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SPECIAL ISSUE PAPER

IAMonSense: multi-level handwriting classification using spatiotemporal information

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Abstract
Online handwriting classification has become an open research problem as it serves as a preliminary step for handwriting recognition systems and applications in several other fields. This paper aims to extend the current trends and knowledge with multiple contributions in handwriting classification using spatiotemporal information. Firstly, it enriches the annotations of several publicly available online handwriting datasets, SenseThePen, IAM-onDB, and IAMonDo, for online handwriting classification and recognition tasks. The said datasets are updated with three distinguished levels of annotations, i.e., stroke, sequence, and line levels. The enriched annotations of these datasets extend their functionality for online handwriting classification at different levels for further research analysis. In addition to enrichment, it also unifies the annotation levels across the datasets, which enables the research community to benchmark proposed methods for comparative analysis using multiple datasets. All the datasets with enriched annotations are made publicly available for the research community as part of the IAMonSense dataset. Moreover, this paper presents a comprehensive benchmark of these datasets using multiple deep neural networks such as traditional convolutional neural networks (CNNs), graph convolutional networks(GCNs), attention-based neural networks, and transformers. These benchmarks can be used later on for further development in online handwriting classification.

Keywords Spatiotemporal information · Handwriting datasets · Handwriting classification · Deep learning · Graph neural networks · Transformers

1 Introduction

Handwriting data has been the most trusted and reliable source of information preservation for ages, from writing on tree barks, stones, and animal hides to writing on papers and digital assets. Even today, many areas, such as industries, banking, healthcare, education, and forensic sciences, rely heavily on handwriting data. The booming digital era urges digitizing handwriting data for record-keeping and storing essential information securely. The manual digitization process is nearly impossible and demands efficient and accurate automation. Hence, understanding handwriting becomes a vital step in this automation process.

Handwriting data analysis methods are broadly divided into two categories. Offline systems where only spatial information is available to process handwriting data, i.e., handwritten document images, whereas in online systems, both temporal and spatial information of handwriting data is available. The handwriting data, whether online or offline, depends on writing data acquisition mechanisms such as tra-

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