

Design And Development Of Stylometric Based Fake News Detection On Social Media Using Natural Language Processing And Machine Learning

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Abstract - Social media is a medium that helps us to stay close with friends and family and they also are helpful platforms to connect to people with similarities. As Social Media plays a crucial role in connecting people, it is necessary to distinguish fact from fake. Due to these reasons, the authenticity of social media is vulnerable where fake news can be easily circulated. The social media platform is the best way to spread fake news faster as it is cheaper than traditional news media(Newspaper and Television). People usually start to believe in the information which they often hear and see and this can be amplified by using the Echo Chamber effect on social media. So if the information which gets circulated on social media is created, fake, or manipulated, then the decisions we make will be completely wrong. So it is mandatory for us as a user of social media to know the information which we see, share are either true or fake as it may lead to serious consequences. Distinguishing a piece of information that is either true or false differs from people's perspectives based on their pre-existing beliefs. So everything must be taken into account while detecting a piece of fake news on social media. In this project, we have reviewed the authenticity of the news articles using Natural Language Processing, Feature Extraction technique, Machine Learning, and Ensemble models. We have also reviewed different Machine learning models, evaluation metrics. We have also mentioned related research areas and future work on fake news detection on social media.

Keywords-*Fake news detection, stylometric approach, Natural Language Processing, Machine Learning*

I.INTRODUCTION

Fake news became predominant during the 2016 Presidential election. This type of news is not new in the post-print social media age, the misleading situation is increasing and goes viral. Usually, Fake news has catchy headlines,so individuals get attracted instantly which makes them share through social media. This fake news dispenses as true news but contains deceptive and biased information. It is difficult to drag down the source from which fake news originated.The ultimate motive of fake news is to mislead public opinion and to attain profit on businesses related to online publishers.There are also situations where fake news is produced by mistake, but it may sometimes confuse. Here we distinguish between several concepts that frequently occur with fake news. Fake news can always be called using many terms such as Satire news - a literary work of holding up human vices and follies to ridicule or scorn, Misinformation - incorrect information that is communicated regardless of an intention to deceive. Disinformation - false information which is intended to mislead and it is a subset of misinformation, Deceptive news - defined as intentionally, knowingly, and/or purposely misleading another person, Clickbait - a sensationalized headline or piece of text on the internet that is intended to attract attention and encourage people to click on links to particular websites. Cherry-picking - the fallacy of incomplete evidence or suppressive evidence. Further, we discuss the overview on fake news where we review the definitions, rise, types of fake news, detecting fake news from four perspectives and their comparative analysis, then we discuss dataset and model construction, different machine learning

models, and evaluation metrics. In continuation with this, we present their related areas, then results and conclusion.

The information which gets circulated on social media is created, fake, or manipulated, then the decisions we make will be completely wrong. So it is mandatory for us as a user of social media to know the information which we see, share are either true or fake as it may lead to serious consequences. Distinguishing a piece of information that is either true or false differs from people's perspectives based on their pre-existing beliefs. The main motivation of the project is to avoid false interpretation of information which we come across on social media.

II.OVERVIEW OF FAKE NEWS

A. Definition

Fake news has been existing for a very long period. However, there is no concurred definition for the term "fake news". Fake news can be defined as a false news article to mislead people. It indicates false information that is published under the semblance of being factual news. Hoax news (Fake news) represents the misinformation or false news article that aims to exploit public opinions. It is shared via traditional news media or social media. There are two highlights in this definition: Authenticity and Intention. The authenticity part means false news content that can be confirmed as such. In the second part, the news is created to manipulate their opinions.

B. Rise of Fake News

The purposeful making up of false news stories to grab attention or entertain us is not new. It has become a trending topic since 2017. Earlier we got our news from reliable newspapers, journalists, mass media which strictly followed the practice code. In the 21st century, the term fake news and the effect of fake news has become global. The increased popularity and immense access to the internet have resulted in its growth. It enabled a whole new way to publish, share and view the content with very few editorial and regulation standards. It has also contributed to the increasing growth of fake news and its publishers. New articles and stories are constantly published at a faster rate. But often it can be hard to tell whether the news articles are trustworthy or not. Due to information overload, it lacks the verification of authenticity media platforms play a major role in the reach of stories as it has excellent algorithms to present us with news, articles, and content based on our recent searches.

C.Types Of Fake News

There are various differing views regarding fake news. The features listed below may help us to evaluate and identify the false news content we need to be aware of. These include Clickbait, Propaganda, Satire/parody, Sloppy journalism, Misleading headings, Biased/Slanted news. Clickbait stories often use exaggerating, misleading, sensationalistic headlines to gain the attention of the viewers at the cost of truth. These stories are purposefully created to gain more website visitors and increase revenue via advertisement. Propaganda stories are deliberately created to promote an agenda or cause or biased point of view (especially in Politics) to mislead readers. Satire/Parody websites publish false information as humorous attempts but have the potential to be shared as true news. Sometimes journalists publish information without verifying all the facts which can mislead audiences. It is referred to as Sloppy journalism. Misleading or sensationalistic types of stories spread faster as they have small snippets of the whole story on the viewers' newsfeed to grab the attention. Social media tends to present us with the news feeds that we will like based on our personalized searches. Many people were attracted to confirm their own beliefs or biased thoughts and fall prey to false news.

D.Detection of Fake News From Four Perspectives

In the previous subsections, we have discussed the definition, rise, and different types of fake news. Here the detection of fake news from four perspectives is listed below.

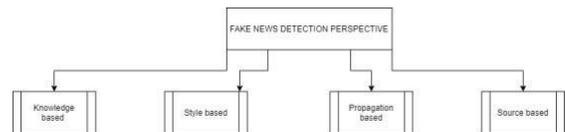


Fig.1 Fake News Detection Perspectives

1) Knowledge-based Fake News Detection

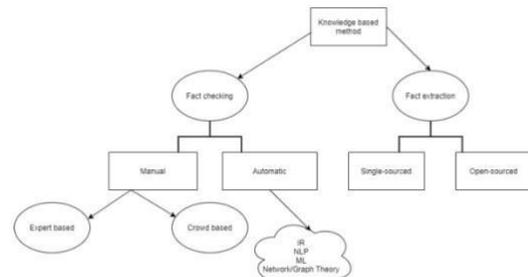


Fig.2 Knowledge-based Fake News Detection

The knowledge-based method aims to verify the truthfulness of the knowledge extracted by the factchecking approach. Fact-checking can be done in both manual and automated ways. The manual factchecking further can be classified into two types as expert-based and crowd-based fact-checking. The former method depends on a group of experts' opinions for content verification. It is accurate but costly and has very poor scalability with the to-be-verified contents. In latter method, fact-checking happens based on collective or crowd intelligence. The crowd didn't find the news to be checked is consistent or not based on the facts. If very large people find it true or false, then it is verified as such. It is not accurate compared with expert-based, the results may be biased, but it has good scalability than the previous method. To address the scalability issue due to information overload, we have moved on to another approach called automatic fact-checking. It uses the techniques of Information Retrieval(IR), Natural Language Processing(NLP), Machine Learning(ML), and also Network/Graph Theory. It consists of two stages: Fact-extraction and Fact-checking. The facts can be extracted from single-sourced or open-sourced. In single-source extraction, we extract facts from only one source. It is more efficient than open-sourced but leads to an incomplete state. In the latter method, more distinct resources are used to obtain the completeness of facts. Further, these raw facts are processed and cleaned to construct the Knowledge Graph(A graph representation that is created using a knowledge base ie. a set of facts or truth). Ultimately, the result is obtained by comparing the input data or news with a knowledge graph or base.

2) Style based Fake News Detection

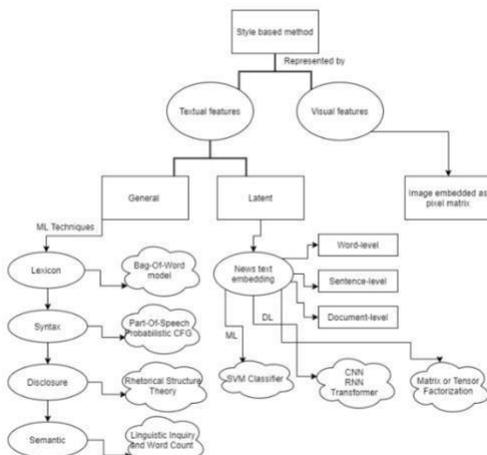


Fig.3 Style based Fake News Detection

Style-based fake news detection assesses the intention of the article whether it is misleading the people or not. Here the news content style is represented using textual features (news text) and visual features (news images). Textual features can be grouped into general and latent features. Observable or general features are used to detect fake news using Machine learning and deep learning frameworks. The content style features are described at four language levels. These include lexicon, Syntax, Disclosure, Semantic levels. The frequency of the lexicon is determined using the Bag of Word technique. At the syntax level, the frequency of POS and rewrite rules are determined by Part-of-speech taggers and Probabilistic Context-free Grammars. The rhetorical relation frequencies are calculated using the Rhetorical Structure Theory(RST). Finally, at the semantic level, these frequencies fall into lexicons as defined in Linguistic Inquiry and Word count. Latent features are hidden features that are extracted from general features. Here the news embedding can be done in machine learning and deep learning techniques. News text embedding happens at word-level, sentence-level, and document-level. Here the news articles are represented by vectors and given as input to classifiers such as SVM classifiers to predict the fake news. These embeddings can be further processed using Convolutional Neural Networks(CNN), Recurrent Neural Network(RNN), and the Transformers which are Deep Learning Frameworks to predict the fake news. News images are embedded as pixel matrices to find fake news.

3) Propagation based Fake News Detection

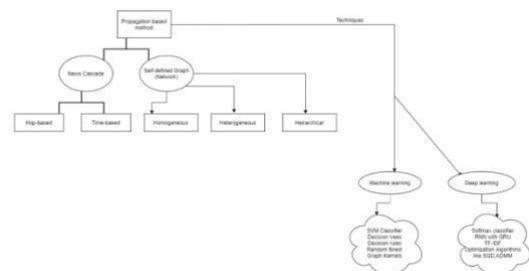


Fig.4 Propagation-based Fake News Detection

Propagation-based Fake News Detection explains how the news spreads or propagates. It is often formulated as a binary (or multilabel)classification problem with different inputs. Input to propagation-based methods can be classified as News Cascade and Self-defined

graph. News Cascade is a tree or tree-like structure and is the direct representation of news propagation. The root node represents the user who first shares the news article (initiator). News Cascade can be represented in terms of several steps (i.e., hops) that the news was traveled (i.e., Hop-based news cascade) or the times that it was posted (i.e., Time-based news cascade). To classify its cascade as true or false, some proposed methods rely on traditional machine learning and Deep Learning. In traditional Machine Learning, to classify a news cascade one relies on supervised learning methods such as Support Vector Machine, Decision tree, Decision rules, Naïve Bayes, and random forest. In deep learning, to represent news cascade relies on neural networks such Softmax function acts as a classifier, Recurrent Neural Network with Gated Recurrent Units (GRU), TF-IDF and optimization algorithm such as Stochastic Gradient Descent (SGD), Adam and Alternating Direction Methods of Multipliers (ADMM). When detecting fake news using Self-defined Propagation Graphs one constructs a flexible network to capture indirectly fake news propagation. These networks are Homogeneous networks, Heterogeneous networks, and Hierarchical networks. Homogeneous networks contain a single type of node or edge. Heterogeneous networks contain multiple types of nodes or edges. Hierarchical networks contain various types of nodes and edges that form a set-subset relationship. other applications 4)

Source-based Fake News Detection

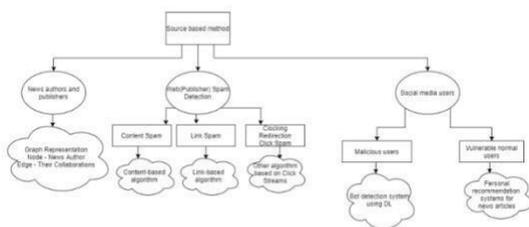


Fig.5 Source-based Fake News Detection

Source-based Fake News Detection assesses the credibility of its source. There are three stages with a [fake]news life cycle namely News writers, News publishers, and the sources that spread the news stories on social media. News writers and publishers are in the form of Graph representation where Nodes represent news authors and edges represent their collaborations. In Web(Publisher) Spam Detection, News publishers often publish their news articles on their websites. To access website credibility, many practical techniques have been developed.

Traditional Web ranking algorithms like PageRank, HITS are used to improve search engine responses. Web Spam can be categorized as Content Spam, Link Spam, and others like Redirection, Click Spam and Cloaking. The algorithms to identify web spam are classified as a Content-based algorithm, Link-based algorithm, and other algorithms, etc. To identify the sources that spread the news on social media there are two ways. First, identify Malicious users, it can often be reduced to detect social bots using Deep Learning. Second, Identifying Vulnerable users. That fake news unlike information such as fake reviews can "attack" both malicious users and normal users. Malicious users such as some social bots often spread fake news intentionally. But normal users spread frequently and unintentionally without recognizing its falsehood.

D.Comparative Analysis

In this section, we discuss the limitations and difficulties of all four approaches to fake news detection. In a Knowledge-based approach, it is unsure whether the sources from which we extract the facts are credible or not. It requires the construction of dynamic Knowledge base KBs, that automatically remove the invalid data and insert new data or facts. Content writing style can be manipulated in a stylebased approach. The propagation-based method is inefficient as it is difficult to detect fake news before it spreads. There are limited ongoing researches in the source-based method.

III.FAKE NEWS DETECTION

A.Dataset

Online data regarding fake news can be collected from various sources like online websites, social media platforms. There are many publicly available datasets like BuzzFeedNews which contains a sample of data published in Facebook, LIAR which is a dataset collected from PolitiFact, fact-checking website, and CRED BANK which is a large crowdsourced dataset regarding millions of tweets.

B.Model Construction

In this section, construction of the models using existing methodologies is discussed. In the previous section, we have discussed four methods in detail. Out of four approaches, we have chosen the style-based method because there is a lot of ongoing research as said in comparative analysis. In style based method, we had chosen textual features. Then preprocessing of data happens where we remove stop words followed by tokenization and lemmatization. After

preprocessing, we have converted our labels into numerical for output. Next, testing of our models using various machine learning models and each machine learning model is discussed below.

C. Different Machine Learning models: We have used different machine learning models for classification. They are Logistic Regression, Multinomial Naive Bayes, Decision Tree Classifier, Passive Aggressive Classifier, Stochastic Gradient Descent Classifier, Linear Support Vector Classifier, and Ensemble Classifier.

Logistic Regression: It is a machine learning algorithm that is widely used for classification problems. Logistic regression is very effective when it comes to textual classification. It also gives good accuracy for simple data sets.

Multinomial Naive Bayes: It is a very suitable classifier for working with discrete features like word count in text classification. Naive Bayes is one of the best algorithms when it comes to text classification and text analysis.

Decision Tree Classifier: It is a supervised machine learning algorithm. It builds classification in a form of a tree-like structure. The decision tree is one of the best algorithms to choose when it comes to multiclass classification.

Passive-Aggressive Classifier: It is a machine learning algorithm and it is also an online-learning algorithm. That's why it is very efficient when it comes to detecting fake news as the data would be large to handle.

Stochastic Gradient Descent Classifier: Stochastic Gradient Descent is a very simple approach for linear classification and regression. It is the best optimization algorithm for minimizing the cost function. It is the go-to algorithm when you need a speedier result.

Linear Support Vector Classifier: It is a nonparametric clustering algorithm. It is considered one of the best classifiers for text classification.

Ensemble Classifier: It uses a set of classifiers whose individual results are combined based on voting (Soft/Hard) to give new results.

D. Evaluation metrics

To evaluate the performance of the algorithm there are different evaluation metrics like accuracy, precision, recall, F1 and it is noted that the performance increases with the increase in value.

True Positive (TP): when the model predicts fake news articles as fake news.

True Negative (TN): when the model predicts true news articles as true news.

False Positive (FP): when the model predicts fake news articles as true news.

False Negative (FN): when the model predicts true news articles as fake news.

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

$$\text{Precision} = \frac{|TP|}{|TP| + |FP|} \quad (2)$$

$$\text{Recall} = \frac{|TP|}{|TP| + |FN|} \quad (3)$$

$$\text{F1-Score} = 2 * \left(\frac{\text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}} \right) \quad (4)$$

IV. RELATED RESEARCH AREA

A. Social Bot Detection

Social bots are software that runs automated tasks on the internet. Twitter executives have testified that as many as 5% of Twitter accounts are operated by bots. It is difficult to detect how many social media accounts are social bot accounts as the bots are designed to mimic human accounts. Even humans fail to detect a bot account from a legitimate human account. The main threat imposed by the social bot is that it gives a false impact on the information which has been circulated and it is also endorsed by many people which triggers the Echo Chamber effect of social media which makes the false information propagate much faster. Ongoing research on social bot detection mainly relies on social network information, discriminative features.

B. Troll Classification

A troll is someone who intentionally ignites conflicts or affronts other social media users either to cause division or distraction by posting agitational posts in any online community or social media platform. Ongoing researches on troll classification mainly rely on natural language processing, social network analysis, identifying heterogeneous groups of features and it also includes the analysis of writing style, sentiment, behaviors, social interactions, linked media, and publication time.

C. Clickbait Detection

The term "Clickbait detection" is a form of fake advertisement which uses a thumbnail link or hyperlink text that is designed to seek attention and to tempt the people to follow that link and view, listen or read to the connected piece of online content, with a defining characteristic of misleading, being deceptive or typically sensationalized. Now there are a lot of researches going on on this topic. In that, clickbait and non-clickbait articles are separated by fusing different features, clustering, and sentence structure using Hybrid categorization.

V.RESULT

Our model has used many classifiers in predicting accurate results. The performance metrics of each classifier are listed in table 1.

MODEL NAME	ACCURACY	PRECISION		RECALL		F1 SCORE	
		0	1	0	1	0	1
Logistic Regression	0.99	0.99	0.98	0.99	0.99	0.99	0.99
Multinomial Naïve Bayes	0.94	0.93	0.94	0.95	0.92	0.94	0.93
Decision Tree	0.99	1.0	1.0	1.0	1.0	1.0	1.0
Passive Aggressive	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Stochastic Gradient Decent	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Linear SVC	0.99	1.0	1.0	1.0	0.99	1.0	1.0
Ensembler	0.99	0.99	1.0	1.0	0.99	1.0	0.99

TABLE 1 PERFORMANCE METRICS

From the results of each of the classifiers, it is inferred as the Decision Tree classifier has the maximum accuracy of 99% and precision, recall, and f1-score of 100% whereas, on the other hand, the Multinomial Naive Bayes classifier gives the least accuracy of 94%. Therefore, the best and least performing classifiers in our model is the Decision Tree and Multinomial Naive Bayes classifiers respectively. For the Ensemble classifier, the accuracy of the best performing classifier is taken into consideration, which is 99%.

VI.CONCLUSION AND FUTURE WORK

With the increase in the rise of social media, sharing information online has become prevalent. So we must identify the fact from the fake. In this article, in section 3, we have an overview of fake news where we have discussed the definition of fake news, the rise of fake news, its types, ways of detecting fake news from four perspectives and we've also comparatively analyzed all the methodologies. In section 4, our model has used textual features of the news articles based on a style based method to identify the fake news using natural language processing and machine learning techniques. In section 5, we have discussed the related research areas to fake news detection like Social bot detection, Troll classification, and Clickbait detection. Our model, for now, has used a single feature for predicting the result. In the future, we will be working to create a better model which considers many features in predicting the result.

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