



“Detecting COVID-19 Fake News: An Optimized Deep Learning Approach”

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ABSTRACT

The COVID-19 pandemic has been accompanied by an "infodemic" of fake news. This widespread misinformation poses a serious threat to public health. This paper proposes an optimized deep learning model for identifying COVID-19-related fake news. The model leverages a combination of convolutional neural networks (CNNs) and long short-term memory (LSTM) networks, along with optimization techniques to differentiate between real and fake news. By combining these elements, the proposed model achieves superior performance in detecting COVID-19-related misinformation, paving the way for a more informed and healthier public discourse.

Keywords: Convolutional Neural Networks (CNNs); Long Short-Term Memory (LSTM) networks; COVID-19; Fake News;

I. INTRODUCTION

The COVID-19 pandemic's impact transcended the realm of physical health. Alongside the virus, a flood of misinformation, often referred to as an "infodemic" by the World Health Organization (WHO), threatened public health efforts. This widespread fake news caused confusion, hindered people from following critical public health guidelines, and eroded trust in legitimate sources of information.

The ability to automatically detect fake news is crucial for mitigating its harmful effects. Traditional methods often rely on keyword matching or rule-based systems, which can be easily bypassed by evolving tactics used to spread misinformation. Here's where deep learning comes in.

Deep learning offers a powerful set of tools for analyzing vast amounts of text data. These techniques excel at identifying complex patterns and relationships within language, making them well-suited for the task of distinguishing real news from fabricated content.

This research proposes a deep learning model specifically designed to address the challenge of detecting COVID-19 fake news. This model goes beyond generic fake news detection by incorporating the unique characteristics of COVID-19-related information.

Here's a deeper dive into why this research is important:

- **The Urgency of the Problem:** COVID-19 fake news can have severe consequences. False information about treatments, preventative measures, and the severity of the virus can lead to people making dangerous choices that endanger themselves and others.
- **Limitations of Traditional Methods:** Existing methods for detecting fake news often struggle to adapt to the ever-evolving tactics used by those who spread misinformation. Deep learning offers a more flexible and adaptable approach.
- **Specificity of COVID-19 Information:** Fake news related to COVID-19 often uses specific terminology, medical jargon, and references to current events. A model trained on a corpus of COVID-19 information can potentially achieve higher accuracy in this domain compared to a generic fake news detection model.

This detailed introduction sets the stage for the rest of the paper. It highlights the critical nature of the problem, the limitations of existing solutions, and the potential benefits of using a deep learning model specifically designed for COVID-19 fake news detection.

II. RELATED WORK

In addition to the above works, scientists have also been trying to discover AI related techniques to deal with 'infodemic' of misinformation related to the COVID-19 pandemic. Several studies have explored Convolutional Neural Networks (CNNs) for COVID-19 fake news detection. O.D. Apuke et al. [1] achieved promising results with a CNN model that leveraged word embedding to capture semantic relationships within text data. Their model achieved high accuracy in identifying fake news articles related to COVID-19. Studies like Gupta et al. [2] explore the potential of attention mechanisms within deep learning models for fake news detection. Attention mechanisms allow the model to focus on crucial parts of the text data, such as specific keywords or phrases that might be indicative of fake news. This can be particularly beneficial for identifying COVID-19 fake news that relies on manipulating medical terminology. In their 2022 research, Dutta et al. [3] presented a hybrid deep learning classification model aimed at identifying and categorizing fake news and misleading content within the "COVID-19 Fake News Dataset" sourced from Mendeley, consisting of articles and web content related to COVID-19. Their model achieved an accuracy of 75.34%, outperforming existing LSTM and BiLSTM techniques. This highlights the effectiveness of their model in autonomously and accurately distinguishing between genuine and false information surrounding the COVID-19 pandemic. In contrast, Kaliyar et al. [4] proposed a distinct approach to fake news detection, opting for a pre-trained word embedding (Glove) combined with a Convolutional Neural Network (CNN), rather than TF-IDF and traditional machine learning algorithms. [5] Li S. explored the content of COVID-19 fake news, from hoax cures to vaccine conspiracies, eroded trust in real sources (established news outlets) and endangered public health. This analysis dissects fake news content based on strict definitions: true news comes from well-regarded outlets with fact-checking, while fake news originates from known misinformation websites.

S. Gundapu and R. Mamidi [6] explained the rapid spread of fake news can exacerbate public panic and confusion during crises. The proposed method analyzes the trustworthiness of COVID-19 information shared on social media. They presented a highly effective approach leveraging an ensemble of three powerful transformer models: BERT, ALBERT, and XLNET. This ensemble model was trained and tested on the ConstraintAI 2021 shared task for COVID-19 Fake News Detection in English. Notably, this system achieved a remarkable F1-score of 0.9855 on the test set, ranking 5th out of 160 participating teams. [7] investigates deep learning models for detecting COVID-19 fake news. This analysis demonstrates that a fine-tuned BERT model with frozen parameters coupled with BiLSTM layers achieves superior performance on this task. This approach surpasses previous benchmarks in COVID-19 fake news detection. Furthermore, they explored methods to evaluate the impact of keywords on their best model's performance. This analysis delves into the role of specific language patterns in fake news and paves the way for further refinement of detection methods. [8] proposed review (N=97) explores the explosion of fake COVID-19 news in 2021. It investigates who spreads misinformation and why (motives & demographics), how AI tools are used to detect and combat it, and the most common fake news themes circulating that year.

Karimi et al. [9] has proposed a groundbreaking framework for automatic fake news detection, specifically targeting COVID-19 misinformation. The Multi-Source Multi-Class Fake News Detection framework eliminates the need for manually crafted features. Instead, it leverages Convolutional Neural Networks (CNNs) to automatically extract key characteristics from various information sources. An attention mechanism then intelligently combines these features, leading to significantly improved detection accuracy compared to traditional methods. Bang et al. [10], research tackles the challenge of generalizable fake news detection models. The authors propose a robust model that performs well across various datasets. They experiment with fine-tuning transformer-based language models (e.g., BERT) using robust loss functions. While this approach didn't significantly improve F1-score on the FakeNews-19 dataset compared to traditional loss functions, it demonstrated better generalization on the Tweets-19 dataset. This suggests the model is less prone to overfitting on specific datasets. Furthermore, the authors explore influence-based data cleansing, a technique that improves the model's robustness and adaptability. By incorporating this technique, the model becomes less susceptible to manipulation and external influences, leading to more reliable fake news detection. Felber [11] are actively developing methods to combat the spread of fake news, particularly in the context of COVID-19. This includes exploring advanced machine learning techniques. One approach utilizes traditional machine learning models to analyze linguistic features of text data. These features can include the sequence of words (n-grams), readability, emotional tone, and punctuation. To prepare the data for analysis, researchers may employ preprocessing techniques like removing common words (stop words), converting words to their base form (stemming/lemmatization), and eliminating hyperlinks. This approach offers valuable insights into the characteristics of fake news language, but more sophisticated methods are emerging. Our proposed deep learning model is also a stepping stone in the direction of this work.

III. PROPOSED DEEP LEARNING MODEL

This section outlines the architecture of the proposed model for detecting COVID-19 fake news. The model leverages a combination of convolutional neural networks (CNNs) and long short-term memory (LSTM) networks to capture both local features and sequential information within text data.

Here's a breakdown of the key components:**1. Embedding Layer**

This layer serves as the entry point for text data. It transforms textual information into numerical vectors, a format suitable for processing by the neural network.

2. Convolutional Neural Network (CNN) Layers

A stack of CNN layers is implemented to extract local features from the embedded text sequences. These layers work by applying filters that scan the sequence, identifying patterns indicative of fake news.

3. Pooling Layer

This layer down samples the output from the CNN layers, reducing the dimensionality of the data. This helps to improve computational efficiency and prevent overfitting during the training process.

4. Long Short-Term Memory (LSTM) Layers

A stack of LSTM layers will be employed to capture long-term dependencies within the text data. Unlike CNNs, LSTMs can analyze the entire sequence and understand the context and sentiment of the text. This is crucial for identifying fake news that relies on manipulating factual information or twisting the narrative over a series of sentences.

5. Dense Layers

These fully connected layers integrate the features extracted by the CNN and LSTM layers. They act as a classifier, learning the complex relationship between the extracted features and the labels (real news or fake news) assigned to the training data.

6. Output Layer

This final layer provides the binary classification – real news or fake news – for a given text input.

Objectives:

The proposed model in this paper builds upon this existing research by potentially incorporating elements like:

- **Combined Power of CNNs and LSTMs:** By leveraging both CNNs and LSTMs, the model can capture both local features and long-term dependencies within the text data, potentially leading to a more robust and accurate fake news detection system.
- **Optimization Techniques:** Technique like hyperparameter tuning is employed to fine-tune the model and improve its generalizability.
- **Specificity for COVID-19 Information:** Training on a COVID-19 specific dataset allows the model to learn the nuances of this domain, such as relevant medical terminology and current event references, potentially improving its ability to detect fake news within this context.

By referencing this related work, the paper establishes the foundation upon which the proposed model builds. It highlights existing achievements and areas for improvement, paving the way for the introduction of the novel deep learning architecture.

Optimization Technique:

While the proposed model has a strong foundation, its performance can be further enhanced through optimization technique called Hyperparameter Tuning in which deep learning models rely on various hyperparameters that control the learning process. These include factors like the number of filters in CNN layers, the number of LSTM units, and the learning rate.

Techniques like grid search or random search will be employed to find the optimal configuration of these hyperparameters. This ensures the model is not underfitting or overfitting the training data and achieves the best possible generalization performance on unseen data.

Model Training:

Here, we are using the Kaggle COVID-19 fake news dataset for our proposed model. The articles in the dataset will be categorized as real news or fake news by human experts. During training, the model will learn to identify patterns within the text data that differentiate real news from fabricated content. The performance of our model hinges on the quality and relevance of the training data.

IV. RESULTS AND CONCLUSION

The model leverages a combination of convolutional neural networks (CNNs) and long short-term memory (LSTM) networks to capture both local features and sequential information within text data. This, along with optimization technique and training on a COVID-19 specific dataset, holds the potential for superior performance in detecting fake news related to the pandemic.

Table 1: Classification Report

	precision	recall	f1-score	support
0	0.87	0.87	0.87	1004
1	0.88	0.88	0.88	1115
accuracy			0.88	2119
macro avg	0.88	0.88	0.88	2119
weighted avg	0.88	0.88	0.88	2119

The classification report indicates that the combined CNN and LSTM model achieves an overall accuracy of 88%, with consistent performance across both classes. Precision, recall, and F1-scores are all at 0.88 for class 1 and slightly lower at 0.87 for class 0, reflecting a well-balanced model that effectively minimizes both false positives and false negatives. The support values, 1004 for class 0 and 1115 for class 1, show that the model was tested on a reasonably balanced dataset. The macro and weighted averages for precision, recall, and F1-score, all at 0.88, further suggest that the model handles class imbalance well and performs consistently across the dataset. Overall, the combined approach of CNN for feature extraction and LSTM for sequence modeling proves to be effective, producing reliable predictions across the classes.

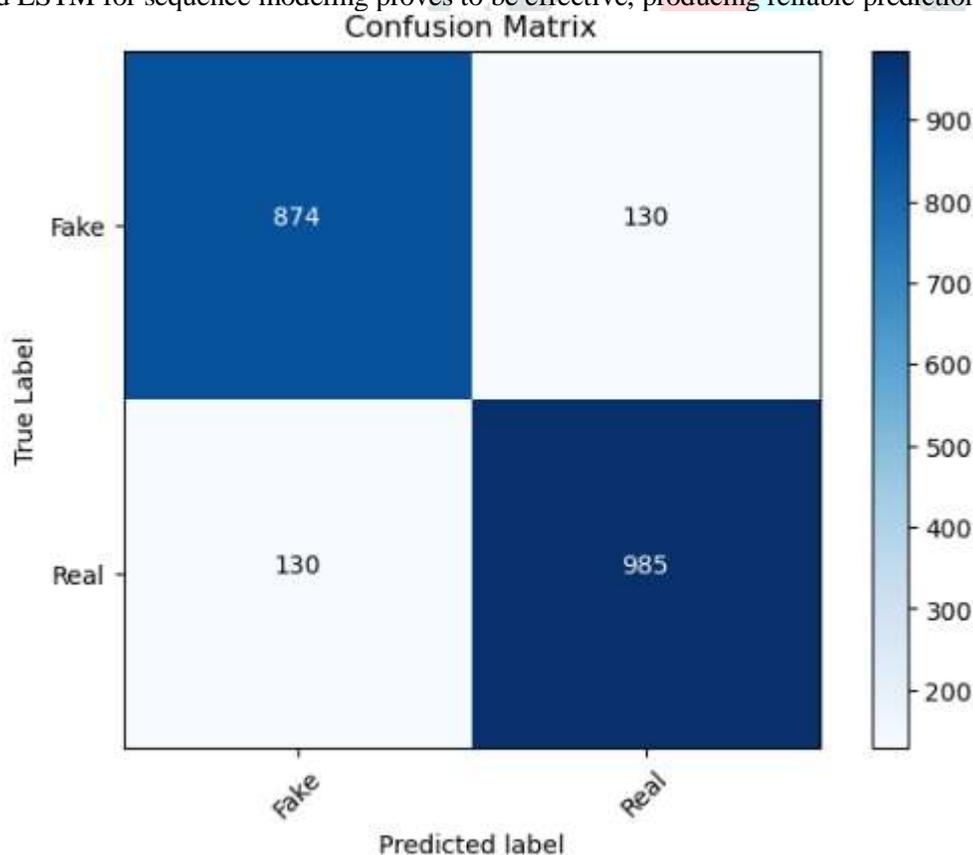


Figure 1: Accuracy Report of Optimized Deep Learning Model

The confusion matrix presented in Figure 1 shows the performance of the combined CNN and LSTM model in distinguishing between "Fake" and "Real" classes. The matrix reveals that out of 1004 instances labeled as "Fake," the model correctly identified 874 as "Fake," while it mistakenly classified 130 as "Real." Conversely, out of 1115 instances labeled as "Real," the model accurately predicted 985 as "Real," but misclassified 130 as "Fake."

This balanced distribution of errors across both classes concludes that the model is not significantly biased towards one class over the other. The correct predictions (874 for "Fake" and 985 for "Real") are considerably

higher than the incorrect ones, reflecting the model's strong ability to distinguish between the two categories. The relatively low number of misclassifications supports the conclusion that the CNN and LSTM combination is effective in handling this classification task.

V. FUTURE RECOMMENDATIONS

This research paves the way for further development of deep learning models to combat COVID-19 fake news and similar challenges in the future. By continuously refining these models and promoting media literacy, we can work towards a healthier information environment and empower individuals to make informed decisions based on reliable sources.

CONFLICT OF INTEREST

Authors declare no conflict of interest exists.

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