Using Graph Neural Networks to Detect Fake News Articles

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1 INTRODUCTION

Since most of the world has become digitized, a lot of information about real-world events can be found on the internet. Providing information about current events allows users to easily access current topics and is an enormous advantage of the web. On the flip side, there is also misleading/fake news that can easily be available simultaneously. Fake news can be detrimental to society as it can influence public opinions, interests, and can reach the daily lives of people at a rapid pace [13]. It can confuse, manipulate public judgment, change how people react to facts, and may pose a significant threat to society. Some social media have professionals check if there are fake posts on their platforms. For example, Facebook encourages users to report false content so it can be examined if fake news is prevalent. There are also some accredited fact-checkers that fact-check information on the web. As there is more and more news on the web, it is an ever-important task to detect what information on the internet is factual or fake autonomously. We propose a Graph Neural Network framework that can automatically detect whether an article on the web is fake by using the sentences within the article as nodes. We would also convert the article into a graph structure and use it as an input for the graph neural network.

1.1 Background

1.1.1 Graphs. Graph G contains $V = v_1, ..., v_n$ set of vertices and $E \subseteq VxV$ set of edges. G is made up of V and E. If we represent the number of vertices by n and number of edges by m adjacency matrix A is the size of nxm where $A_{i,j} = 1$ if there is an edge from vertex v_i to vertex v_j otherwise $A_{i,j} = 0$ if there is no edge between vertex v_i and v_j [7]. The nodes may include a set of features f (for example, a user profile) and can be represented by a node feature matrix X^{nxf}.

1.1.2 Graph Neural Networks. Graph Neural Network (GNN) is a deep learning method that performs analysis on graphs. GNNs are designed to process the data represented in the format of graph and it provides three general types of prediction tasks:

- Graph-Level Tasks: predicting a single feature for the entire graph.
- Node-Level Tasks: predicting some features for each node in the graph.
- Edge-Level Tasks: predicting the features or presence of each edge in the graph.

Then, these tasks can be applied to machine learning techniques like prediction, regression and node clustering [10]. The multiple representations of GNNs are Recurrent Graph Neural Networks (RecGNNs), Convolutional Graph Neural Networks (ConvGNNs), Graph Autoencoders (GAE), and Spatial-temporal Graph Neural Networks (STGNNs). Graph Neural Networks could either be used for Unsupervised or Supervised tasks.

1.2 Problem Statement

Since there is a rapid rise of fake news, having an algorithm that can automatically detect deception will be vital to preventing the spread of misinformation. Many existing deep learning algorithms use deep learning to solve this problem, but we will use a graph embedding within the article to represent it as a graph that can pass through a graph neural network. We propose utilizing a graph neural network to improve the prediction of fake news instead of a neural network or natural language process (NLP) models.

2 RELATED WORKS

Several papers in the literature have explored the use of graphs for fake news detection. Most of them use a combination of Weibo, Twitter and FakeNewsNet as datasets since they hold real-world data.

Some approaches, as presented in [4] study the relationship between words in the document itself, by organizing the words into a graph and placing an edge between them given a relationship score. This type of approach is called summarization and this proposed solution was more effective than BERT and other works in the literature.

The paper in [14] used a domain-adversarial and graph-attention neural network to attempt predicting if news from another domain can be correctly classified as fake or not. This method can perform better when compared to existing baselines.

However, there are approaches to solving the fake news detection problem that leverage how a news article is propagated to determine whether it is fake or not. In this case, one of the drawbacks identified by [12] is computational expense, since is takes longer to run. Another propagation-based approach developed by [2] used graph neural-networks to deal with the non-Euclidean data and detect if a news is fake or not. The latter did not perform well and the continuous learning displayed forgetting problem. To solve this problem, the authors in [2] applied Gradient Episodic Memory (GEM) and Elastic Weight Consolidation (EWC), common in continuous learning. Despite not being necessary to train on the entire data set, it can become computationally infeasible.

Furthermore, by using an external knowledge base, [3] was able to improve the learning model. Since news articles are related to a given topic, this topic can be used to improve the graph representation by extracting truthful data from the knowledge base. Testing this method on common data sets showed the effectiveness of the approach.

Finally, the detection of misinformation can also be done by analyzing a person's behavior on social media [1, 11]. By taking into

consideration not only the content being shared, but someone's confirmation bias, i.e. how and what someone shares something, it is possible to identify whether the information being propagated is real or not. Also, in the same topic of analyzing a person's interaction with a given social media platform, a learning model can identify people who are more likely to spread rumours.

3 METHODOLOGY

Different deep learning algorithms such as CNNs (Convolutional Neural Networks) and LSTMs (Long Short Term Memory Networks) are good at capturing hidden patterns in Euclidean data (image, video, text). However, the graph data, which represents complex relationships between objects, is generated from a non-euclidean space. Data provided in the graph format created a lot of challenges for existing machine learning algorithms. The graphs are different from simple data types, which have a fixed structure and size. Graph networks can have a variable number of unordered nodes in which each node can have different number of neighbors. On the other hand, in the graph structure each node is related to others by different types of links. This violates the core assumption in most of the existing deep learning tools that data instances are independent of each other [6].

Following the graph theory we need to map each node to a d-dimensional embedding space so that similar nodes in the graph are close to each other in the embedding space. The encoder function maps the nodes from the graph space to embedding space and should be cable of performing [6]:

- Locality: keeping local network neighborhoods using a computational graph. Computation graph can be formed using all the possible connections and neighbors of them for each node.
- Aggregating information: this is done using neural networks to aggregate the information in each local neighborhood.
- Stacking multiple layers: forward propagating and transforming information from the input layer towards the output.

There are different applications of GNNs including Node Classification, Graph Classification, Graph Clustering, Graph Visualization, Link Prediction, etc. We are aiming to use GNNs for graph classification in the field of fake news detection. Inspired from previous works done in this field, we are going to construct a sentence level graph from the available fake news detection datasets to better understand each document. The nodes in the sentence level graph will be the sentences in one specific news article. While the relationships between the sentences are represented by the edges. Since relationship ratio between different pair of sentences might be different, we can calculate the ratio of information reflection between each pair of sentences using an attention mechanism. These ratios will be assigned to the weights of the edges. Having such a graph we can purpose a graph-level prediction task to demonstrate whether a news article is fake or not.

We are aiming to explore a couple of papers including: [1–5, 8, 9, 11, 12, 14].

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