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Deep Convolutional Neural Network for Fake News Detection over Online Social Networks

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Abstract

With the proliferation of Online Social Networks (OSNs), people of all walks of life are able to have instant sharing of information and opinions. Thus they became virtual platforms for exchanging views and making friends. The news shared over social media helps in understanding various aspects. They also come in the form of reviews or product or service news that will help people in making well informed decisions. As people are increasingly relying on social media to ascertain knowledge of products or services, the news over social media needs to be genuine. Unfortunately, it is observed that there are some fake news articles or reviews over OSNs. Unless, such news is identified and eliminated, it will cause people in making wrong decisions. They influence of fake news on people will defeater the purpose of social media content. The existing machine learning algorithms used for fake news detection provide a great deal of advantages in detection of fake news. However, they suffer from deterioration of performance due to lack of multiple layers of training. This is achieved by deep learning techniques. In this paper, a deep Convolutional Neural Network (CNN) is used for prediction of fake news. An algorithm known as Deep Fake News Detection (DFND) is proposed and implemented. A prototype application is built using Python data science platform to show the utility of the proposed system. The empirical results of the proposed system are compared with that of existing ones.

Keywords – Deep Learning, Convolutional Neural Network, Fake News Detection Deep Fake News Detection Algorithm

1. INTRODUCTION

As people are increasingly relying on social media to ascertain knowledge of products or services, the news over social media needs to be genuine. Unfortunately, it is observed that there are some fake news articles or reviews over OSNs. Unless, such news is identified and eliminated, it will cause people in making wrong decisions. They influence of fake news on people will defeater the purpose of social media content. News articles provide valuable information as the day to day happenings are covered. This information is useful to people to understand the present situation and make decisions from it. With social media, this phenomenon has become indispensable and people rely on it. Provided this fact, it is essential that the news is reliable and useful. However, the recent incidents prove that there are people spreading fake news to benefit their organizations or services. Keeping this in mind, it is essential to identify and eliminate fake news from social media. Thus people can use the news reliably and their decisions are based on valid information.

The existing machine learning algorithms used for fake news detection provide a great deal of advantages in detection of fake news. However, they suffer from deterioration of performance due to lack of multiple layers of training. From the literature, it is understood that the deep learning models need further optimization and ideal configurations in order to improve accuracy in fake news detection. Our contributions of this paper are as follows.

1. An algorithm is defined using advanced CNN for detection of fake news.
2. A strong pre-processing module is implemented in order to improve performance.
3. An application is built to validate the system and find the performance advantages.

The remainder of the paper is structured as follows. Section 2 reviews literature on fake news detection research. Section 3 provides the proposed system and its details. Section 4 presents experimental results. Section 5 concludes the research gives directions for the future work.

2. RELATED WORK

This section reviews literature on existing methods used for fake news detection. Westerman et al. [1] proposed a technique to find credibility of information over social media. It finds whether given information is credible and its probability. Rubin et al. [2] studied the concept of deception detection and investigated on three kinds of fakes in the news items over Internet. Fake information is also found through malicious advertisements. Chen et al. [3] on the other hand used news items and investigated on the need for an approach for automatic crap detector. Masri et al. [4] proposed an automated methodology in order to detect

malicious advertisements. Qbeitah and Aldwairi [5] explored detection of malicious content that comes in the form of mails. They used NLP approaches and machine learning in order to detect it. Pogue [6] illustrated mechanisms useful for stamping out fake news so as to filter them. Konagala and Bano [7] used deep learning methods use supervised learning approach for fake news detection. Balmas [8] defined methods to detect fake news from real and detected different political attitudes in the news spread by certain quarters. Aldwairi et al. [9] focused on malicious URLs that are spread over Internet.

Aldwairi et al. [10] used machine learning techniques to detect attacks that propagate malicious contents. Messabi et al. [11] investigated DNS records along with domain name features in order to detect malware propagation. Abu-Nimeh et al. [12] investigated on spam posts and malicious news over social media. They proposed methods to detect such news items. Brewer et al. [13] investigated on the impact of real news that talks about fake news. Monti et al. [14] proposed a deep learning method based on Geometric deep learning to detect fake news. Qawasmeh et al. [15] proposed a deep learning based framework to detect fake news automatically. Sahoo and Guppta [16] used multiple feature based deep learning approach for fake news detection. From the literature, it is understood that the deep learning models need further optimization and ideal configurations in order to improve accuracy in fake news detection.

3. PROPOSED METHODOLOGY

The proposed fake news detection framework is described here. The framework illustrates the flow of operations in the process of detecting fake news collected from social media. The dataset collected is subjected to segmentation to divide the data into 80% training, 10% testing and 10% for validation. The training data which has class labels is used for training the machine learning model Naive Bayes, deep learning model CNN and the proposed model known as CNN advanced model. After the training a model is created with knowledge meant for fake news detection.

3.1 The Framework

The knowledge gained from training is used to know whether news items in the testing data are fake or not fake news. Overview of the framework is shown in Figure 1.

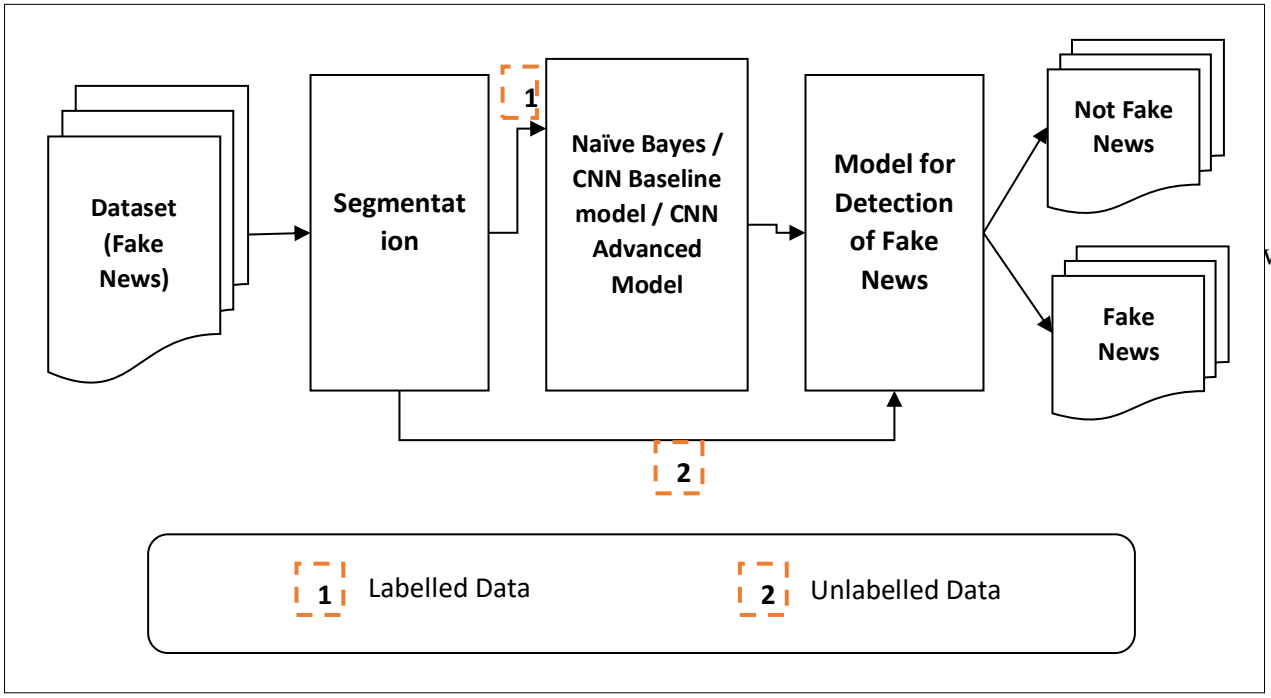
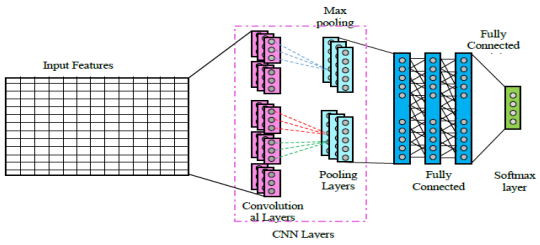


Figure 1: Illustrates the overview of the methodology

Before using data, there is pre-processing of



data that performs NLP procedures such as stop word removal, stemming, etc. It also makes use of Google's word2vec embedding's model for better vectorization of data. Thus it becomes easy to extract and compare features in order to determine whether a new item is fake or not. Pickle standard is used to serialize model for persistence and later reuse it. Figure 2 shows the underlying process in deep learning with convolutional and maxpooling layers.

w of CNN

The input features are taken after pre-processing where NLP and Google's word2vec vectorization process are involved are taken by CNN model. For each filter size convolutional and max pool layers are created and tanh is used as activation function. The convolutional layers are used to learn from data while subsampling is carried out by the max pool layers. The outputs are finally associated with fully connected and softmax layers prior to detection outcomes and performance evaluation results.

3.2 Proposed Algorithm

An algorithm named Deep CNN based Fake New Detection (DCNN-FND) is defined and implemented for improving performance of fake news detection.

Algorithm: Deep CNN based Fake New Detection (DCNN-FND)

Inputs: Fake news dataset D (from [15])

Output: Detection of fake news (labelling unlabelled training data)

1. Start
2. Initialize output vector R
3. (TrData, TestData) ← Segmentation(D)
4. D' = PreProcess(TrData)
5. Configure convolutional layers
6. Configure max pool layers
7. Configure activation function
8. Combine outputs
9. Add dropouts
10. Configure softmax layer for final scores
11. R← GetFinalPredictions(TestData, model)
12. Compute accuracy
13. Compute loss function
14. Return R
15. End

Algorithm 1: DCNN-FND algorithm

As presented in the algorithm 1, the DCNN-FND is defined with different instructions. It takes Koggle dataset as input and produces predictions and also performance outcomes. It has different layers configured in order to realize the CNN advanced model.

3.3 Evaluation Methodology

Performance of the proposed framework is evaluated based on the confusion matrix and the underlying measures.

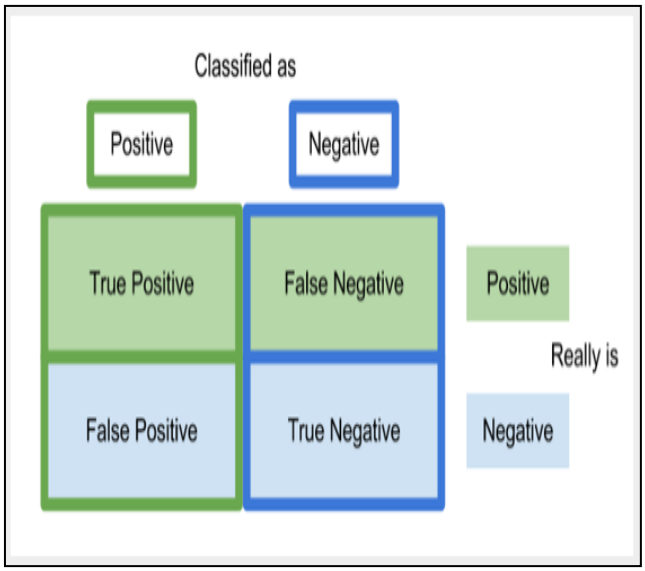


Figure 3: Illustrates confusion matrix

Performance evaluation is carried out using confusion matrix provided in Figure 3 that is basis for computing model accuracy. The accuracy computed is based on the number of true positives, true negatives, false positives and false negatives exhibited by the prediction models evaluated (Naïve Bayes, CNN, CNN advanced model (DCNN-FND)). Eq. 1 shows the way accuracy is computed.

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \quad (1)$$

The proposed framework implemented using Python data science platform, evaluated for its performance and compared with many existing

techniques. The results revealed that the DCNN-FND shows better performance over the state of the art.

4. EXPERIMENTAL RESULTS

4.1 Results of Baseline CNN

CNN model is employed to detect fake news initially. The baseline model is the default model that is not optimized for given solution. The performance of the baseline algorithm is provided in this section.

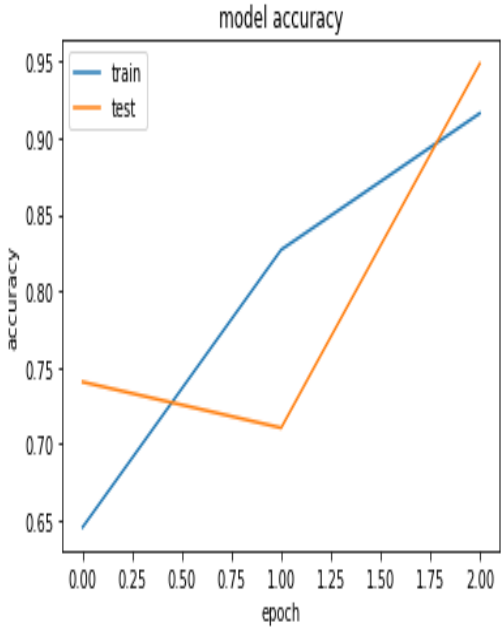


Figure 4: Shows accuracy of baseline model

Figure 4 shows the train and test accuracy against number of epochs. As the epochs is increased, it revealed increased train and test accuracy.

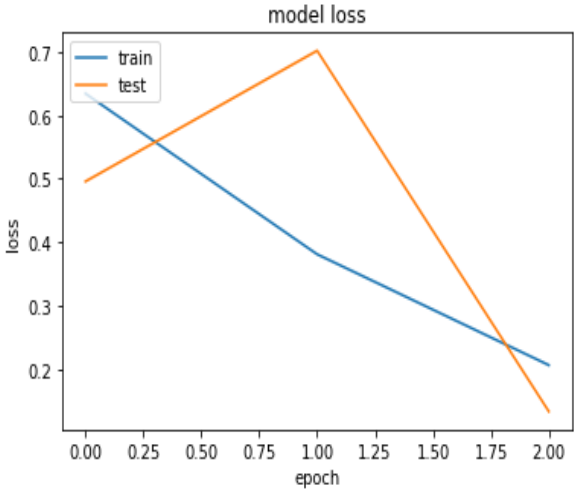


Figure 5: Shows model loss associated CNN baseline

Figure 5 shows the model loss with respect to both training and testing. As the number of epochs is increased, the model loss is gradually reduced.

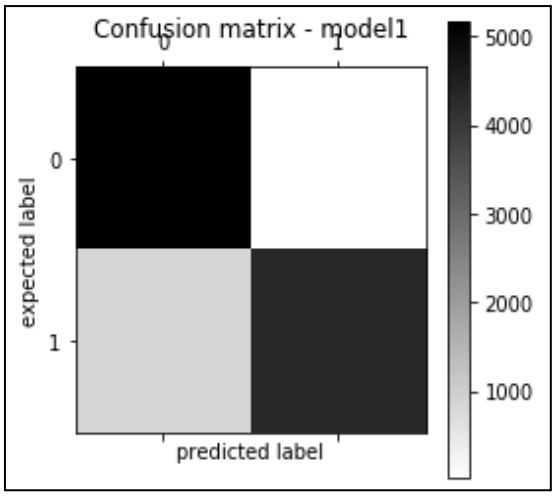


Figure 6: CNN model's confusion matrix

Figure 6 shows the measures needed to understand performance in the form of confusion matrix. It is the basis for different performance metrics to ascertain the enhancement in prediction accuracy when deep models are used.

4.2 Results Advanced CNN Model

CNN advanced model is the one which is suitably configured to perform better in the fake news detection.

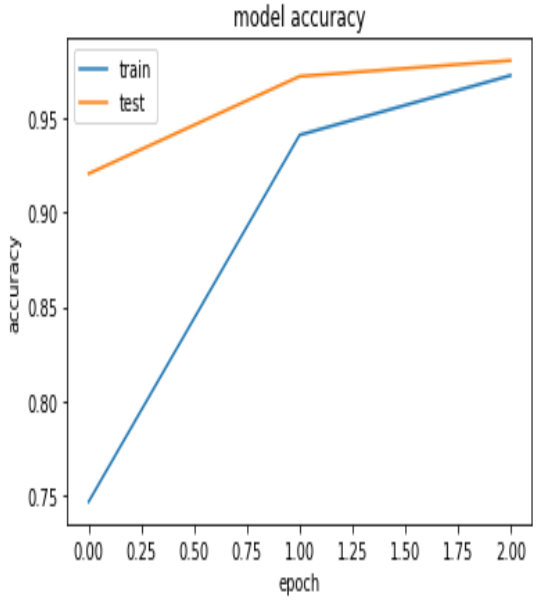


Figure 7: CNN advanced model's accuracy

Figure 7 shows the accuracy performance of CNN model with advanced configurations. Both training and testing related accuracy metrics are visualized. It is understood that the three is increase in accuracy when there is increase in number of epochs.

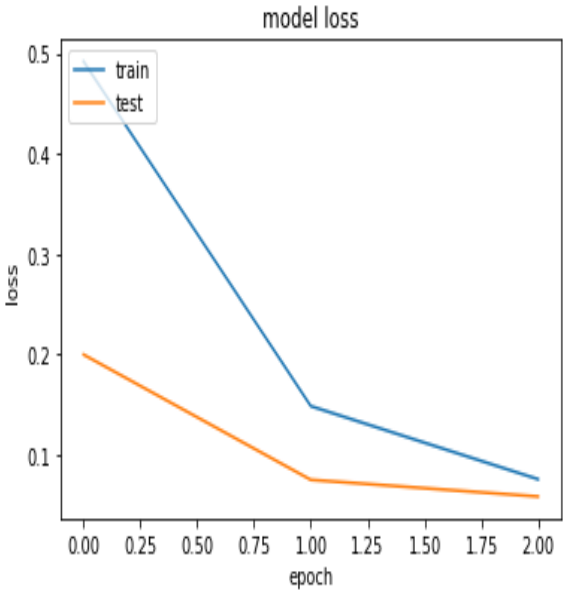


Figure 8: Performance of CNN advance model in terms of model loss

Figure 8 shows the performance of the advanced CNN model in terms of model loss that reflects both training and testing.

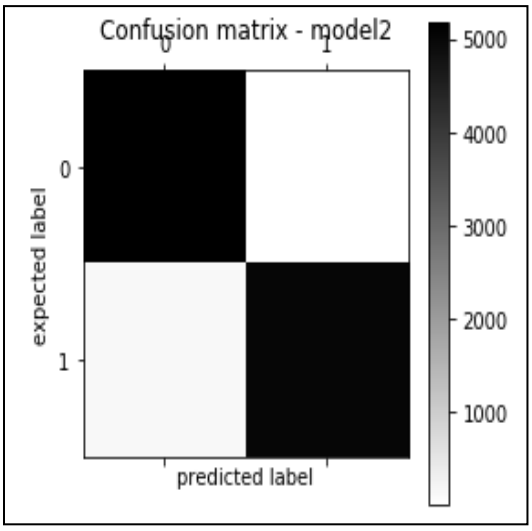


Figure 9: Measures for CNN advance model

Figure 9 presents the measures that can be used to know performance in the form of confusion matrix. It is used to derive different metrics that are

useful in machine learning to ascertain performance of prediction models.

4.3 Performance Comparison

This section provides performance comparison among different models such as CNN baseline and advanced models and machine learning algorithm known as Naïve Bayes. The number of test samples used for per performance evaluation for both the models is 10400 instances. The CNN model predicted 9516 correctly with model accuracy shown as 0.9150 while CNN advanced model shows 0.9835 accuracy with 10229 instances correct predicted.

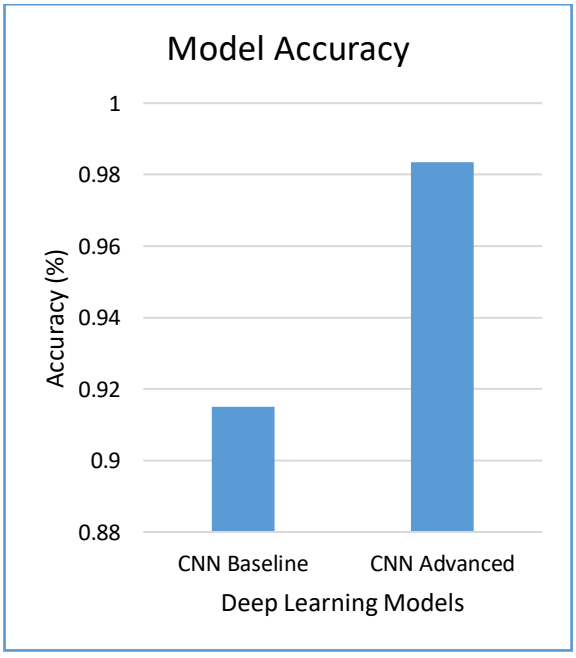


Figure 10: Performance details

Figure 10 shows the two deep learning models and the performance in terms of accuracy. The accuracy of the advanced model is found to be better significantly when compared with the baseline model. When the performance is compared with machine learning model known as Naïve Bayes, the deep models showed high performance. For instance, CNN model's accuracy is 0.9150 that is better than 0.8997 exhibited by Naïve Bayes. The CNN advanced model showed the accuracy 0.9835 which is better than the baseline model.

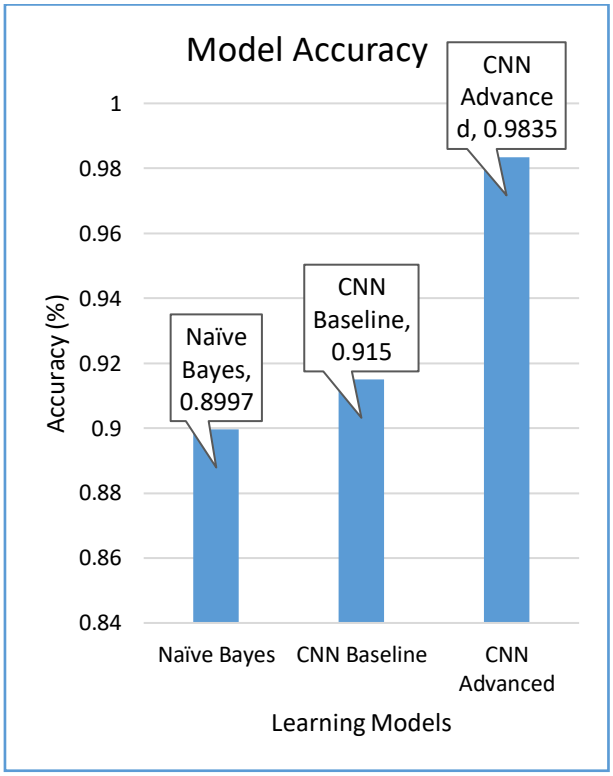


Figure 11: Prediction models with accuracy comparison

Figure 11 shows accuracy comparison among fake news prediction models. The results show that the deep models are better than traditional models. And the CNN advanced model is found better than its baseline counterpart.

5. CONCLUSION AND FUTURE WORK

In this thesis CNN advanced model with an underlying algorithm known as Deep CNN based Fake New Detection (DCNN-FND) which exploits deep Convolutional Neural Network (CNN) and novel pre-processing mechanism with Natural Language Processing (NLP) is proposed and implemented. The algorithm is compared with baseline CNN model and traditional machine learning model known as Naïve Bayes. Koggle dataset is used for evaluation the proposed model. The news dataset is subjected pre-processing with NLP methods and word embedding. The DCNN-FND, CNN and Naïve Bayes are used as fake new detection models for performance comparison. The results revealed that the DCNN-FND shows better performance over the state of the art. DCNN-FND showed highest performance with 0.9835 accuracy while CNN baseline model showed 0.9150 accuracy and Naïve Bayes 0.8997. In future, we use transfer learning methods to improve performance of DCNN-FND further.

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