

A Hybrid Model for Fake News Detection Using Deep Learning

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Abstract— Fake news detection on internet is very challenging task yet. Fake news has real-world social and political impacts so it becomes the very interesting and highly motivated field in research. The fake news agreed upon two characteristics: the text of news article, the source of news. The traditional methods like TFIDF and n-grams methods do not able to detect the fake news effectively. In this work, we proposed a new deep learning hybrid model that combines these two characteristics for fake news detection. This model consists two different deep learning models, one is convolutional neural network and other is multilayer perceptron. CNN is applied on news articles, GLoVe word vector is used for word embedding and multilayer perceptron model is applied on the speaker profiles credit history. Credit history consists of historical record of truth statement for a speaker. Both the models are then concatenated. This proposed model achieved high accuracy, tested on LIAR fake news dataset as compared to existing models.

Keywords—Convolutional neural network, multilayer perceptron, deep learning, GLoVe, word embedding, TFIDF, n-gram, relu

I. INTRODUCTION

Fake news is a type of propagandas that consists of misinformation spreads over the online social platforms such as twitter, facebook, instagram etc. Due to increasing the social media platforms very rapidly, there are large amount of data textual data spreading over the social media. But it is difficult to define the fake news, most probably definition of fake news, a made-up story with an intention to befool. Therefore, analyzing the truthfulness of these textual data becomes the interesting topic in the field of research. Now a day's measuring precision and trustworthiness in text are well-studied topics in disciplines from psychology to journalism [1], [2], [3]. As the world has been moving toward the online platforms, it is necessary to know the truthfulness of news articles on the internet because it has tremendous impact on the social and political environment. For example, in past presidential election of US, the world saw that how fake news was spread on the internet. Political parties were claimed to each other for spreading the fake news to divert the voters. The impact of fake news seems to have real life panic. After the presidential election of US, the Facebook's CEO Mark Zuckerberg, issued a public statement that refusing that the Facebook had the any role on the election result outcome.

Now, all online media outlets like Facebook have started to develop technologies to detect fake news and to stop this content spreading over the online outlet.

A related problems on deception detection [4], is also a natural language processing problem. A recently work on deception detection [5], concentrates on the deception detection on user's review.

II. RELATED WORKS

The analysis of fake news is very challenging task now a days and detection of fake news has become the active domain in research on social media and other online platforms. We review some of the latest published work going on fake news and deception exposure using machine learning and deep learning techniques. In [6], the author presents a simple Naive Bayes classifier for fake news detection. All the words presented in the news articles are treated as independent word, it is not affected by the context of the word being used. The dataset is collected for this experiment from the Facebook's posts. The results show that simple machine learning can be improved by applying new feature extraction techniques for better results to detect the fake news articles on the internet. In [7], the paper examines Term Frequency-Inverted Document Frequency and n-gram techniques as the feature extraction methods and applies several machine learning algorithms on news articles. The TF-IDF features extraction with linear support vector machine model outperforms for fake news detection. In [8], the author developed four neural network models for fake news challenge (FNC-1) that is a competition for fake news detection. Two recurrent neural networks and two feed-forward networks are developed. After 100 experiments with different architectures and parameters tuning, the bag-of-words with three-layer multi-layer perceptron (BoW MLP) was shown the best model among all the models In [9], the author presents LIAR: dataset for fake news detection. The dataset collected from POLITIFACT.COM, and this dataset hold 12886 labeled statements in dissimilar contexts. Which supply analysis report and links to source documents. They have designed a new hybrid convolutional neural network which concatenates two different convolutional neural networks, one for text and other for metadata to final class prediction. They have shown that the hybrid approach can improve a text-only CNN model.

In [10], a fresh focus-based For the purpose of identifying bogus news, the LSTM model will use speaker profiles. The speaker profile is used in two ways in this model one for attention based model and other for topic information. This hybrid model, which combines two LSTM models, uses presenter profiles from the attention model, including speaker title, location, and party affiliation. For subject information for the news clauses, the speaker profile is employed, and both LSTM models are combined with soft-max activation for final sorting. The hybrid model outperformed the regular fake news detection dataset by 14.5%, according to the results.

We have reviewed several publications that described the methods for fake news detection. The numbers of methods are used for features extraction used in different models. However none of the models used the convolutional neural networks (CNN) with multilayer perceptron (MLP). We hypothesized that by concatenating the convolutional neural networks (CNN) with multilayer perceptron (MLP) can yield the better results.

III. PROPOSED MODEL

We used two different classifier that effectively works together to classify the fake news. Our proposed model used CNN model as text only classifier and a multilayer perceptron model is applied on the metadata of news articles. A convolutional neural network model takes the input in vector form either in 1D vector or in 2D vector. So it is necessary to represent the every news articles in vector form as shown in figure 1. So before feeding the raw text to the network, we need to represent each sample to a sequence of words. Neural network trained in batches of samples therefore it is necessary to represent every sample to same length of words by padding the zero. The first layer of convolutional neural network is an embedding layer which represents each word to a dimensional (between 50- 300) vector. Word embedding technique is highly effective for text classification problem. We used pre-trained word vector that is GLoVe [11] word vector to build the embedding layer .GLoVe word vector is trained over 400000 words. If any word is not found in GLoVe, we initialized the vector form similar words.

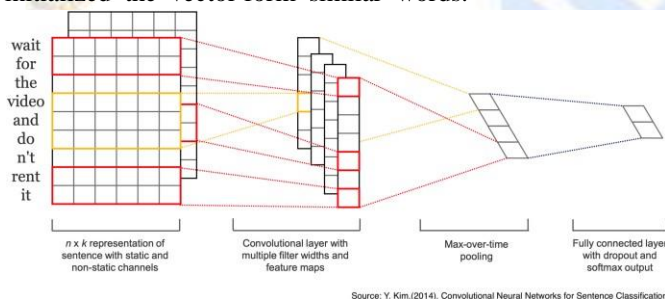


Figure 1

Figure 1 shows the text based convolutional neural network architecture proposed in [12].

Let N be a collection of news and S be a collection of speaker profile. A news $n_k, n_k \in N$ includes both its news articles as text sentence denoted by t_k and a speaker profile s_k . Every text sentence is a sequence of words $t_k = w_{k1}, w_{k2}, w_{k3} \dots w_{k|t_k}$, where $|t_k$ is the length of sentence t_k . Every word $w_k \in t_k$ is represented

by the vector of length V. A speaker's profile's credit history is represented by h_{sk} .

Every $w_k \in t_k$ is feed into the simple convolutional neural network model and every $h_{sk} \in s_k$ feed into the multilayer perceptron model. For the final classification, the outputs of both models are then combined with a soft-max activation task. A sentence of length L (after padded if necessary) is represented as

$$W_{1:L} = w_1 \oplus w_2 \oplus \dots \oplus w_L,$$

Where \oplus is an concatenation operator. A filter F is used in a convolutional procedure, This creates a new feature when it is applied to a window of x words. A feature c_i is generated form a window of words $w_{L:L+x-1}$ by

$$C_i = f(F \cdot w_{L:L+x-1} + b)$$

Where b is bias term and f is non linear activation function such as relu or any other. This filter is applied to each possible window of words in the news article sentence which produce the feature map. A max-pool operation is also applied on the feature map and selects the highest possible value for the characteristic associated with this filter. Max-pool operation reduced the feature map and take only maximum values. By this process one feature is generated by one filter. We can use multiple filters to produced large number of features from same window size filters. In text classification by CNN model, we can use bi-gram, tri-gram, four-gram up to n gram filters to produce the feature map. After all the features is extracted, a flatten layer is used followed by a fully connected layer (dense layer).

The credit history of speaker's profile is represented by h_{sk} , each have total five attributes. Therefore multilayer perceptron model have five input nodes and can have different number of hidden layers as well as hidden layer's nodes followed by a dense layer. Both the model uses the backpropagation algorithm for training.

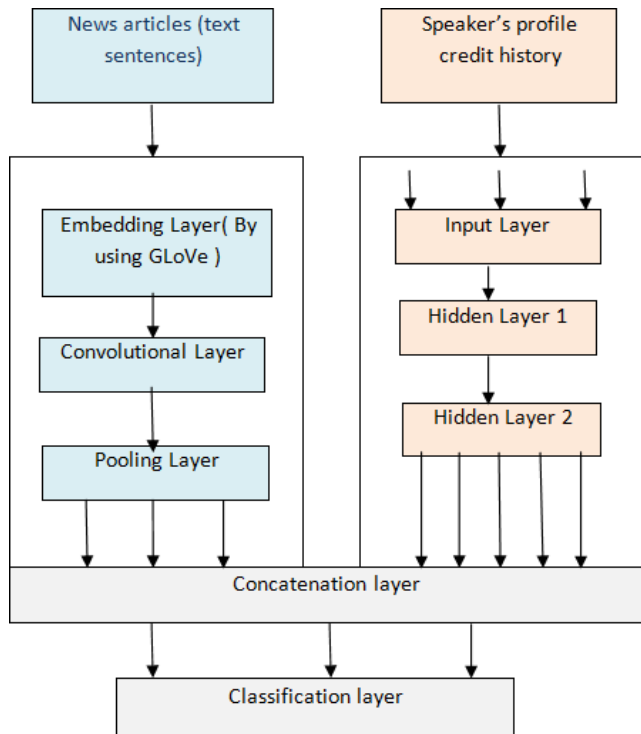


Figure 2

The figure 2 shows the architecture of hybrid model. Note that the first model is CNN model for news articles and the second model is multilayer perceptron model for speaker's profile credit history. Then these two models are concatenated, a softmax activation function is applied before final classification of news articles.

IV. EXPERIMENT DESIGN

The model evaluations are performed on the LIAR dataset for fake news detection by Wang [2017]. This dataset contains the 12836 instances on 141 topics from POLTIFCT.COM. Each instance includes the wording sentence that is news article and related meta-data that is topic, speaker profile. Speaker profiles contains speaker name, current job, location of job, party affiliation, title and credit history. There are six labels in this dataset such as pants on fire, fake, barely-true, half-true, mostly-true and true. The credit history of speaker profile includes the past report of incorrect statements for all speaker. The table 1 shows the information of LIAR dataset.

The LIAR dataset statistics.	
Training set size	10,269
Validation set size	1,284
Testing set size	1,283
Avg. statement length (tokens)	17.90
Pants on fire	1050
False	2511
Barely-true	2108

Half-true	2638
Mostly-true	2466
True	2063

Table 1

The performance of five baseline models are shown in Table 2 including regularized logistic regression classifier (LR), support vector machine [13], a bi-directional LSTM networks model [14], [15], a convolutional neural network model [12], hybrid convolutional neural network [9], and a new speaker's profile attention based model [10].

Models	Valid	Test
Majority	0.204	0.208
Logistic regression	0.257	0.247
SVMs	0.258	0.255
Bi-LSTM	0.223	0.233
CNN(kim)	0.260	0.270
CNN(wang)	0.277	0.274
LSTM(attention)	0.407	0.415

Table 2

In proposed hybrid model, before feeding the raw text into network there is lot of preprocessing is done CNN model is used to classify the text. There are number of way to choose the parameter in CNN text classification. We have four GloVe word-vectors that is 50 dimensions, 100 dimensions, 200 dimensions and 300 dimension. We have tuned the parameter to get the highly efficient model parameters. There are number of ways to extract the features from text data. We can use bi-gram filter, tri-gram filter and so on. In this experiment, we have used all the subset up to 5-gram filters. In bi-gram filter, two words are taken together for feature extraction. We extract 512 features for different size of filters that is bi-gram, tri-gram and so on. The multilayer perceptron architecture has two hidden layers each of having 80 nodes and relu activation function is used as non-linear activation function. The architecture is implemented in python programming language. Keras deep learning library with tensorflow as backend is used to implement the combination of convolutional neural network and multilayer perceptron architecture. The table 3 shows the evaluation on accuracy using different combination of filters.

Filter size	Validation	Test
(2,3)	45.72	44.35
(2,4)	46.50	42.01
(2,5)	46.88	44.27
(3,4)	46.35	42.93
(3,5)	47.12	45.30
(4,5)	46.73	43.56
(2,3,4)	47.35	44.27
(2,3,5)	47.27	44.59
(2,4,5)	44.47	42.77
(3,4,5)	47.35	45.30

(2,3,4,5) 45.64 44.19

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Table 3

The table 3 has shown the results of model by using the 50 dimensions word vector. The top performers on 50D word vectors are also tested on the 100D, 200D and 300D GLoVe word vector. Table 4 shows the testing accuracy on different dimensions word vector.

Filter size	100D	200D	300D
(3,5)	46.96	45.46	44.27
(2,3,4)	42.46	43.25	44.43
(2,3,5)	42.85	42.06	44.59
(3,4,5)	43.25	43.88	42.54

Table 4

The result shows that the hybrid model that is combination of CNN and MLP yields the better results as compared to previous models. The result shows that tri-gram and four-gram feature extraction have high validation and testing accuracy on 50D word vector that is 47.12% and 45.30% respectively. These filters also have best results on 100D and 200D word vector with accuracy 46.35% and 45.30% respectively.

CONCLUSION

A new hybrid approach for fake news identification was developed in the paper. This model includes speaker profiles credit history, which can help identify bogus news. The experiment shows that the combination of a convolutional neural network and multilayer perceptron architecture is highly efficient architecture. This work shows that speaker profile plays an important role with news articles posted on internet for fake news detection. In future, this model can be improved by considering all other attributes present in the dataset. We can also combine two or more different models in efficient way.

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