



### J29 An Exploratory Analysis of Handwriting Features: Investigating Numeric Measurements of Writing That Are Important for Statistical Modeling

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**Learning Overview:** The goal of this presentation is to provide insights into which features of handwritten documents are important for statistical modeling with the task of writer identification and to discuss how these features overlap with features that questioned document examiners typically examine.

**Impact on the Forensic Science Community:** This presentation will impact the forensic science community by introducing ongoing forensic statistics research to practitioners in the field. Collaboration and communication is fundamental to the success of emerging research.

In recent years, researchers have begun to uncover the process that document examiners follow when conducting a visual analysis of documents. This has been done using several approaches. One of the most fascinating is eye movement tracking, where a device tracks where the eyes are drawn and how long they stay fixated at certain locations on writing samples. This provides insight into which features are seemingly important to examiners when making decisions of writership. There has also been a significant emphasis on the use of data and statistical methodologies to assist in comparison of handwritten documents. For us, data are numeric measurements extracted from handwriting that has been scanned and processed. This research conducts a statistical analysis of measurements that have the power to discriminate between writers and will be important to a statistical model.

Decomposing a document to focus on smaller, meaningful bits of writing at a time lends nicely to an algorithmic approach to writer identification. These pieces of writing, often corresponding to letters, are treated as small graphs with nodes and edges and collect measurements from the graphs. Measurements such as curvatures, lengths, and slants of edges, relative heights of graph nodes, the diameter and shapes of loops, and many more are taken into consideration.

An exploratory analysis with a multitude of measurements is conducted. This is done by comparing features of graphs with similar structures across writers to investigate their ability to discriminate between writers. Measurements that separate writers well in a numeric capacity will be useful for statistical models. Such models are designed to complete the task of writer identification. The results of this feature analysis are discussed with relation to features of writing that document examiners typically consider important in casework as well as results from eye-tracking studies.

Since writing is a realization of a physical action and one cannot expect measurements taken from a single writer to be identical for every repetition of writing, a within-writer analysis is conducted. The writing samples used as data for this analysis were collected from a variety of individuals across the country. Participants were asked to complete writing tasks on a few occasions, each one month apart. The results of the within-writer analysis with respect to samples taken from a single writer with the same content and differing content will be discussed. These comparisons are conducted for writings in a single day, one month apart, and two months apart. These statistical analyses will provide numerical insights into how variable writing is for a single writer over varying periods of time.

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#### Document Examination, Statistics, Writing Features