Rakib Raihan Fahim (2017-1-60-143)
Group: 04

1. The background study for "Recognition and Verification of Unconstrained Handwritten Words

Alessandro L. Koerich, Member, IEEE, Robert Sabourin, Member, IEEE, and Ching Y. Suen, Fellow, IEEE"

Link: https://ieeexplore.ieee.org/document/1498748

This paper is primarily focused on a system to improve an existing state-of-art unconstrained offline handwritten word recognizing system from a big data set that is writer independent. This handwritten recognizing system(HRS) includes segmentation and feature extractions with a pre-processing stage (eliminating some stages which are not required for recognition). The goal is to recognize a word with an HMM-based word recognizing system and verify it to give a result.

Objectives and Motivations for the paper: Some motivations for using HMM (Hidden Markov model) in using handwriting recognition are that it can absorb a lot of variabilities related to the intrinsic nature of handwriting and also it is very good for understanding words and characters.
But there is also some shortcoming for using HMM. If there is over-segmentation, mainly for cursive words, this procedure is not able to give good results.

Methodology: In the paper, they have proposed a method where they rely on the segmentation of the word into characters (S_n) and their labels (H_n) to make SNN (Segmental Neural Network) carry out verification at the character level in order to discriminate between characters and lessen the ambiguity between words to have a good result.
The HRS will take a word as an input and run segmentation on it. A module generates an N-based word hypothesis list by extracting features with the HMM classifier which is defined as an N-based word hypothesis. Another module is used to extract features and run SNN and with the N-based word hypothesis list, it creates a combination of character probabilities, which is defined as the N-Best word hypothesis with confidence scores. This procedure occurs in the verification stage. Word hypothesis re-ranking results by the combination of the recognition and verification confidence scores which decide whether the imputed word is accepted or rejected, and if accepted then what the word is.

Contribution of the work: In the paper, they have mainly put forward a verification strategy that relies on the strengths and weaknesses of HMM-based recognition to improve performance while not affecting the recognition time. Though the verification

stage is not completely optimized (as the paper described), the proposed system has a significant impact on recognition rate, reliability, and recognition time.

Lackings of the work: Despite achieving such an improvement in recognizing characters and words, there are some lackings. The verification stage relies on the HMM-based recognizing system. If there is no true word in the N-best word hypothesis list, then the word will not be able to get verified. But this problem can be solved by having a large N-best word hypothesis list.

Finally, after going through the paper, I have understood the mentality the author had to have greater results in recognizing words and characters. They did not only used recognition but also used verification to verify a word to have a better result. I, along with my groupmates, could use this strategy to have a finer and preferable result.

2. The background study for "Coding and Comparison of DAG's as a Novel Neural Structure with Applications to On-Line Handwriting Recognition I-Jong Lin and Sun-Yuan Kung, Fellow, IEEE"

Link: https://ieeexplore.ieee.org/document/650096

This paper mainly focused on recognizing patterns where the data has linear ordering with the help of directed acyclic graphs (DAG).
In writing, continuous streams and time-indexed series of real points are two formats that are used for transmitting the information. Since the continuous stream has no obvious structure other than ordering, in the paper, they have proposed to use segmentation for recognizing patterns. Continuous stream creates *microstructures* within themselves and with the help of those *microstructures,* they recognize a pattern or a word or a sentence as some of the *microstructures* are previously defined. Obtaining data from these *microstructures*, "breaks" are placed into the stream which is represented as *nodes* in the directed acyclic graph (DAG).
So, in the paper, they have proposed a way to use the segmentation method by compactly encoding ordering and also ambiguity within DAG.

Objectives and Motivations: Constructing words from a continuous stream is a huge challenge as it has nothing but ordering as a structure. This works as a motivation to discover a method that will be useful to address this matter.
DAG coding methodology provides a robust segmentation process, so the similarity between two patterns can be demonstrated as a path matching score of each other's DAG. For this reason, the objective of this paper is to come up with an effective and efficient robust dynamic programming algorithm that can do a comparison for the process.

Methodology: In the paper, they used a basic data structure, polar DAG, where there is a source node and a sink node. They have also used edge values for each edge. They have used multipath DAG to insert a series of "breaks" in the continuous segment. To analyze the DAG, first, it has to be segmented into an identifiable microstructure and then orders information. And by comparing the data between breaks and their immediate predecessor, the pattern is recognized.

Contributions of work: As explained earlier, to transmit a continuous stream of information, there is a difficult problem as it has no structure other than ordering. For that specific reason, this paper tried to fix the problem by segmenting a pattern into microstructures within themselves to define the pattern using DAG. Using their method,

it is proved to recognize 94%(on average) of the isolated handwritten cursive characters. This method can also be used to recognize speech and any kind of continuous stream.

Lackings of the work: In the paper, they have used directed acyclic graphs (DAG) to compare patterns. DAG learning is inherently structural. So, the more pattern is recognized, the larger the data set will become. In my opinion, they could have proposed a method that results in the reduction of nodes and edges. There are well-defined algorithms for reducing nodes and edges and this could have been used in the proposed system.

Finally, I can say that this paper has given me a lot of ideas to think about for our project. Also, I will try to explore the DAG as much as I can.

3. **The background study for "Pattern Recognition - Recognition of Handwritten Document Using Convolutional Neural Networks M.Rajalakshmi, P.Saranya P. Shanmugavadivu"**
Link: https://ieeexplore.ieee.org/document/8951342

This paper is actually a review article that particularly focuses on handwritten recognizing systems based on Convolutional Neural Network (CNN). The main purpose of this paper is to point out the quality, merits and limitations of different techniques. Pattern recognition is a difficult process as there is a large amount of handwriting pattern available. Various approaches have been taken in this field but the major challenge is to recognize unconstrained handwritings such as cursive, titled and block writing. Though the challenge has been sorted out by many proposed system which converts the unconstrained handwriting into a digital format. Keeping all these in mind, this paper did a tremendous job by summarizing research works and their limitations so that researchers can find the knowledge gap and work on it to have a better system that provides more accuracy and less error rate.
This article has summarized twenty research papers and I personally find this paper very much useful as I can use some of the strategies in our project work and discuss among my fellow groupmates about various things that we can use in our project. Reading this article is equal to reading twenty more research paper on pattern recognition (kind of).

The End