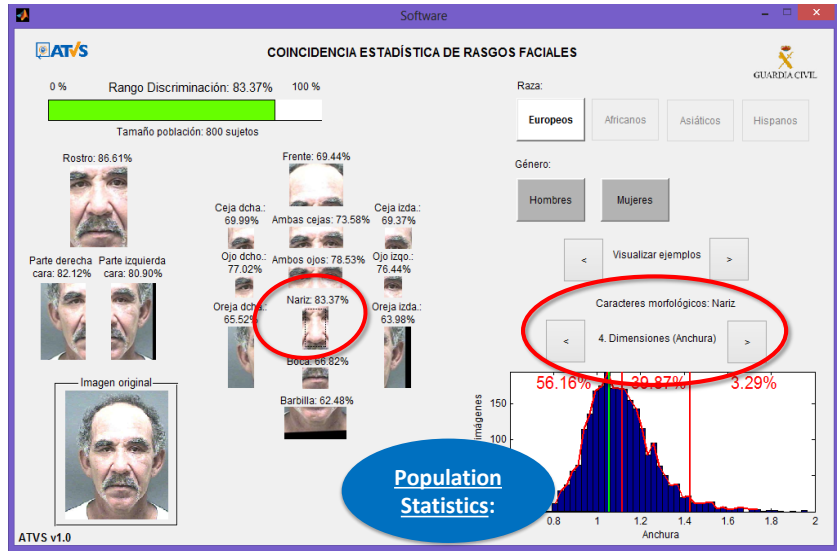
Forensic Biometrics App 3: Improving the Reports



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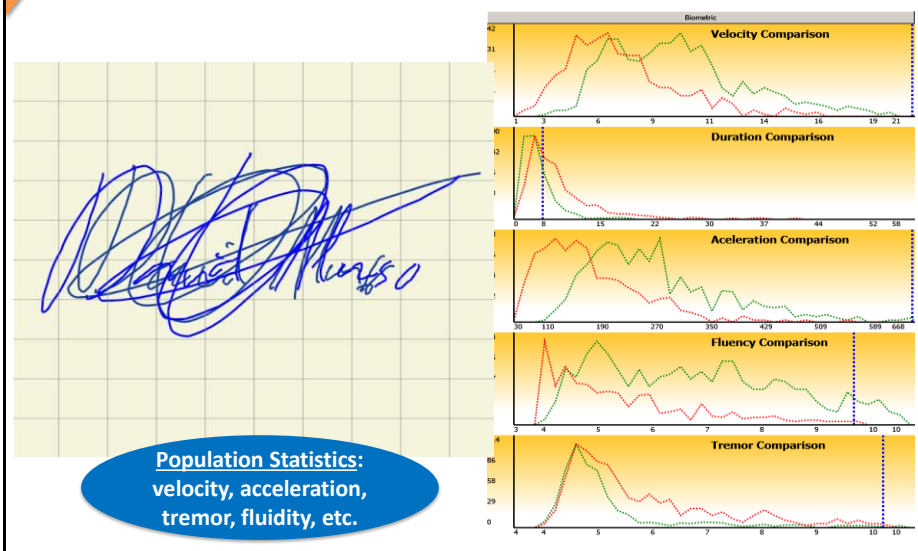

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Forensic Biometrics App 3: Improving the Reports

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.

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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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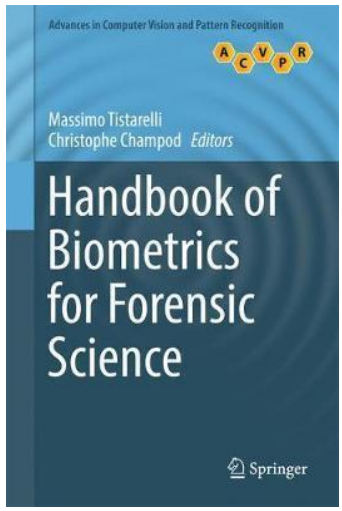
More on Biometrics for Forensics



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