



From Ink to AI: Innovations and Integration in Forensic Handwriting Examination

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1

Forensic handwriting examination

2

Automatic handwriting and signature analysis

3

Differences between disciplines and their implications

4

Pathways to integration

1

Forensic handwriting examination

2

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3

Differences between disciplines and their implications

4

Pathways to integration

Some projects have already combined elements of both fields:

MAN VS. MACHINE: A COMPARATIVE ANALYSIS FOR SIGNATURE VERIFICATION

Muhammad Imran Malik¹, Marcus Liwicki^{1,2}, Andreas Dengel¹, Bryan Found³

Abstract. *Signatures have been used as a means to authenticate documents for centuries. From the outset, the focus of forensic examinations was to both objectively and subjectively establish whether they were genuine (written by the specimen author) or simulated (written by an imposter/forgery). With the emergence of new computing technologies, additional objective examination techniques designed to determine the authenticity of questioned signatures became available. Although the opinions of Forensic Handwriting Examiners (FHEs) remain the most popular method of signature authenticity determinations, computer based techniques are attracting increasing interest within the forensic community. The question here is; which is better: man or machine? To address this question we focus on empirically comparing the performance of the two, on the same or similar material. The novelty of this work is that we have applied various state-of-the-art signature verification systems to questioned signature problems which had already been worked by FHEs and then performed a comparative analysis of the two.*

Reference: Muhammad Imran Malik, Marcus Liwicki, Andreas Dengel, Bryan Found (2014). Man vs. Machine: A Comparative Analysis for Signature Verification. J. Forensic Document Examination, Vol. 24, pp. 21-35.

Keywords: Signature verification, Signature Comparison, Forensic handwriting analysis, Performance comparison, Evaluation, 4NSigComp2010, 4NSigComp2012.

Some projects have already combined elements of both fields:

Automatic Signature Verification: Bridging the Gap between Existing Pattern Recognition Methods and Forensic Science

Dissertation

approved by the

Department of Computer Science

Technische Universität Kaiserslautern

for the award of the Doctoral Degree

Doctor of Engineering

(Dr.-Ing.)

by

Muhammad Imran Malik

Some projects have already combined elements of both fields:

Forensik und Biometrie zur Benutzererkennung

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Zusammenfassung

Die eigenhändige Unterschrift als Authentifizierungsmerkmal ist seit Jahrhunderten rechtlich und gesellschaftlich anerkannt und wird bereits seit vielen Jahrzehnten im forensischen Bereich zur Schreiberidentifikation herangezogen. Die in den letzten Jahren entwickelten Ansätze zur biometrischen Benutzerauthentifikation beruhen zum Teil ebenfalls auf Charakteristiken der Handschrift, beispielsweise bei der automatischen Unterschriftenverifikation. In diesem Beitrag werden systematisch Merkmale der Handschrift aufgezeigt, die im Bereich der forensischen Handschriftenuntersuchung veröffentlicht wurden und dargelegt, welche dieser Eigenschaften in Form von biometrischen Merkmalen zur Benutzerverifikation adaptiert werden können. Es wird ein Benutzerverifikationsverfahren basierend auf einer Menge von 14 Merkmalen aus der Forensik vorgestellt, welches in ein biometrisches Verifikationsverfahren integriert wird. Die Verifikationsergebnisse dieser forensischen Merkmale werden in ausführlichen Tests denen von nicht-forensisch begründbaren Merkmalen gegenübergestellt und es wird gezeigt, dass signifikante Verbesserungen in den Falscherkennungsraten durch den Einbezug der Forensik erreichbar sind.

In: Patrick Horster (Ed.), *D.A.CH Security 2004: Bestandsaufnahme, Konzepte, Anwendungen, Perspektiven*, syssec, 2004, pp. 192–205.

Some projects have already combined elements of both fields:

The influence of physical and biomechanical processes on the ink trace. Methodological foundations for the forensic analysis of signatures

Katrin Franke

Artificial Intelligence

Research output: Thesis › Thesis fully internal (DIV)



Overview



Fingerprint

Abstract

Handwritten signatures play an important role in daily life. They are widely accepted and frequently used to verify the claimed identity of a person. Consequently, there is a strong need for objective and automatic signature evaluation. The dissertation at hand aims (i) to provide a scientific basis for procedures applied in the forensic analysis of signatures and (ii) to derive advanced computational methods for the machine processing of signatures written on paper documents. Special emphasis will be put on methods for inferring writer-specific behaviors from the residual ink trace. The respective micropatterns, caused by biomechanical writing and physical ink-deposition processes, provide important clues for the analysis. These inner-ink-trace characteristics of signatures, which are determined by the individual movements of a person, will be studied in depth, taking into account the effects of writing materials, such as the type of pen used. The studies work towards a fundamental understanding and a comprehensive multidisciplinary approach to the forensic, computer-based analysis of signatures ... [Zie Summary](#)

Some projects have already combined elements of both fields:



FORENSIC OFFLINE SIGNATURE HANDWRITING EXAMINATION BASED ON THREE-DIMENSIONAL AND PSEUDO-DYNAMIC FEATURES

thèse de doctorat

UNIL/CHUV/Unisanté + institutions partenaires

CHEN, XIAOHONG Auteure/Auteur

Champod, Christophe Directeur·rice

[Champod, Christophe](#) 

[Chen, Xiaohong](#) 

[Faculté de droit, des sciences criminelles et d'administration publique](#) 

[Science forensique](#) 

Université de Lausanne, Faculté de droit, des sciences criminelles et d'administration publique

Accepté

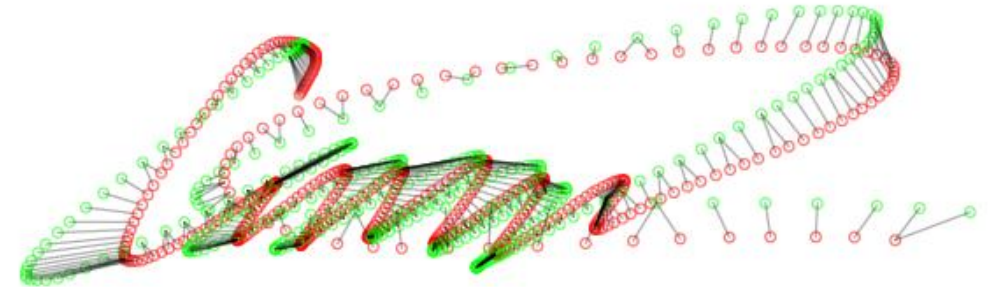
2023

anglais

The scientific foundation of forensic handwriting examination has been a subject of debate and controversy for many years. This is mainly attributable to the subjective approach adopted by experts who do not take advantage of modern computer-based techniques to support their decision-making. One reason for their reluctance is that computer-based systems focused on two-dimensional and static features remain vulnerable to skilled forgeries. This research aimed to overcome this limitation by enriching the features used by an offline recognition system. In addition to two-dimensional features, pseudo-dynamic three-dimensional information was included, measured using three-dimensional microscopy synchronized with white-light imaging. Three-dimensional and pseudo-dynamic features were acquired from a dataset comprising 23,624 signatures. The sample comprised genuine signatures and a range of forgeries (freehand, random, or traced). For forensic purposes, score-based likelihood ratios were adopted to estimate the strength of handwriting evidence. The rates of misleading evidence were low enough ($RMEP = 0$, $RMED = 0.0002$) to warrant implementation in forensic laboratories. In addition, the testing of machine learning techniques demonstrated the feasibility and robustness of the system for commercial application and consideration of feature selection. For the most accurate classification algorithm, a precision of 99.91% is reported for an equivalent recall rate.

Some projects have already combined elements of both fields:

Statistical Analysis of Electronic Signatures
using Dynamic Time Warping:



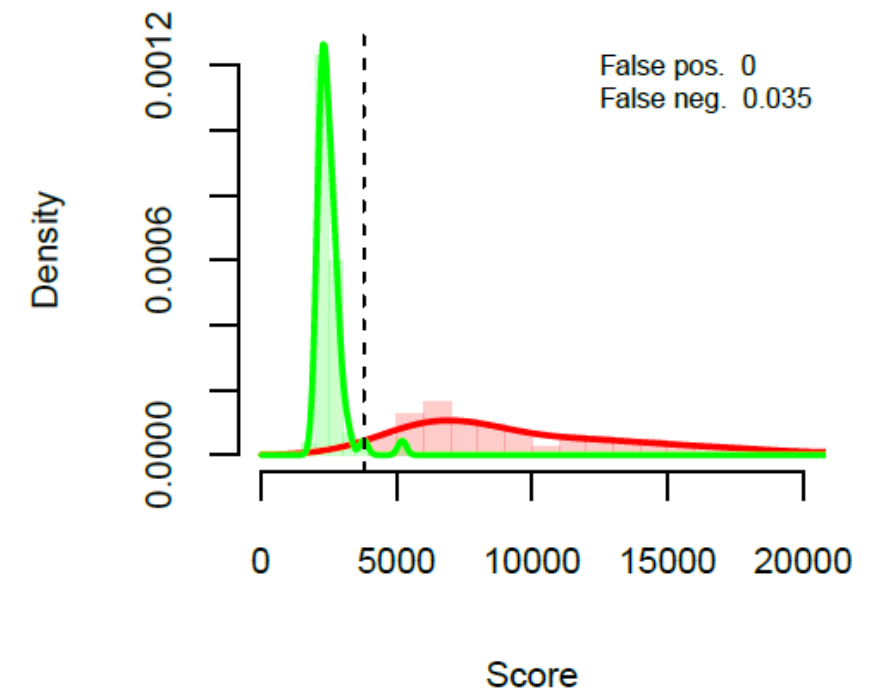
What is the Value of Simple Signature Elements?

Diploma Thesis, Advanced Studies in Applied Statistics

under supervision of Lukas Meier

Erich Kupferschmid, Forensic Science Institute Zurich

Zurich, May 2017



Some projects have already combined elements of both fields:

Unil.



Université de Lausanne
Faculté De Droit, Des Sciences Criminelles Et D'administration Publique
Ecole Des Sciences Criminelles

and

Athens University of Economics and Business
School of Information Sciences and Technology
Department of Statistics

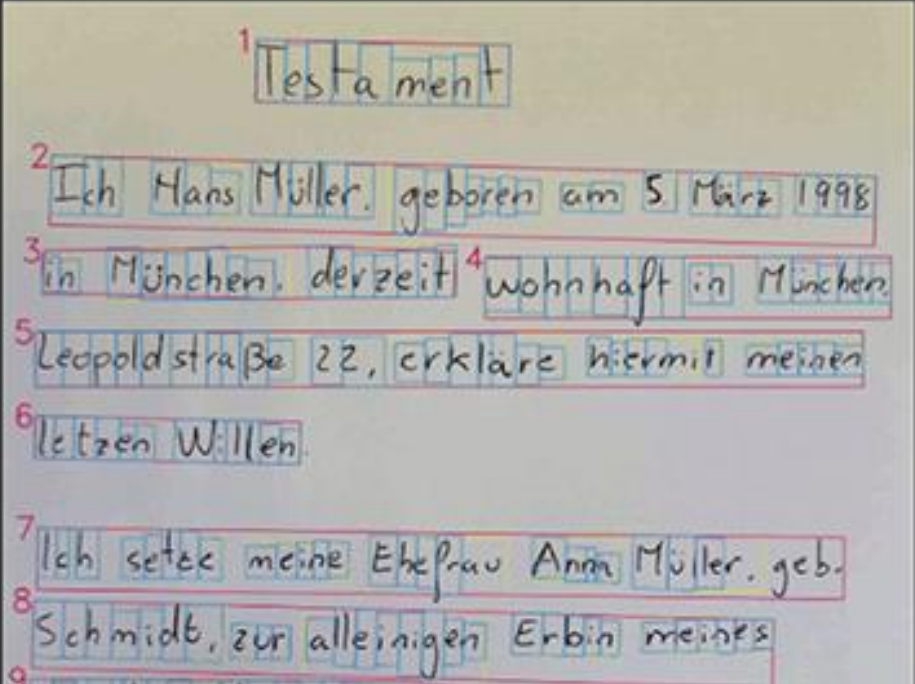
Statistical Methods for the Forensic Examination of Handwriting and Dynamic Signatures Data.

PhD THESIS of
Lampis TZAI

Some projects have already combined elements of both fields:

DE-CASE4_SAMPLE1_CROP.JPG

DOCUMENT EDITOR
DE-Case4_Sample1_Crop.jpg



1 Testament

2 Ich Hans Müller. geboren am 5. März 1998

3 in München. derzeit

4 wohnhaft in München.

5 Leopoldstraße 22, erkläre hiermit meinen

6 letzten Willen.

7 Ich setze meine Ehefrau Anna Müller, geb.

8 Schmidt, zur alleinigen Erbin meines

9

TRANSCRIPTION
Text Detected per Line

1	Testament
2	Ich Hans Müller. geboren am 5. März 1998
3	in München, derzeit
4	wohnhaft in München.
5	Leopoldstraße 22, erkläre hier mit meinen
6	letzten Willen.
7	Ich setze meine Ehefrau Anna Müller, geb.
8	Schmidt, zur alleinigen Erbin meines
9	gesamten Vermögens ein.
10	Sollte meine Ehefrau vor mir versterben, so
11	setze ich meine beiden Kinder, zu gleichen
12	Teilen als Erben ein.
13	München, den. 12 Oktober 2020
14	Hans Müller

Where do we see opportunities for closer collaboration?

- 1) Forensic-oriented competitions
- 2) Models addressing forensic casework needs
- 3) Computational tools supporting FHEs

1) How can competitions reflect forensic casework?

- Forensically realistic questions and scenarios
- Forensically realistic datasets, including “same writer, different conditions” such as
 - handwriting or signatures collected over a longer time
 - disguised writings
 - health issues
 - special writing positions
 - only limited reference material
 - only genuine writings?
- Forensically meaningful evaluation and output

2) Which modelling approaches are most useful for forensic questions?

- Writer-independent vs. property-conditioned vs. writer-dependent models?
- Case-relevant population models
- Explainable and defensible models

3) How can pattern-recognition methods support FHEs?

- Automatic extraction of forensic features
 - Alignment and comparison tools
 - Extraction of pseudo-dynamic information
 - Quantification of handwriting characteristics (e.g., features, variability)
 - Support for evidential evaluation
- Not necessarily full automation:
Support for individual examination steps can already add substantial value

What could we actually do together?

- Joint forensic datasets, benchmarks and competitions
- Develop and test practical tools with FHEs
- Joint research projects and knowledge exchange

Summary: Bridging two disciplines creates new opportunities

- Two disciplines still largely operating separately
- Promising cross-disciplinary projects already conducted
- Strong potential for closer future collaboration
- Need for practical, casework-oriented tools
- Open invitation for joint projects and collaboration
- **We welcome practical tools for forensic casework and opportunities for joint projects**



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