

# Small: Deep Learning in Forensic Handwriting Comparison

Sargur N. Srihari, University at Buffalo, The State University of New York

## Project Summary

A common task in forensic document examination is handwriting comparison. The human expert performs side-by-side comparison of the evidence (handwriting of unknown origin) and known (handwriting of known writership). The outcome is a statement of whether the two had the same source, had different sources or whether there is insufficient information. Today the task is largely done by human experts who use specialized perceptual training and years of experience performing the task. More recently it has become necessary to characterize uncertainty of the conclusion, e.g., in the form of a likelihood ratio (LR)– the ratio of joint probability of evidence and known under two alternative hypotheses (same/different). Such quantitative characterizations are impractical without using automated methods of comparison. But previously developed automation methods use human-engineered feature extraction algorithms and their performance falls short of human expert performance.

In this research we propose to develop more powerful automated approaches to handwriting comparison that learn features from the data. The necessary likelihood ratios are computed as a byproduct. The methods are based on deep learning– a machine learning approach based on neural networks– that has shown spectacular results in many tasks such as speech recognition, computer vision, natural language processing and recommendation systems.

The proposed architecture will consist of an autoencoder to learn the internal representation. Convolutional network architectures will be modified and evaluated, e.g., separate networks for known and evidence with shared weights which are combined at later stages, nonlinear activation functions suitable for LR computation, (ReLU and probit), regularization using data augmentation, etc. Experiments with several handwriting data consisting of words, sentences, paragraphs and full pages are proposed.

## Intellectual Merit

Three new concepts are to be explored: (i) deep neural networks for forensic comparison (evidence and known), (ii) compute a measure of uncertainty in forensic comparison, and (iii) obtaining a single probabilistic opinion using several comparisons.

## Broader Impact

The forensic sciences are at a crisis mode at present- with methods based on human expertise being routinely questioned for their scientific basis. Proposed deep learning methods are a potential break-through and may benefit several forensic domains.

## Key Words

Breakthrough; deep learning; neural networks; forensic analysis; impression evidence; likelihood ratio