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Foreword

By the grace of Allah, it is a great pleasure to introduce this issue of **The International Journal on Islamic Applications in Computer Science and Technology**

The success and the welcome of this Journal by researchers from many countries gave us great encouragement for continuing issuing in the due time. This Journal is aimed at publishing original research papers in the field of Islamic Applications in computer science and technology. This field is catching a momentum in the recent years. As a Journal interested in this field, it is the first International Journal of its specific field. As research is growing in this field, we hope that this Journal will be a platform for researchers working in the field to publish their research.

This issue contains three papers. The first one is entitled: **Localization and Extraction of Qur'an Verses Using Computer Vision**

Localizing Quranic verses, by detecting the verse bounding boxes, with respect to Quran page images is crucial for UI applications. These applications rely on the user interacting with the verse to view the translation, share the verse, listen to its audio, etc. Moreover, the automatic detection of the verse bounding boxes enables additional image processing and analysis of the Quran pages at the verse level. For these use cases, we need to map the user's click within the image boundary and know which verse is selected. In this paper, a computer vision approach using a Faster RCNN neural network to analyze Quran page images and automatically localize the boundary of every verse with respect to the page is proposed. This information can, later on, be fed into various UI applications that allow the user to interact with Quran verses. The model was trained and run in several experiments on the following narrations: Hafs, Douri, Shubah, Qalon, and Warsh. Results showed 100% accurate detection of all verse boundaries for these narrations.

The second paper is entitled: **AI Classification of Linguistic Expression Between The Quran, The Hadith, and Pre-Islamic Poems Using an LSTM Deep Learning Model**

This paper demonstrates the distinct and separate source of authorship between the Quran, Hadith, and Pre-Islamic Poetry using an Artificial Intelligence deep learning model of Long Short-Term Memory (LSTM) network. The Quran has 6236 verses, and 5181 Hadiths were extracted from Sahih Bukhari's book with verified trusted chain of narrations, as well as used 858 lines of Pre-Islamic Poetry. The three models were trained on the same percentage of available text from the Hadiths, and Poems, and then tested each of the models on the residual 75%, 80%, and 85%**,** respectively, of Quran verses, Hadiths, and Poems. Accurate classification of the three LSTM Models of testing Quran verses was 98.58%, 98.95%, and 83.47% respectively. Accurate Hadith's classification accuracy of the three LSTM Models 98.97%, 99.73%, and 99.59% respectively. Accurate classification of the three LSTM Models for the Poems was 100%, 100%, 100% respectively. These results demonstrate the distinct nature of the expression style of authorship between the Quran, the Hadith, and the Pre-Islamic Poetry leading to the conclusion that they are indeed from different sources of authorship.

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Localization and Extraction of Qur'an Verses Using Computer Vision

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Abstract

Localizing Quranic verses, by detecting the verse bounding boxes, with respect to Quran page images is crucial for UI applications. These applications rely on the user interacting with the verse to view the translation, share the verse, listen to its audio, etc. Moreover, the automatic detection of the verse bounding boxes enables additional image processing and analysis of the Quran pages at the verse level. For these use cases, we need to map the user's click within the image boundary and know which verse is selected. In this paper, we propose a computer vision approach using a Faster RCNN neural network to analyze Quran page images and automatically localize the boundary of every verse with respect to the page. This information can, later on, be fed into various UI applications that allow the user to interact with Quran verses. We train our model and run several experiments on the following narrations: Hafs, Douri, Shubah, Qalon, and Warsh. Our results show 100% accurate detection of all verse boundaries for these narrations.

Keywords: **Computer Vision, Detectron2, Faster RCNN, Quran, Quranic Verse Extraction, Quranic Verse Localization.**

1. Introduction

The Quran has been accessed and read online for many years. Many applications provide features where you can click on a certain verse (ayah) and be able to interact with it. However, the process of providing verse boundaries for such applications has been mainly manual. Several tools were built to facilitate the manual data entry of the verse bounding boxes. The process has been labor-intensive from one side. On the other hand, the process needs to be repeated for any new printing of the Quran and for every narration of the Quran. Most of the online applications are available only for Hafs narration. Other narrations lack such features and support. This is the result of not having a clickable window associated with each verse due to the significant amount of manual effort required to label verses for each narration. The lack of windows that allow for verses to be clicked on severely limits the possibilities of having other narrations published on websites with the same functionality as the Hafs narration.

In this paper, we present QR-Vision, a Verse, and the beginning of Surah localIzatiOn Neural Network system. QR representing the website QuranResearch.org (QuranResearch, 2020). A model that detects the verse markers across different narrations. We have tested our model on the following narrations: Hafs, Shubah, Douri, Qalon, and Warsh using Quran pages taken from the King Fahd Glorious Quran Printing Complex (King Fahd Glorious Quran Printing Complex, 2022). However, we believe the model is generalizable to any narration. After detecting the verse markers, we apply an iterative logic to find all the boxes belonging to each verse in between the verse markers. We also detect the beginning of chapters (surahs) and we mark them so we can find the correct boundaries of the first verse of each chapter (surah). We note that the Quran page images associated with different narrations have differences among them in terms of verse locations and numbering. Figure 1, as an example, illustrates the difference between the narrations of Hafs and Douri in the first page. Verse 7 in Hafs is split into two verses in Douri while Douri narration does not consider the basmalah as separate.

Figure 1. Differences Between Narrations in Verse Numbering and Localization

In this paper, our contributions can be summarized as follows:

- We present QR-Vision, a Quran Visual Extraction Neural Network system that detects verse markers and the beginnings of chapters with high accuracy.
- We conduct experiments utilizing this neural network model to automatically scan different narrations and generate bounding boxes for all verses. The narrations we considered are Hafs, Shubah, Douri, Qalon, and Warsh. Yet we believe the model is extensible to other narrations.
- We publish our training datasets, trained model, inference results, and code online to make it available to advance research in this area (GitHub, 2022).

2. Research Background

In this section, we overview related work along two main lines. First, we overview some research directions that utilize Machine Learning techniques to leverage digital access and to verify authentication of the digital Quran copies. Second, we highlight the Deep Learning Models that we used in our computer vision approach to detect verse boundaries.

2.1 Machine Learning Techniques to Detect and Verify Quran Verses

There are several research directions (Sabbah, 2013; Kurniawan, 2013; Hassan, 2020; Hakak, 2018) that focus on validating the authenticity of the Quran verses that are published online. These directions use a form of a matching algorithm, e.g., Boyer Moore algorithm, for verification purposes. Once verification is complete, a watermarking technique is used for the purpose of tamper identification. There are many other types of research around detecting Quran words and verses from text such as (Sabbah, 2014) using support vector machines, and

(Rafea, 2021) which uses a tree-linked hash table data structure to facilitate the matching process.

In (Jannah, 2020), convolution techniques are used to detect Harfu Jar from Quran images, while in (Rizal, 2015), convolution techniques and Bray Curtis distance are used to detect and classify the different Tajwid rules in Quran images. In this paper, we leverage convolution neural networks (CNNs) to detect and localize verse boundaries within a Quran page.

2.2 Machine Learning Techniques to Detect and Verify Quran Verses

Convolution techniques have been the backbone of recent computer vision neural networks. Convolutional neural networks (CNNs) have witnessed tremendous improvements over the last few years. One of the major improvements in this area has been the introduction of Fast R-CNN (Girshick R. , 2015) and Faster R-CNN (Sun, 2017). Faster R-CNN achieved state-of-the-art results on the COCO dataset (Lin, 2014) which is the standard dataset used in object detection tasks.

Recently, transformer-based neural networks have been increasingly used in the field of computer vision such as ViT (Matt, 2021) and Swin Transformer (Guo, 2021). The Swin Transformer uses a shifted window with limited attention to be able to capture features at different scales to achieve better results on segmentation and detection tasks.

In this paper, we use Faster R-CNN based models provided by the Detectron2 library (Girshick Y. W.-Y., 2019). Detectron2 provides models with near state-of-the-art performance for many computer-vision tasks. It also provides rich content in the form of available resources, documentation, examples, and supported frameworks.

3. System Architecture

Figure 2 illustrates the overall architecture of the QR-Vision System. First, we gather sample images of Quran pages from different narrations. We label these sample pages by manually identifying the verse markers in these pages. These sample pages will be used to train the model. We build and retrain a neural network model to localize verse markers and to detect the beginnings of the chapters. We then use the trained neural network model, to localize all verse markers and the beginnings of the chapters in the entire Quran narration. Based on the localization information from the neural network, we perform simple logic to isolate and detect the boundaries of each verse. In the next sections, we discuss each stage of the localization process in more detail.

3.1 Sample Data Collection and Labeling Module

To start the process, we need to train our neural network model with a sample data set. All images are collected from the King Fahd Quran Complex (King Fahd Glorious Quran Printing Complex, 2022). With the quality of images, and with a training dataset that contains only 15 pages, we are able to achieve high accuracy in the detection of both verse markers and chapter beginnings. Each verse marker and each chapter beginning that appears in the 15 training images are carefully labeled manually by us. Figure 3 illustrates the tool we used to identify and box each verse marker and each chapter beginning. Then, we exported this training dataset in the COCO format (Lin, 2014). The model performs well even with a tiny dataset, as we will see later in the results section.

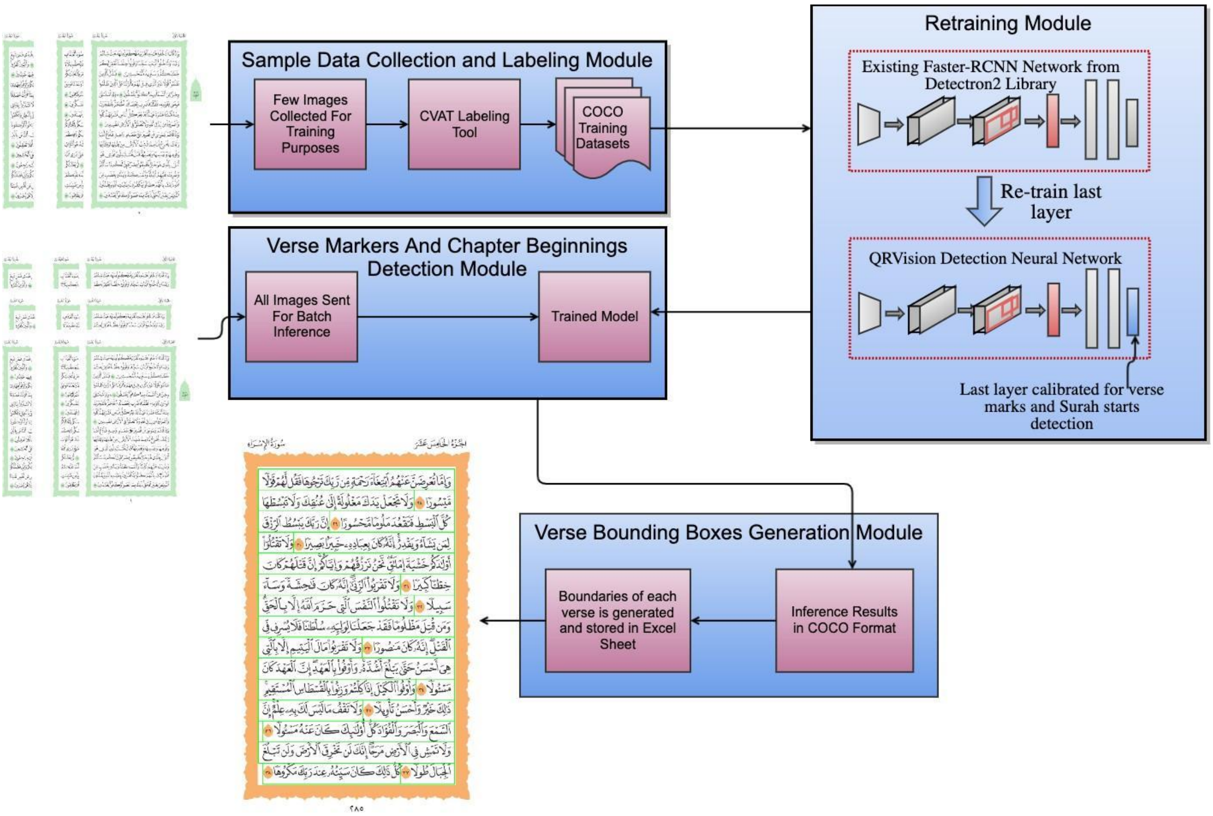

Figure 2. The QR-Vision System Architecture

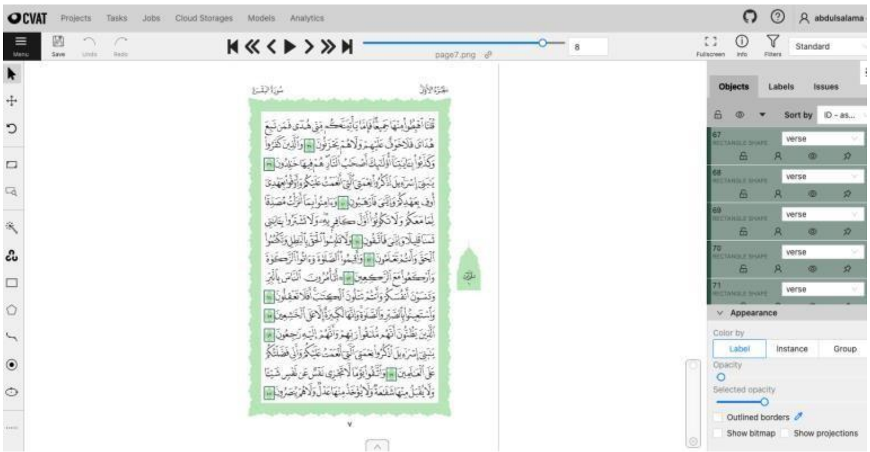

Figure 3a. Labeling Tool for Verse Markers

Figure 3b. Labeling Tool for Chapter Beginnings

3.2 Neural Network Retraining for Visual Extraction

This module uses a convolutional neural network to extract the visual properties of Quran images. Our final goal is to mark verse boundaries and generate boxes representing the area in the image that belongs to each verse separately. In order to achieve this, we first detect and localize verse markers and the beginnings of the chapter. Once we have verse markers, it becomes straightforward to separate the boundaries for each verse. This module focuses on the task of just detecting and localizing verse markers and chapter beginnings. For this purpose, we utilize Detectron2 (Girshick Y. W.-Y., 2019), a library that provides collections of Fast R-CNN (Girshick R., 2015) and Faster R-CNN (Sun, 2017) neural networks for object detection. As illustrated in Figure 4, Faster R-CNN essentially introduces a separate network to learn and predict the region proposals. These regions are fed to the detection network for object detection. The regions make it faster and also more suitable for re-training on different classes since the region proposal network can be re-trained as well.

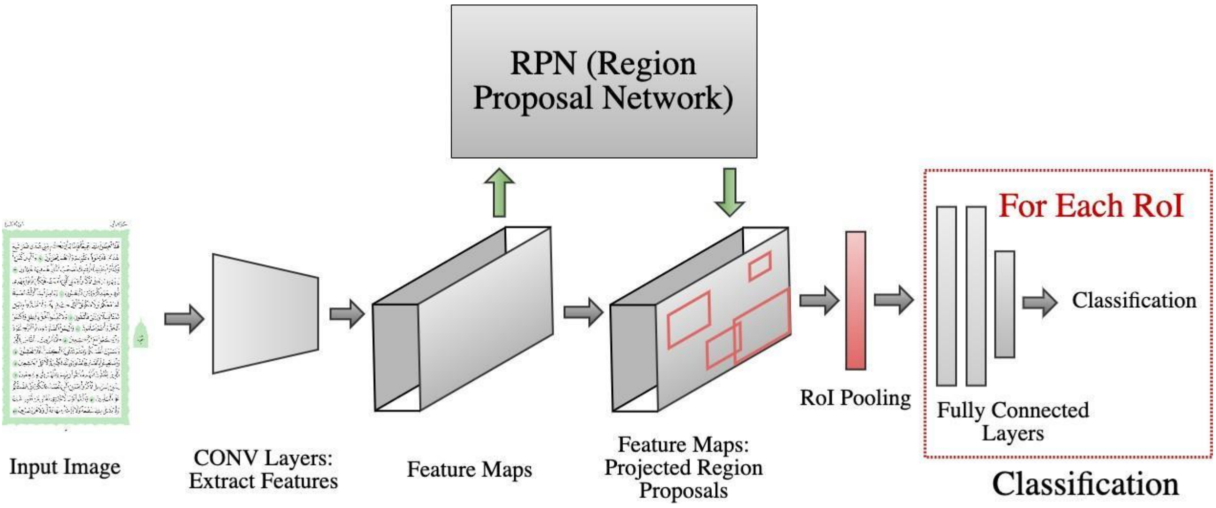

Figure 4. Faster R-CNN High-Level Architecture

We then prepare a new training dataset by labeling a few Quran images obtained by downloading images from the King Fahd Quran Complex. We freeze all layers in the neural network except the last one. The last layer is a fully connected layer. We use the training dataset to retrain the network and tune the weights of this last layer based on the new dataset and desired classes to be detected. We have two classes of objects that we want to detect; verse markers and the beginnings of the chapters (surahs). Our small dataset was enough to retrain the model which shows the power and flexibility of these models. Figure 5 presents the re-training architecture. After retraining and tuning, we use the trained model to do batch inference on all pages of the Quran for verse markers and beginnings of chapter detection.

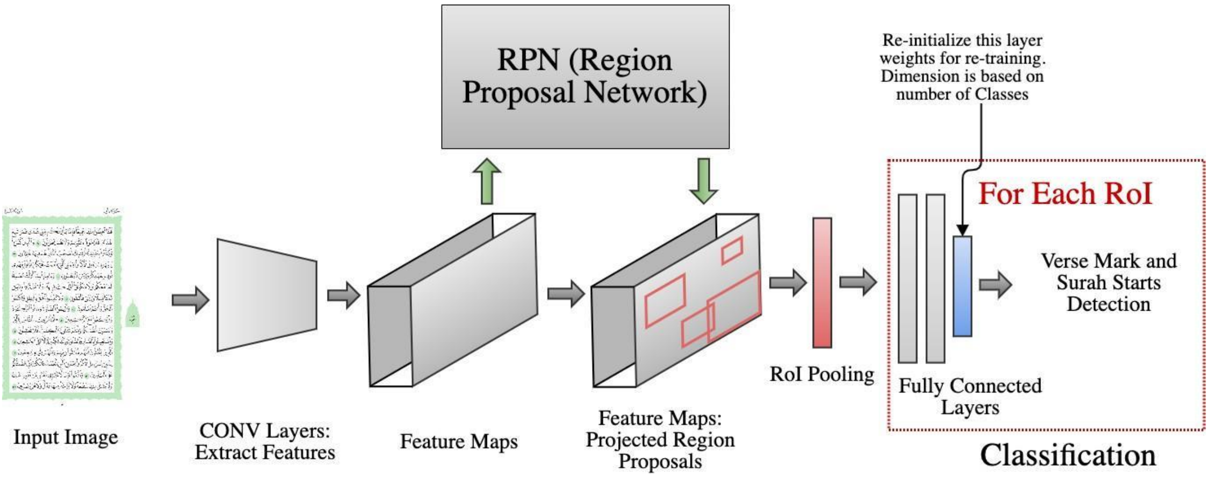

Figure 5. Retraining Architecture at a High Level

3.3 Verse Markers and Chapter Beginnings Detection

This module feeds all Quran images, for a specific narration, into the neural network for batch inference. The neural network processes all pages and detects verse markers and chapter beginnings in all pages and generates boundary boxes around them. The inference results are presented in COCO format. The COCO output file is fed into the next component to finally generate verse boundaries. Figure 6 visualizes the resultant verse markers and chapter beginnings to give a sense of the accuracy of the model.

We analyze the total number of verses and surah beginnings detected by the model and compare them with expected numbers for the narration. After manually checking the output of the model, the number of verses in each Surah was correctly verified.

Figure 6. Verse Markers and Chapter Beginnings Detected by The Model

3.4 Bounding Boxes Visualization

In this section, we present the results of generating boxes for Verse boundaries. We use the inference, the verse markers, and chapter beginnings detected by the model, and feed it into the Verse Boundary Generation module. This module processes this information and performs simple logic to draw boxes around the content of each verse. The content belonging to each verse falls in between the current verse marker and the previous verse marker. If the verse is the first verse in the chapter, we use the beginning of the chapter mark to detect the beginning boundary of this verse. Figure 7 illustrates an example.

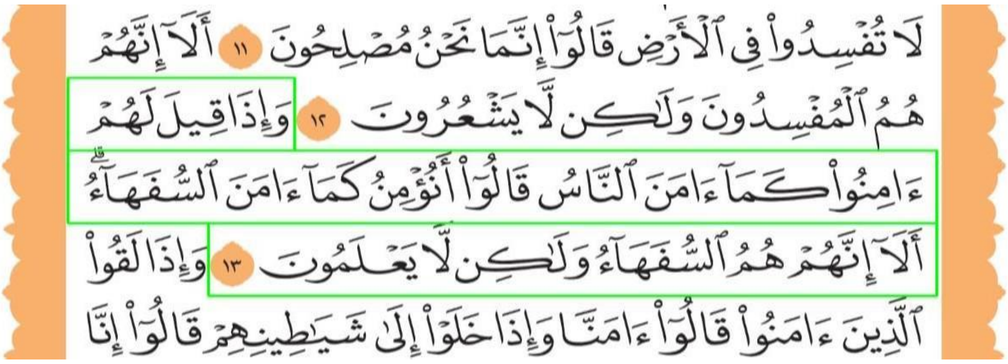

Figure 7. Example Bounding Boxes of a Verse

Figure 7 shows the boundaries of verse 13 of chapter Al-Baqara. The way we achieve this is by using the inference results, which tell us the exact location of verse 13 and the exact location of verse 12. Note that the inference results keep track of the verses in order. With this info, we have a logic that will draw boxes for all the lines in between these two verses. The boundary of each verse can be composed of multiple boxes. In Figure 7, the boundary of verse 13 is presented with a list of 3 boxes. The first bounding box starts from the end of Verse 12 to the end of the line. The second box is the full line in between the two verses. The third box is the box from the beginning of the line until the mark of verse 13.

	A	B	C	D	E	F	G	H
1	Page Number	Verse Serial Number	Box Number	x	y	w	h	
2	1	1	1	808	1099	729	119	
3	1	2	2	590	1099	218	119	
4	1	2	3	712	1218	825	119	
5	1	3	4	590	1218	122	119	
6	1	3	5	1095	1337	442	119	
7	1	4	6	616	1337	479	119	
8	1	5	7	590	1337	26	119	
9	1	5	8	791	1456	746	119	
10	1	6	9	590	1456	201	119	

Figure 8. An Example Tabular Format of the Detected Verse Bounding Boxes

We do this logic iteratively on all verses and mark the boundaries of all verses. We compile and store these results in a table. This format contains for every verse a list of boxes indicating the boundaries that belong to it. Note that we use the verse serial number. Each box is represented with (x,y) coordinates of the top left corner, height, and width. Figure 8 shows a cross-section of this table.

Some of these detected bounding boxes are visualized in Figure 9. For presentational reasons, distinct verse boundaries are indicated with different colors. Figure 10 displays some corner cases that appear in the pages of the Quran. For example, Surah At-Tawba has no Basmallah, and Surah Al-Fatihah has a unique layout across narrations. Despite these exceptions, the model still marks the verses correctly.

Figure 9. Verse Bounding Boxes Visualization on Page of Quran

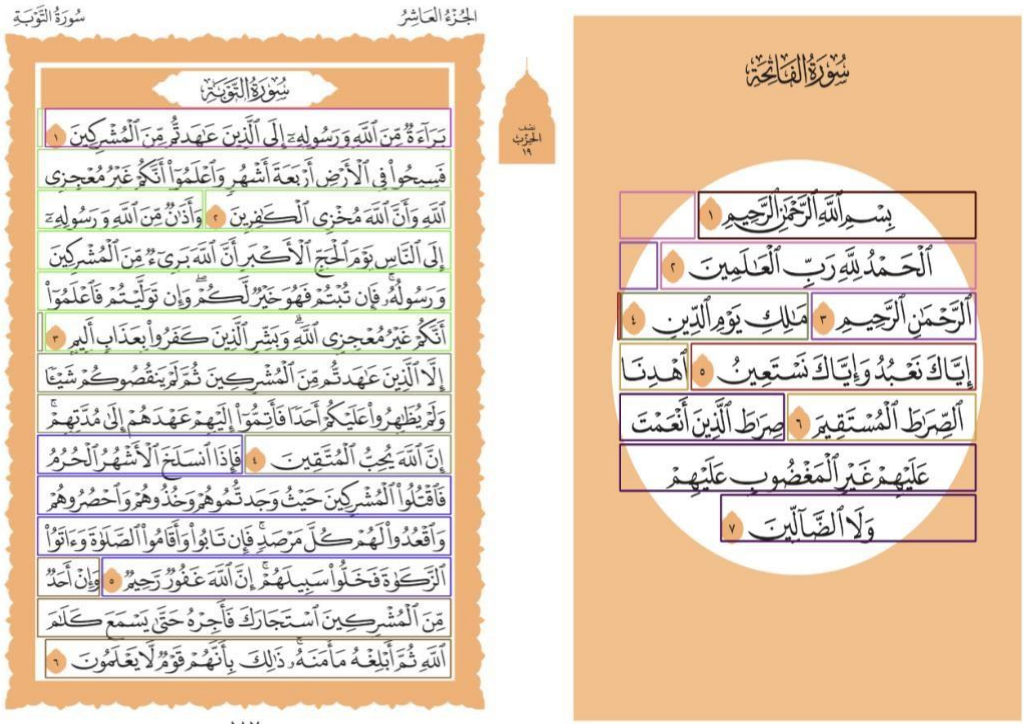

Figure 10. Visualization of Some Corner Cases in the Detection of Verse Bounding Boxes

4. Conclusion

In the paper we detected verse markers and the beginnings of the chapters using a neural network model for several different Quran narrations with 100% accuracy. Then, we identified the line spacings in each page to create a list of bounding boxes for each verse. The outcome of this research facilitates the automatic localization of verse boundaries across any Quran narration and any Quran printing. It could also be used to fact-check the number of verses in a Mushaf. Also, several applications can benefit from this research to provide clickable windows around verses for different narrations and Quran printings. We hope that the technologies and processes introduced in this paper can help inspire future work to use robust computer vision techniques to verify new copies of the Quran for authenticity.

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AI Classification of Linguistic Expression Between The Quran, The Hadith, and Pre-Islamic Poems Using an LSTM Deep Learning Model

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Abstract
The Quran is God's (Allah subhanah) universal and final message to humanity through his prophet Muhammad peace and blessings be upon him (PBUH). This research aims to prove the distinct and separate nature of the linguistic style of expression used in the Quran vs. the Hadith vs. Pre-Islamic Poetry in Mecca during the prophet's era, known as the "Ten Hanging Poems". While all these sources were all in Arabic language, we demonstrate that they are each distinct in their style of expression and belong to separate authoritative sources. The prophet's (PBUH) style of natural language expression is transmitted verbatim through his Hadith via each Hadith's trusted chain of narrations. While the Quran is authored by Allah subhanah and transmitted to his prophet Muhammad PBUH through the angle Jibreel (Gabrael) PBUH. This research will demonstrate the distinct and separate source of authorship between the Quran, Hadith, and Pre-Islamic Poetry using an Artificial Intelligence deep learning model of Long Short-Term Memory (LSTM) network. The Quran has 6236 verses, and we extracted Prophet's words (PBUH) through 5181 Hadiths from Sahih Bukhari's book with verified trusted chain of narrations, as well as used 858 lines of Pre-Islamic Poetry. For the Hadiths processed, we purposefully avoided text not expressed by the prophet, including narration chain, expression by others, or quotes of Quran verses.. We trained three different models Net21, Net20, Net19 on 25%, 20%, and 15%, respectively, of total 6236 Quran verses with randomized order of the verses so as to avoid bias of model due to verse length. Similarly we trained the three models on the same percentage of available text from the Hadiths, and Poems, and then tested each of the models on the residual 75%, 80%, and 85%, respectively, of Quran verses, Hadiths, and Poems. Accurate classification of the three LSTM Models of testing Quran verses was 98.58%, 98.95%, and 83.47% respectively. Accurate Hadith's classification accuracy of the three LSTM Models 98.97%, 99.73%, and 99.59% respectively. Accurate classification of the three LSTM Models for the Poems was 100%, 100%, 100% respectively. These results demonstrate the distinct nature of the expression style of authorship between the Quran, the Hadith, and the Pre-Islamic Poetry leading to the conclusion that they are indeed from different sources of authorship. This research results provides objective scientific proof that the Quran is not the creation of the Prophet Muhammad (PBUH) but is from a divine source (Allah *subhanah*). It also demonstrates that the Prophet's style of expression in his speech in the verified trusted Hadith was not influenced by the Quran. It further demonstrates that the Prophet's style of expression was not influenced by the Poetry style that was common in his era in Mecca where he grew. Finally, this research demonstrates that the Quran did not follow the poetic style of expression common in the era of Pre-Islamic Mecca, but rather was distinguished in its own

class of expression style that fascinated and attracted people to it as it was different from what they heard before in poetry. These facts are also mentioned in the following 7 Quran verses that the Quran is not the creation of the prophet Muhammad (PBUH) as falsely claimed by some people. It is also mentioned that the Prophet was "not a poet" in 3 Quran verses.

Sura Chapter	Verse	
10	38	أَمْ يَقُولُونَ افْتَرَىٰهُ قُلْ فَأْتُوا بِسُورَةٍ مِّثْلِهِۦ وَادْعُوا مَنِ اسْتَطَعْتُم مِّن دُونِ اللَّهِ إِن كُنتُمْ صَٰدِقِين
11	13	أَمْ يَقُولُونَ افْتَرَىٰهُ قُلْ فَأْتُوا بِعَشْرِ سُوَرٍ مِّثْلِهِۦ مُفْتَرَيَٰتٍ وَادْعُوا مَنِ اسْتَطَعْتُم مِّن دُونِ اللَّهِ إِن كُنتُمْ صَٰدِقِين
11	35	أَمْ يَقُولُونَ افْتَرَىٰهُ قُلْ إِنِ افْتَرَيْتُهُۥ فَعَلَىَّ إِجْرَامِى وَأَنَا۠ بَرِىٓءٌ مِّمَّا تُجْرِمُون
25	4	وَقَالَ الَّذِينَ كَفَرُوٓا إِنْ هَٰذَآ إِلَّآ إِفْكٌ افْتَرَىٰهُ وَأَعَانَهُۥ عَلَيْهِ قَوْمٌ ءَاخَرُونَ فَقَدْ جَآءُو ظُلْمًا وَزُورًا
32	3	أَمْ يَقُولُونَ افْتَرَىٰهُ بَلْ هُوَ الْحَقُّ مِن رَّبِّكَ لِتُنذِرَ قَوْمًا مَّآ أَتَىٰهُم مِّن نَّذِيرٍ مِّن قَبْلِكَ لَعَلَّهُمْ يَهْتَدُون
46	8	أَمْ يَقُولُونَ افْتَرَىٰهُ قُلْ إِنِ افْتَرَيْتُهُۥ فَلَا تَمْلِكُونَ لِى مِنَ اللَّهِ شَيْـًٔا هُوَ أَعْلَمُ بِمَا تُفِيضُونَ فِيهِ كَفَىٰ بِهِۦ شَهِيدًۢا بَيْنِى وَبَيْنَكُمْ وَهُوَ الْغَفُورُ الرَّحِيم
21	5	بَلْ قَالُوٓا أَضْغَٰثُ أَحْلَٰمٍ بَلِ افْتَرَىٰهُ بَلْ هُوَ شَاعِرٌ فَلْيَأْتِنَا بِـَٔايَةٍ كَمَآ أُرْسِلَ الْأَوَّلُون
52	30	أَمْ يَقُولُونَ شَاعِرٌ نَّتَرَبَّصُ بِهِۦ رَيْبَ الْمَنُون
69	41	وَمَا هُوَ بِقَوْلِ شَاعِرٍ قَلِيلًا مَّا تُؤْمِنُون

Table 1 Quran verses: the Prophet did not author the Quran nor was he a Poet

Deep learning LSTM network models are suitable for this application of text comparison because of their ability to hold memory states of text sequences and because they adapt well extracting key features for classification via its state memory structure even in the presence of scarcity of input training data. In this paper we will overview the structural properties of LSTM deep learning models, and the pre-processing of Arabic language text into a numeric form accepted by the model for training and testing, and finally we will demonstrate the results of the model application and review conclusions.

***Keywords*: Long Short-Term Memory Network, LSTM, Deep Learning Model, Quran, Hadith, Text Classification.**

1. Introduction

AI Deep Learning models are considered the most advanced algorithms for applications requiring classification problems. They are adapted to process vast amount of multi-dimensional datasets, and can extract features that are extremely difficult for humans to identify, in order to use these features for classification of input data series into multiple output classes. These models belong to supervised training classification where the model is iteratively adapted to reduce an estimation error cost function by providing training datasets at the input data layer, and adjusting the hidden (inner) network layers weights to minimize the classification error on the output layer.

Deep learning models are objective and unbiased, they do not readily understand Arabic language nor know the meaning of the words they are being presented with. Words presented at input of the deep learning network are a sequence (time series) of letter strings that are converted into a sequence of numeric values. Deep learning models examine the sequence of letters presented in each word as well as the sequence of words in each input sentence which embodies the style of expression of the author.

LSTM Networks are designed for applications where the input is an ordered sequence or time-series of data. LSTM networks maintain state memory of previous inputs where information from earlier data in the sequence may be important to the information that follows, often the case in waveform signals or text time-series data. This is a prediction problem where given a sequence of letters, it provides context to predict the following sequence of letters. LSTMs can be used to identify the authors of a text by learning their style of expression of language during a training phase, and then evaluating during a testing phase new unknown test sequences (sentences) to identify who the author is.

2. Research Method: Approaches, Analysis and Results

LSTM is used for Sequence Classification. LSTM is a type of a recurrent network, that reuses the output from a previous step as an input for the next step. The node performs a calculation using the input and returns an output value. This output is then used along with the next element as the input for the next step. In LSTM, the nodes are recurrent but they also have an internal state as a working memory space where information is stored and retrieved over many time steps. The input value, previous output, and internal state are all used in the node calculation for outputs, and to update the state.

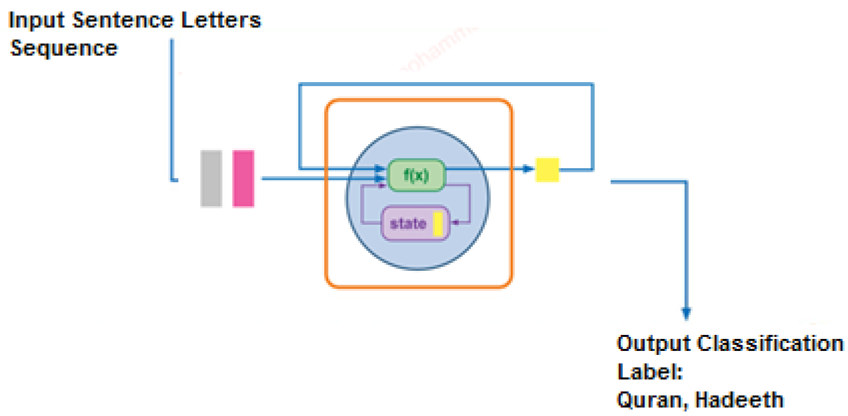

Figure 1. An LSTM node with state memory transforming an input to an output

Sequence Classification: We used LSTM to predict which author wrote a given sequence of text. A single output class (author) for the whole input sequence (verse or sentence or line) The LSTM will take a sequence as an input and calculate an output for each input element. Only the last output is used to make a prediction (sequence to label classification).

Forty forms of Arabic alphabets were converted to numeric sequences to represent the verse or sentence as a time-series (sequence) of numbers. The number 1 represents the presence of the letter and 0 represents the absence of it.

All models training and inference was performed using Matlab Deep Learning Toolkit from MathWorks, Inc (Natick, MA, USA) version 2022a. All models, source code, input data, and output results can be downloaded from the following URL:
https://tinyurl.com/QuranHadithPoemsSource

To Convert Arabic text to numeric sequences

a) Combine Training set of Quran verses, Hadiths prophet's expressions, and Poem lines sequences. The training set is comprised using a pre-determined percentage of the total available text of 6236 Quran verses, 5181 Hadiths, and 858 Poem lines. The training set is randomized for the order of sequences presentation to LSTM.
b) Perform training of LSTM until convergence and error reduction.

c) Combine Testing set of residual Quran verses, residual Hadith sequences, and residual Poem lines, then randomize the order of sequence presentation to LSTM.
d) Perform testing using trained LSTM model and produce classification results as either Quran or Hadith or Poem classes.
e) Compare results with the truth table to produce a result confusion map and %Accuracy.

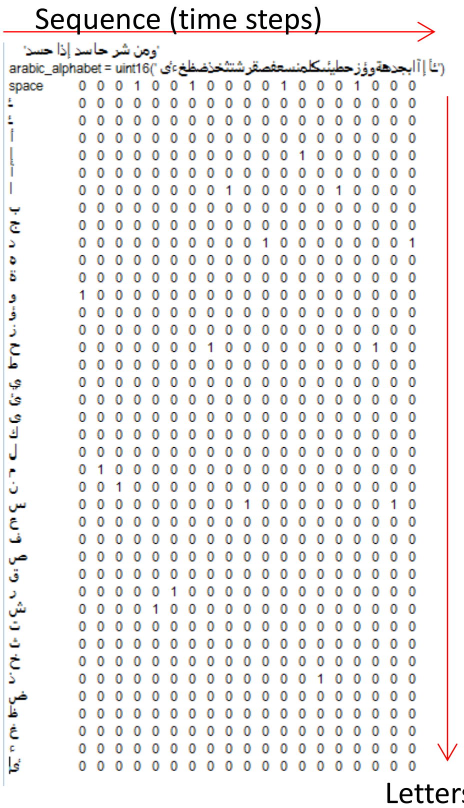

Figure 2. Each Arabic alphabet is given a 1 if present of 0 if not in the sequential order of letters in the words, and words in the sentence being converted.

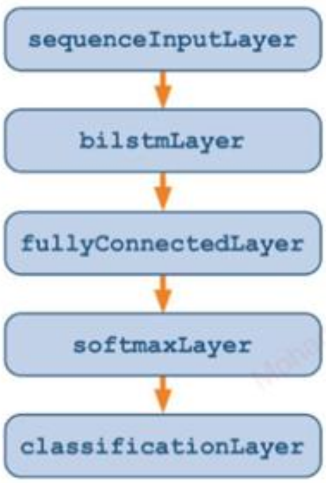

Figure 3A Layers of the Bi-Lateral LSTM Network

```
layers =

  6×1 Layer array with layers:

     1   ''   Sequence Input          Sequence input with 40 dimensions
     2   ''   BiLSTM                  BiLSTM with 25 hidden units
     3   ''   BiLSTM                  BiLSTM with 25 hidden units
     4   ''   Fully Connected         2 fully connected layer
     5   ''   Softmax                 softmax
     6   ''   Classification Output   crossentropyex
```

Figure 3B. Detailed description of the Layers of the Bi-Lateral LSTM Network

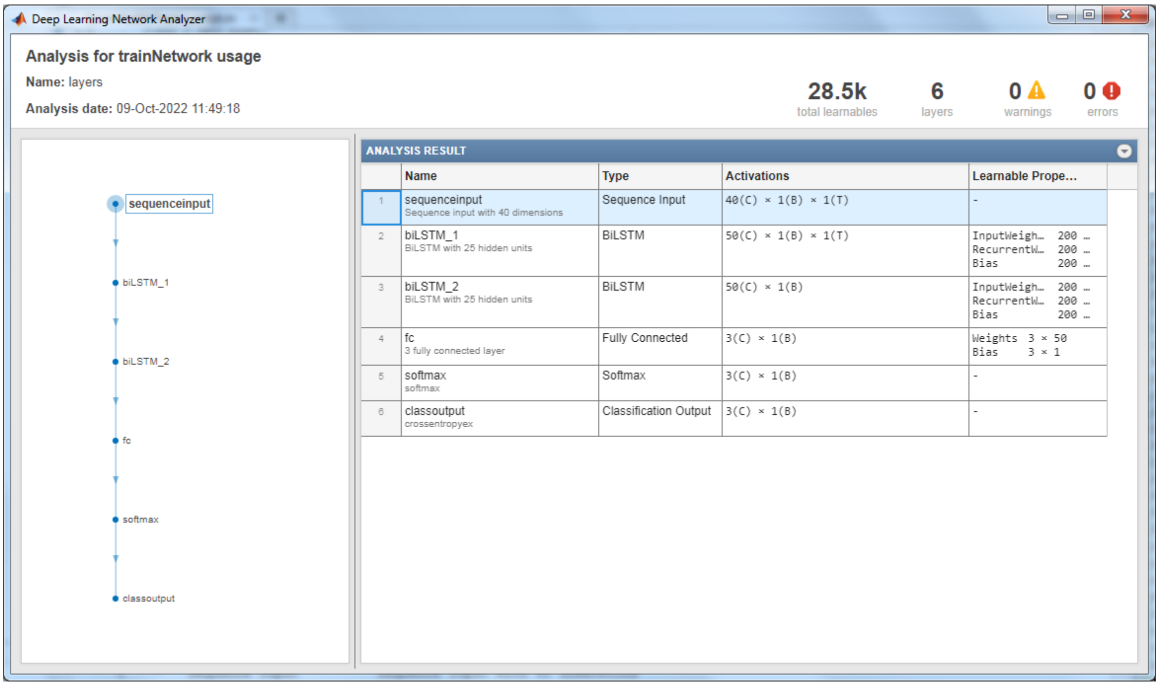

Figure 4. Network layers detailed structure with number of parameters

For training and testing the model, we used 6236 Quran verses (Hafs narration), 858 lines of poems, and 5181 Hadith text processed from Sahih Bukhari's book with verified trusted chain of narrations, extracting only the words expressed directly by the prophet PBUH for use for the purpose of this research. For the Hadiths processed, we purposefully avoided text not expressed by the prophet, including narration chain, expression by others, or some quotes of Quran verses.

Each group of Quran and Hadith were each randomized in order, this is so we can avoid bias of results with dominantly long strings at the beginning and dominantly short strings at the end of the dataset.

We trained three different models Net21, Net20, Net19 on 25%, 20%, and 15%, respectively, of total 6236 Quran verses with randomized order of the verses so as to avoid bias of model due to verse length. Similarly, we trained the three models on the same percentage of available text from the Hadiths, and Poems, and then tested each of the models on the residual 75%, 80%, and 85%, respectively, of Quran verses, Hadiths, and Poems. Accurate classification of the three LSTM Models of testing Quran verses was 98.58%, 98.95%, and 83.47% respectively. Accurate Hadith's classification accuracy of the three LSTM Models 98.97%, 99.73%, and 99.59% respectively. Accurate classification of the three LSTM Models for the Poems was 100%, 100%, 100% respectively.

Model Version	% of Quran & Hadith & Poems used for Training	% of Quran & Hadith & Poems used for Testing	Quran Classification % Accuracy	Hadith Classification % Accuracy	Poems Classification % Accuracy	Number of Quran Verses Training	Number of Hadith Training	Number of Poem lines Training	Number of Quran Verses Testing	Number of Hadith Testing	Number of Poem lines Testing
Net 21	25%	75%	98.58%,	98.97%	100%	1559	1295	214	4677	3906	644
Net 20	20%	80%	98.95%,	99.73%,	100%	1247	1036	171	4989	4145	687
Net 19	15%	85%	83.47%	99.59%	100%	935	777	128	5301	4404	730

Table 2 Training / testing size of inputs & accuracy of results of network classification

The following demonstrates the training adaptation of the LSTM network with reduction of error and improvement of classification up to 100% training accuracy and reduction of the error loss cost function.

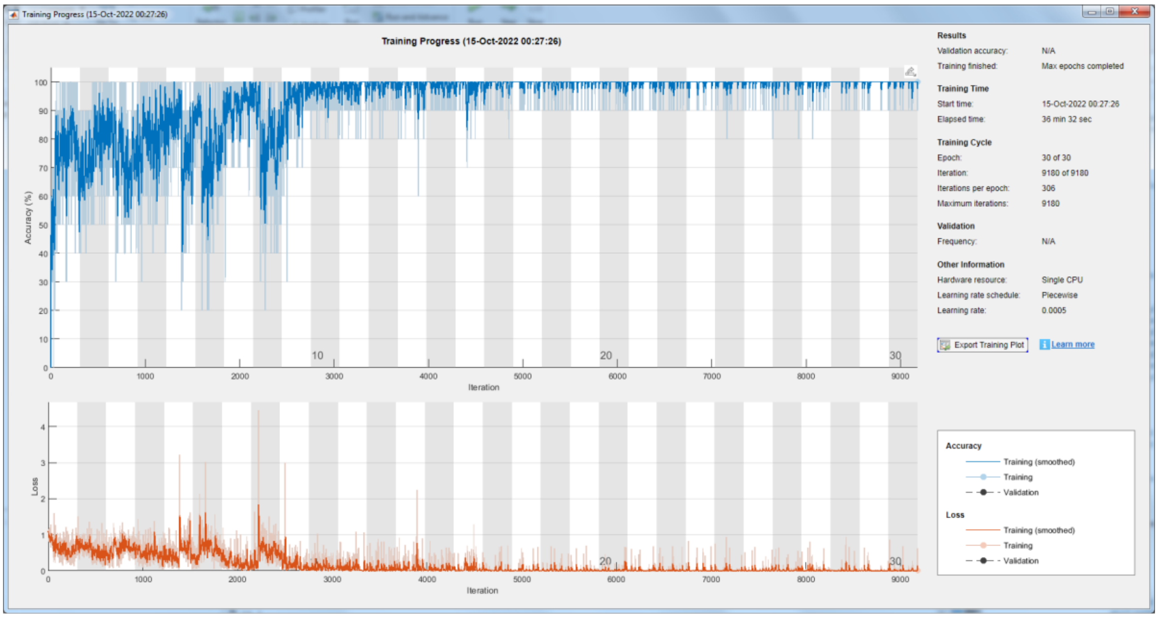

Figure 5. Net21: Training on 25% of the Quran 6236 verses and Bukhari 5181 Hadith & Hanging Poems 858 lines - reached 100% goal in training validation

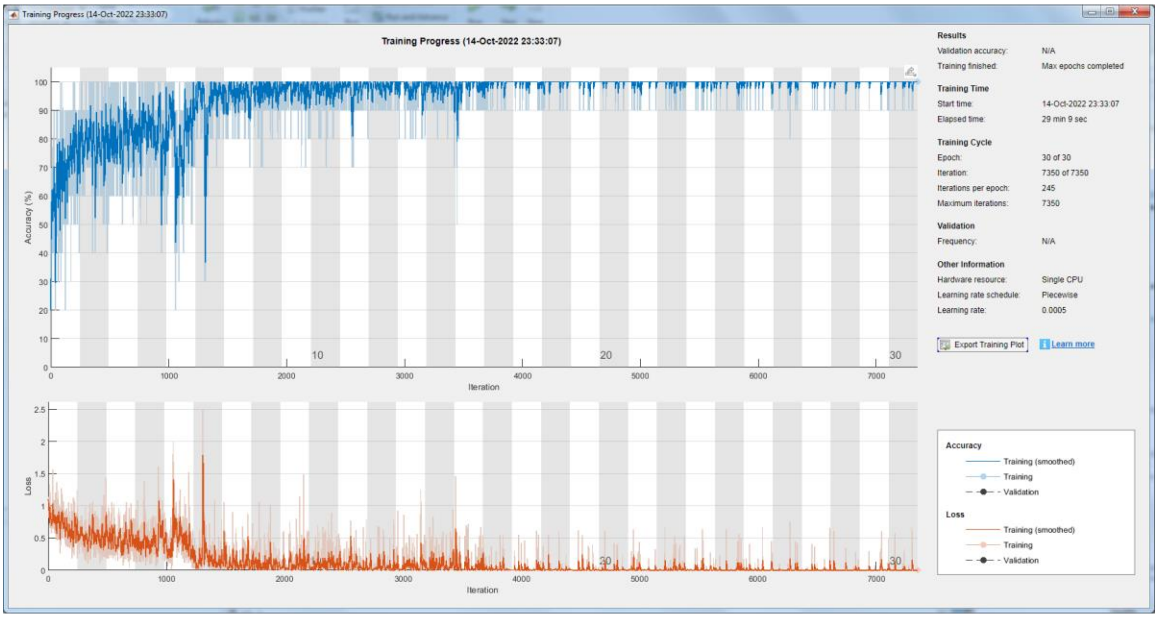

Figure 6. Net20: Training on 20% of the Quran 6236 verses and Bukhari 5181 Hadith & Hanging Poems 858 lines - reached 100% goal in training validation.

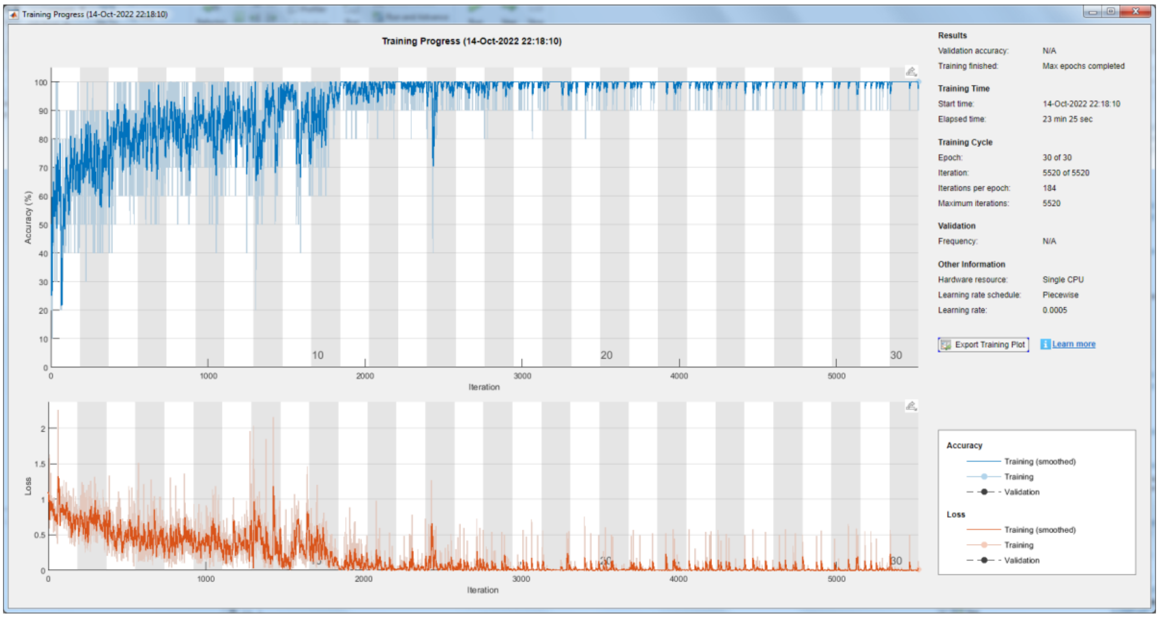

Figure 7. Net19: Training on 15% of the Quran 6236 verses of Bukhari 5181 Hadith & Hanging Poems 858 lines - reached 100% goal in training validation

Results:

Training: 25%
Quran 99.93% Accuracy, N=1559

Testing: 75%
Quran 98.58% Accuracy, N=4677

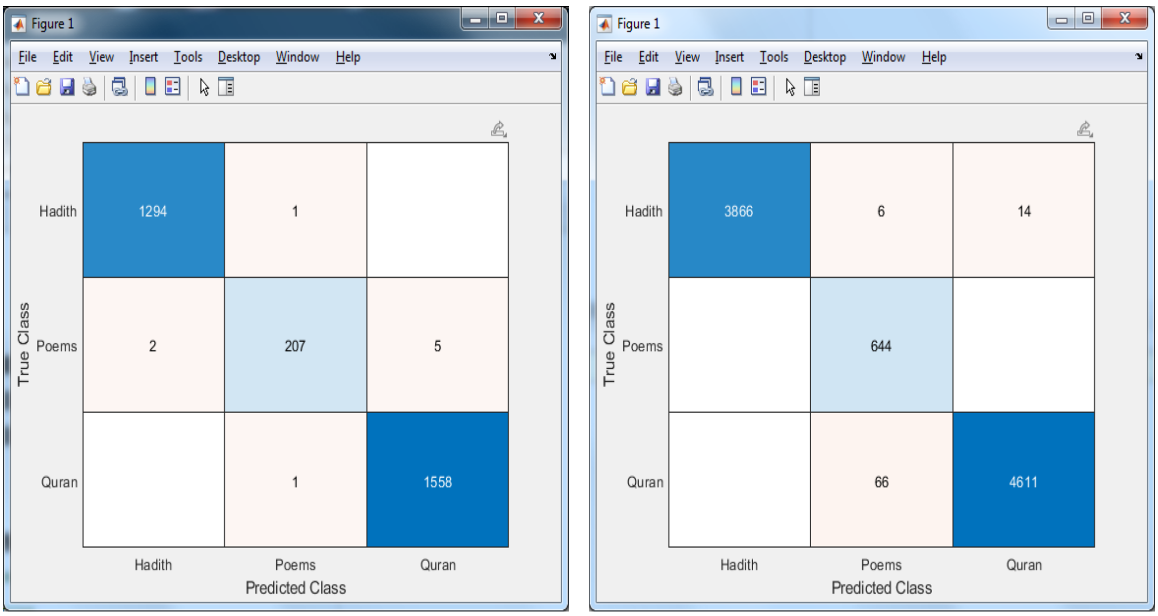

Figure 8. Net21 Training and Testing Results AI Confusion Matrix

Training: 20%
Quran 100% Accuracy, N=1247

Testing: 80%
Quran 98.95% Accuracy, N=4989

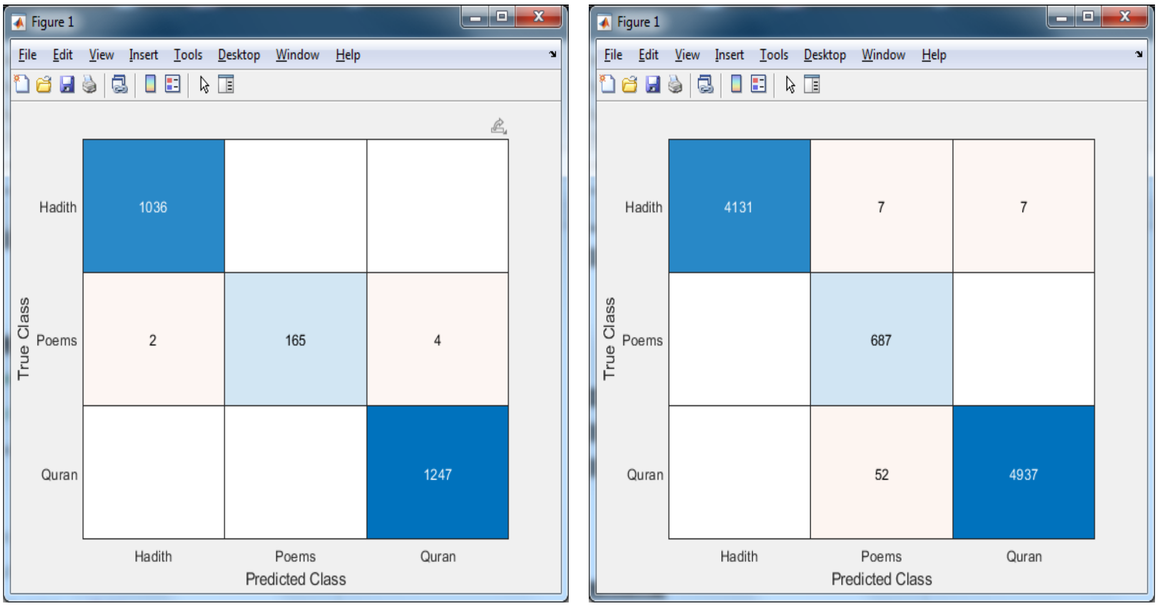

Figure 9. Net20 Training and Testing Results AI Confusion Matrix

Training: 15%
Quran 100% Accuracy, N=935

Testing: 85%
Quran 83.47% Accuracy, N=5301

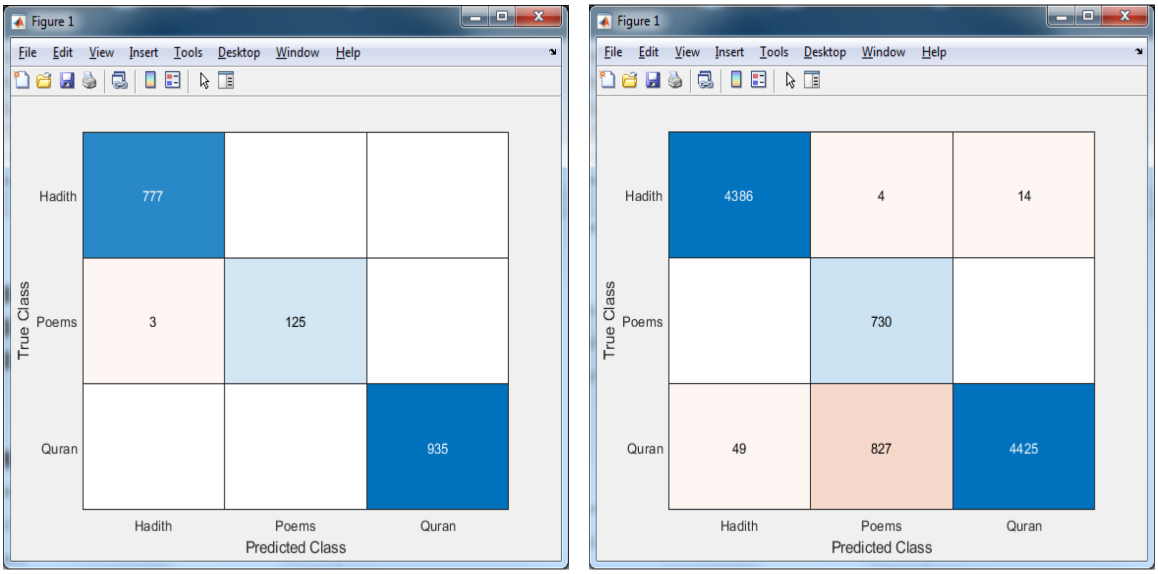

Figure 10. Net19 Training and Testing Results AI Confusion Matrix

Quran / Hadith / Poem confusion results text table can be found in this file link:
https://tinyurl.com/QuranHadithPoemsResults

3. Conclusions

AI deep learning models are typically data hungry requiring large amounts of data for training with wide diversity in the input data and unbiased grouping to ensure fair representation of the input data during training so they can perform adequately during testing. Typically 70-80% of the data is used for training and 20-30% is used for testing. In this research we started with using only 25% of the data used for training and the residual 75% used for testing. Model classification accuracy results were ~99%. Further reduction of training data volume down to 20% did not affect the results accuracy significantly which demonstrates the robustness of the model against information scarcity. However, reduction of training data volume down to 15% starts to demonstrate some sensitivity to training information scarcity, given 3 classes of classification at the output layer: Quran, Hadith, and Poem.

The results also demonstrate the distinct expression style used in poems during the prophet's era in Mecca vs. that of the Quran and vs. the Prophet's Hadith. The poems were identified with 100% classification accuracy, while the Hadith's classification accuracy was >= 99% and the Quran's classification accuracy was >=83%-99%.

Hadiths in the confusion text of net21, net20, and net19 models are a result of shared vocabulary content common in the Quran. Some of the Quran confusion text was a result of Nourani letters characterized by very short sequences of letters and a single word verses. These words resulted in confusion text due to their very short length that is not sufficient to characterize well during classification, and due to the randomized training data set did not including their example during the training phase. These results demonstrate the distinct nature of the expression style of authorship between the Quran, the Hadith, and the Pre-Islamic Poetry leading to the conclusion that they are indeed from uniquely different sources of authorship. This research results provides objective scientific proof that concludes the Quran is not the creation of the Prophet Muhammad (PBUH) but is from a different source, that is the divine source (Allah subhanah).

It also demonstrates that the Prophet's style of expression in his speech in the verified trusted Hadith was not influenced by the Quran. It further demonstrates that the Prophet's style of expression was not influenced by the Poetry style that was common in his era in Mecca where he grew for indeed he is not a poet!. Poetry was identified with strong 100% classification accuracy in the three models, which demonstrate its unique differentiation from the Quran and the Hadith. This research demonstrates that the Quran did not follow the poetic style of expression common in the era of Pre-Islamic Mecca, but rather was distinguished in its own class of expression style that fascinated and attracted people to it as it was different from what they heard before in poetry.

4. Acknowledgements

The author acknowledges the contribution of the following colleagues for development of the database for the Hadith text based on Sahih Bukhari: Mohammad Hmeidi, Alami Ilyas, Zafer Mohyeddin, and Adel Abd Hassen. The author also wishes to thank Dr. Sayoud Halim for providing text resources that helped stimulate early development of this research.

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Author's Biography:

	Mohammad Khair is the CEO of the International Computing Institute for Quran and Islamic Sciences, QuranComputing.org, and is also a medical device Engineer & Director with a Bachelor (1989) and Masters of Science (1991) in Biomedical Engineering from Marquette University, and an Executive MBA from University of Illinois Urbana-Champaign (2007). Also participated in graduate studies towards a PhD (ABD) in Electrical Engineering at Illinois Institute of Technology (1990-1998). Mohammad's research interests are in medical device technologies and algorithms for novel and reliable health diagnostics and therapeutics. Mohammad is currently a Principal Engineer at General Electric Healthcare, with 35+ years experience in his field with top medical device global companies. In addition, Mohammad's interests include development of Quran analytical databases and applications that are enabling for discovery of numeric structures reflecting the precision within the Quran verses. Furthermore, linking of knowledge elements within the Quran and Hadith to enable an improved understanding and insights that complements the linguistic aspects of their content. Also building databases that enables development of Artificial Intelligence applications Large Language Models, and Arabic natural language processing for automated translation. Mohammad has over 65+ patents and patent applications, and 5 scientific journal publications.

Abstract in Arabic

تصنيف الذكاء الصطناعي للتعبير اللغوي بين القرآن، والحديث، والمعلقات الشعرية باستخدام نموذج التعلم العميق (LSTM)

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الخلاصة: عادةً ما تكون نماذج التعلم العميق للذكاء الاصطناعي متعطشة للمعلومات، وتتطلب كميات كبيرة من البيانات للتدريب مع تنوّع كبير في بيانات الإدخال، وتجميع معلوماتي غير متحيز لضمان التمثيل العادل لبيانات الإدخال أثناء التدريب حتى تتمكن الشبكات من أداء التصنيف للمعلومات بشكل مناسب أثناء الاختبار أو الفحص، وعادةً ما يتم استخدام 70–80٪ من البيانات للتدريب، و 20–30٪ للاختبار، وفي هذا البحث بدأنا باستخدام 25٪ فقط من البيانات المستخدمة للتدريب في النموذج الشبكة net21؛ ولفحص مدي حساسية النموذج، واعتماده على كمية المعلومات المتوفرة بالتدريب قمنا بتقليص المعلومات المتاحة للتدريب إلى 20% فقط بالنموذج الشبكة net20، ثم كررنا تقليص المعلومات للتدريب بالنموذج الشبكة net19 إلى 15٪ فقط، وقد أظهرت النتائج أن هذا النوع من النماذج LSTM تتعامل بمرونة مع قلّة المعلومات، ونلاحظ أن نتائج الاختبار لم تتأثر بشكل كبير. تبين نتائج التصنيف عند فحص النصوص أنه تم التعرّف على الشعر بدقة 100% والتعرّف على الحديث بدقة 99% والتعرّف على النص القرآني بدقة 83%–99%. من الأخطاء في تصنيف الحديث كانت نتيجة لأنها تتضَمّن مفردات مشتركة شائعة في القرآن، ومن الأخطاء في تصنيف الآيات للقرآن كانت نتيجة الحروف النورانية (الحروف المقطّعة) التي تتميز بتسلسلات قصيرة جدًا من الأحرف، وآيات من كلمة واحدة، ونتج عن هذه الكلمات خطأ بالتصنيف؛ بسبب طولها القصير جدًا من حرفين، أو ثلاثة الذي لا يكفي للتصنيف الجيد، أو بسبب عدم وجود أمثالها في مجموعة بيانات التدريب أثناء مرحلة التدريب. نستنتج بشكل موضوعي أن هناك اختلافات قوية، وكبيرة في أسلوب التعبير بين القرآن، والحديث النبوي؛ والتي تثبت أن أسلوب التعبير فريد من نوعه ومختلف لهذه النصوص لإختلاف المصدر للنص بين القرآن (من الله سبحانه وتعالى)، والحديث النبوي (من الرسول محمّد صلى الله عليه وسلّم)، والشعر الجاهلي (من شعراء المعلقات العشر). الإختلاف في هذا التصنيف للفئات الثلاثة يتجلى في إختلاف الأسلوب اللغوي في التعبير. وتثبت هذه النتائج البارزة في تطبيق الذكاء الإصطناعي للتعلّم العميق بنماذج LSTM بدليل موضوعي قوي أن القرآن ليس من تأليف النبي محمد – صلى الله عليه وسلم– لأن القرآن مميز بشكل فريد في أسلوبه في التعبير عن أسلوب النبي نفسه في التعبير المقتبس من خلال روايات خطابه في الحديث الصحيح الموثوق الرواية. كما أنه تثبت النتائج أن أسلوب النبي في التعبير لم يتأثر بالأسلوب اللغوي للتعبير في القرآن الكريم. قال الله تعالى " أَمْ يَقُولُونَ افْتَرَىٰهُ ". وتمكنت النماذج الثلاثة من التعرّف على نصوص الشعر بنسبة 100%، مما يؤكد تميّز الشعر في أسلوبه عن نصوص القرآن والحديث. فعند مقارنة النص القرآني بالشعر الجاهلي نرى أنهما متميزان عن بعضهما البعض؛ فالقرآن لا يقلّد أسلوب التعبير في الشعر الجاهلى المكّي بنفس الحقبة الزمنية التي أنزل بها القرآن بمكّة المكرمة. لذلك جذب جماله التعبيري باللغة العربية إهتمام الناس وإعجابهم بما تميّز وإختلف به عن ما كانو يتداولون من لغة وشعر. وكذلك يتبيّن أن الشعر الجاهلي يختلف تماما عن أسلوب الرسول محمد – صلى الله عليه وسلّم– في التعبير؛ حيث إنه لم يتأثر بأسلوب الشعراء في الكلام في حقبة زمنه في مكّة. ونستنتج من مقارنة القرآن بالشعر والحديث بالشعر دليلا يثبت ما قاله الله تعالى–: " وَمَا هُوَ بِقَوْلِ شَاعِرٍ".

الكلمات الجوهرية: التعلم العميق، الذكاء الاصطناعي **LSTM** ، القرآن الكريم، الحديث الشريف، والمعلقات الشعرية، التعبير اللغوي

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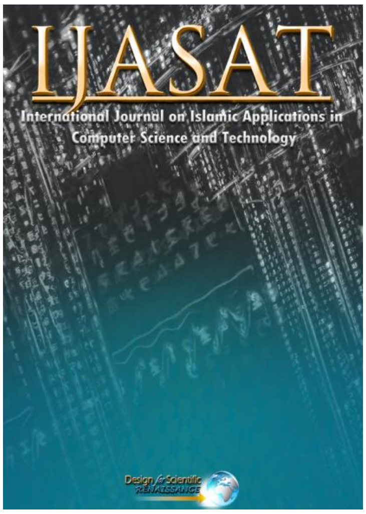

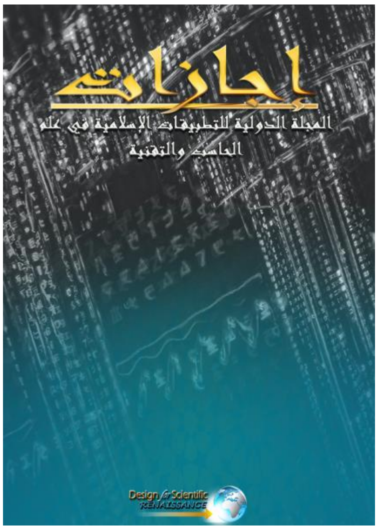

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