Offline Handwritten Character Recognition using BERT Model

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Abstract

The research is about the offline handwritten character recognition system using the BERT model. The collective data that is being obtained here can be very helpful in the case of implementing different tools and processes in this model. The BERT models framework has already been preinstalled using different text from Wikipedia and also has been fine tunes by the inclusion of different datasets that have questions and answers. Different types of problems were found in the implementation of the newly developed natural language model that was being developed by BERT as well as the problems of using an offline handwriting character recognition system. The solution to this problem has also been provided using different artificial intelligence-based machine learning and deep learning algorithms.

Keywords: *BERT model, Offline handwritten Character, Algorithm*

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1. Introduction

In modern times, the use of handwritten character recognition systems has progressed further. It happened due to the inclusion of a deep convolution neural network as well as using BERT (Bidirectional Encoder Representations from Transformers). It is an open-source machine learning framework that is being used by natural language processing (NPL). By using surrounding text to establish context, the BERT can help computers to understand the meaning of ambiguous language in the text. The framework of BERT is already pre-trained using the text from Wikipedia and can also be more fine-tuned with the different datasets that have questions and answers.

2. Aim and Objectives

Aim

The main aim of this study is to recognize the different types of handwriting that are being found in different text formats so that the computer can understand as well as distinguish the difference between different written languages and can also distinguish between their users.

Objective

- To analyze the advantages of using BERT over other handwriting recognition techniques
- To analyze the new type of natural language model developed using BERT
- To analyze the problems in using offline handwritten recognition models

3. Literature Review

Overview of the BERT model and usage

The BERT's handwriting tool is very effective to find out the exact model of recognizing handwriting with the collaboration of the latest technology and algorithm. The model is developed with the best version of the technology to determine the particular patterns or repetitive bits of handwriting to understand the common aspects of handwriting (de Vries et al.2019). There are several patterns and bits which come after almost the same quantity of time, thus algorithm development becomes very easy to develop the algorithm according to the fraction of the gaps between two bits. Thus the majority of the BERT model helps in various fields to

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recognize and find out the inner details of the handwritten note.

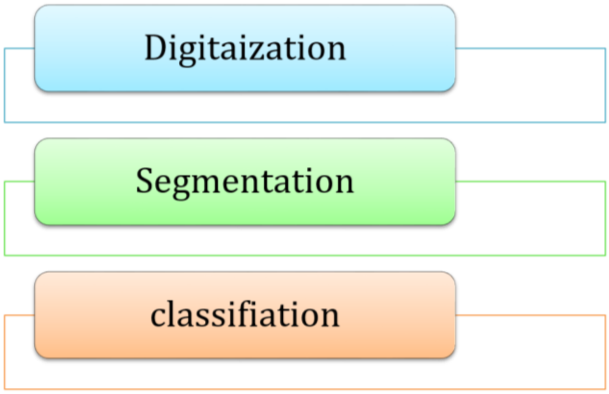

Figure 1: Various steps of the handwriting recognition

(Source: Canete et al.2020, p.78)

The handwriting recognition model is also able to find out the majority of the details of the writer with the collaboration of machine learning and artificial intelligence (Canete et al.2020). The collaborative output is very helpful to find out the common actors of the writer that are hidden in the written note, it gets determined by some common and repetitive nodes by the writer, so the handwriting model is very effective to find out the details of the writer or other details.

4. Method

The majority of the data that are collected for the study to develop are taken by the secondary data collection where most of the data are collected from various written sources like various books, journals, newspaper articles, and many more. The collected data is passed through sorting where the outdated, spoiled, or other problematic data are excluded to get in testing (Sun et al.2019). The data that is in another language other than English are also excluded due to non-readable aspects. After sorting the eligible data is analyzed with qualitative data analysis, where the best quality is maintained with the data and the entire data might be very helpful to be used in the different upcoming research projects by different future researchers.

5. Data Analysis and findings

Datasets for Handwriting

- **IAM Handwriting Database**

It consists of

- 657 writers samples of their handwriting
- 1'539 scanned text
- 5'685 labeled sentences
- 13'353 defined text lines
- 115'320 defined words

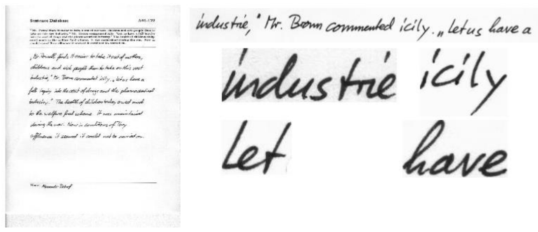

Figure 2. IAM Handwriting datasets

(https://fki.tic.heia-fr.ch/databases/iam-handwriting-database)

- **The MNIST Database**

It consists of the MNIST training set is composed of 30,000 patterns of SD-3 and 30,000 patterns of SD-1. The 60,000-pattern set contained samples from around 250 writers.

Figure 3. MNIST Dataset

(https://en.wikipedia.org/wiki/MNIST_database)

Application of BERT for offline handwritten recognition

It has been noticed that BERT-induced language detection has been developed to make the chances of computational understanding build-up. It is one type of machine learning that has been used for making the efficient for the recognition process. As per Hu et al. (2022), the design of BERT has been developed to establish context. It has been noticed that the BERT model has the capability of using pre-trained text which has been applied in the context of question-and-answer datasets. The operational approach of Bidirectional Encoder Representation and involvement of deep learning has been detected (Masala et al.2020). Transformer-based activity has been noticed which is connected with user input elements for the recognition purpose. In the aspect of the attention process, it has been noticed that output element connectivity and way of developing dynamic calculation is based on their connection.

Parameter	Existing model	BERT model
Performance accuracy	45.1%	65.2%
Large data processing	33.4%	43.5%
Routing easy	23.7%	47.25
Fine-tuning of language	33.6%	46.2%

Table 1: Comparing BERT Model Efficiency

(Source: Created by Author)

Developing a comparison of BERT efficiency with the existing model of handwritten recognition it has been noticed that there is a limitation. The previously existing model has the capability of reading only 'right to left' or 'left to right but with the development of the BERT model chances of removal of this limitation are raised. Dependency on this developing efficiency has been developed from the use of the advanced design of operation. It has been noticed that improved design accuracy and the developing direction make the growth of gaining advantages of handwritten recognition. Li et al. (2021) stated that from the operation of the use of BERT, it has been noticed that there is the integration of two models which include language modeling mask and sentence prediction. From the perspective of observing this including model impact for the recognition, it has been noticed that MLM has the capability of word hiding in sentences and later on the scope of recognition within the hidden word context.

Types of reorganization sequences	**Accuracy**
Question answering	33.12%
Summarization of abstract	42.7%
Prediction of sentences	23.4%
Response generation	37.3%

Table 2: Recognition Sequences used by BERT

(Source: Created by Author)

From the above table, it has been noticed that there are different types of recognition sequences that are used in the practical field. From the above table percentage of accuracy from the use of the BERT, model has been reflected. It has been noticed that different sequences have an impact on outcome accuracy (Lee and Hsiang 2019). It needs to be understood that efficiency and concern are both required to be considered while used for recognition purposes.

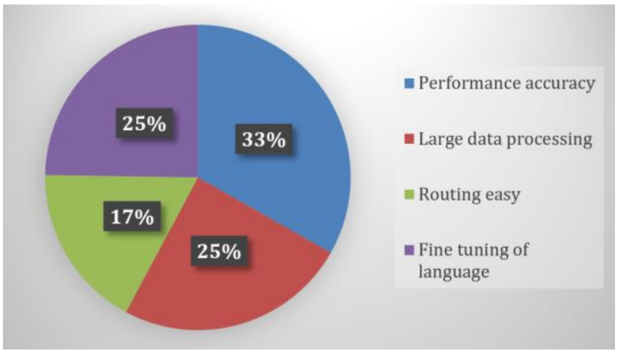

Table 3: Performance chart

(Source: Created by Author)

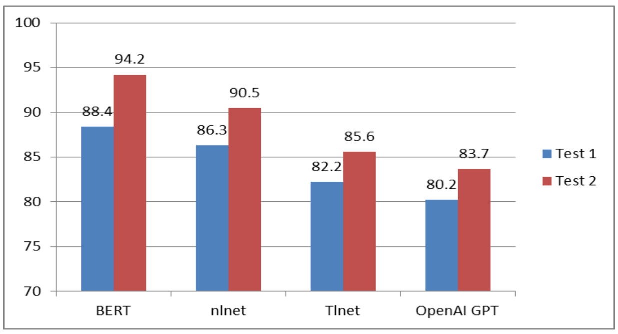

Figure 3: Data chart of different Handwriting Recognition Systems

(Source: Created by Author)

Benefits of BERT model application

- It has been detected that efficiency has been developed over the existing legacy model in the use of handwritten recognition. The need of handling large-scale data for processing sometimes becomes difficult which has been handled with the integration of the BERT model. An easier systematic process makes the growing need for the application of the BERT model (Teslya and Mohammed 2022). Fine-tuning is another area that has been developed for the selected language of recognition by the use of the BERT model.

6. Conclusion and Future Scope

In this research study named "Offline Handwritten Character Recognition using BERT Model," we can say that all the problems that were found in this research such as the implementation of a newly developed natural language model that was being developed by BERT, the different issues that were faced in the time of using an offline handwriting character recognition system all have been taken to account. The inclusion of deep learning, artificial intelligence, and machine learning algorithms has helped BERT to maintain this offline-based handwritten character recognition system. To offline handwritten character recognition system using BERT has already been trained by the spatial information from Wikipedia.

As offline handwriting character recognition systems always stay less accurate than online systems. Using them in modern days as well as the future does not seem to shine any new thoughts. As in an offline system, only spatial information is available to be used. In terms of using the online system, it has both spatial as well as temporal information that is always available for online systems. With the increased number of modern technology the offline handwriting system does not has much use. The offline handwriting character recognition system is mainly used by government officials to continuously check for any illegal information that needs to stay secret and is mainly stored in a very closed server.

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