# Defining News Authenticity on Social Media Using Machine Learning Approach

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## Abstract

*Social network and online news media are becoming popular in today's era. Due to low cost, easy access and rapid diffusion, social media platform becomes a source to distribute false information. Fake news propagation on social media can cause serious negative effects on human society especially in politic, reputation and finance. So, automatic fake news detection plays a vital role to robust news media platform on social network. Defining news authenticity is insufficient based on news content only. It also needs to analyze social features of news. In this paper, we propose an approach to detect fake news on social media that covers both news content and social context. We use synonym-based feature extraction method and three different classifiers based on multidimensional dataset. Experimental result shows the effective as an accuracy way to define news authenticity on online news media.*

***Keywords:*** *fake news, news media platform, news content, social context, news authenticity*

## I. INTRODUCTION

Nowadays, the more people use online news media, the less they spend with traditional news media such as newspaper, journal and television due to advancement of latest technology. Social media becomes a global information network and it provides an easy, fast dissemination and less expensive way to access news than traditional news media. According to recent survey, an estimated 3.484 billion people in the world were using the social media and it predicts that the number of social media users will increase 9.1 % year on year[1] .In particular, dissemination of fake information on social media has been increasing in today's world. Popular social networking sites such as Facebook, Twitter, YouTube and Google plus are the primary source of diffusion misinformation on online news media[2] .

Fake news refers to news articles which intent to mislead news consumers in order to damage individual or society's reputation, politics and economic events. Social media users are often less likely to critically evaluate the information shared by other people or confirm their existing beliefs. Therefore, digital false information is more spreading about politics, finance and economy in recent years. Sufficed to mention that during the 2016 US presidential election, social bots spread misinformation on Twitter to confuse people opinion. One interested fake news is "Pope Francis shocks world, endorses Donald Trump for president" release statement that was very popular among social media users and it caused unexpected impacts on election[3]. The another conspicuous example of fake news is that Steve Job's company stock share would significantly decline in a short time due to fake news report of CNN's iReport.com in October 2008 [4].

Detecting misinformation on social media is unique challenges. A news piece on online news media has several characteristics to analyze news authenticity. First, fake news is written to mislead viewers and it mimics real news like topic, writing styles and media platform. Thus, it is insufficient based on only news content to detect fake news. Other auxiliary information including social engagement and stance of news or comments are also useful factors for improving automatic fake news detection. Second, exploiting social engagement and news comments are another critical challenge. Today researchers consider to build multidimensional model by combining news content and social context to detect fake news . News on social media is continuously updating which may not be verified with existing knowledge base because it is lack of corroborative evidence. However, auxiliary information in online news is noisy, big, incomplete and unstructured [5]. Therefore, detecting news authenticity on social media needs further investigation such as defining user authenticity, extracting useful post features and social features. The core motivations of this paper are summarized as follows:

- Automatic fake news detection is an emerging problem on social media and it can cause serious impacts on social, political and economic issues.

- Exploring effective features from news content and social context to analyze news authenticity is also a technically challenging task.
- The prior researches about this problem lack labeled benchmark datasets that covers news content, social context. To better guide the future direction of this problem, new multidimensional fake news benchmark datasets are necessary.

In this paper, we discuss News Application Programming Interface (News API), Graph Application Programming Interface (Graph API) to collect news stories from social media, synonym based feature extraction method and three different classifiers to define news authenticity on online news media. The objective of this paper is to describe the framework of fake news detection system by exploring the correlations of content of news, stance of news and social engagement. It also aims to analyze which features of news stories are helpful for fake news detection and to know the ideas and process of automatic fake news detection system.

The remainder of this paper is follows. In section II, we review related work of previous research for fake news detection system. In section III, we briefly discuss our proposed model and fake news detection methods. We describe nature of dataset, evaluation metrics and performance result of the proposed system in section IV and conclude and discuss future directions of this paper in section V.

## II. Related Work

The propagation of fake news on social media can cause negative effects on human society. Therefore, automatic fake news detection becomes emerging research topic and there were many prior researches about this problem. We can consider that online news includes news content and social context. The previous research based on these factors to detect fake news on social media.

The authors described fake news detection problem in online news articles using semantic features and three machine learning techniques in [6]. In this paper, it used real-or-fake benchmark dataset which includes 6256 news articles from kaggle.com. They compared the performance of recurrent neural network, naïve bayes and random forest classifiers based on various features extraction methods such as term frequency, term frequency-inverse document frequency, bigram, trigram and quadgram to perform binary classification of online news.

In reference [7], the author discussed automatic fake news detection problem in two aspects: fake news characterization and fake news detection. In fake news characterization phase, they presented the key factors related to fake news on online media including psychological and social theories of fake news, news content features and social context features of fake news, fake news distributors on social media and types of fake news and differences of news patterns between traditional media and social media. In fake news detection phase, they discussed the approaches to detect fake news, available benchmark fake news datasets and challenging issues for fake news detection system on social media.

The author introduced a fake news detection model using hybrid convolutional neural network. It used large dataset "LIAR" which includes over twelve thousands news short statements with meta information from politifact fact checking website in [8]. Then, they evaluated text feature only in this dataset to detect news authenticity by using various classification models and compared the performance with hybrid model which based text and meta data of news.

In reference [9], the authors proposed a model to detect false information on Facebook news pages that covers news content and social context features on three different fake news datasets. In this system, they described content-based methods for news content only and logistic regression and Harmonic Boolean label crowdsourcing methods for social features. These methods are used depending on the social engagement threshold parameter. This paper is also implemented fake news detection model within a Facebook Messenger Chabot to validate the authenticity of real time Facebook's news.

The authors presented WordNet-based similarity measure to calculate the similarity between sentences by using ontology structure in [10]. They discussed about existing sentence level similarity evaluation approaches, WordNet structure, calculating word similarity, computing sentence similarity based on two example sentences and dataset that includes ground truth for sentence similarity calculation.

In reference [11], the authors discussed different approaches for sentiment analysis and compared the performance of domain adaption using supervised, semi-supervised and unsupervised methods. They also explained how to extract words from social media comments and how to work on sentiment dictionary for opinion target.

## III. Proposed System and Methodology

The aim of our system is to define political news authenticity on social media. In this section, we describe the overview flow diagram of proposed system in Fig1.In this system, we collect data from Facebook news posts using Graph API. Each news post includes news content, reactions counts and comments. Before we define the authenticity of Facebook news post, we need to calculate content similarity. Therefore, we fetch political news stories from reliable news websites using News API to check similarity of news content.

The system collects news stories from twelve most reliable websites [12] such as BBC News, The Washington Post etc., to compute content similarity with Facebook news. We use synonym-based (WordNet-based) sentence similarity method to get content similarity score in this system.

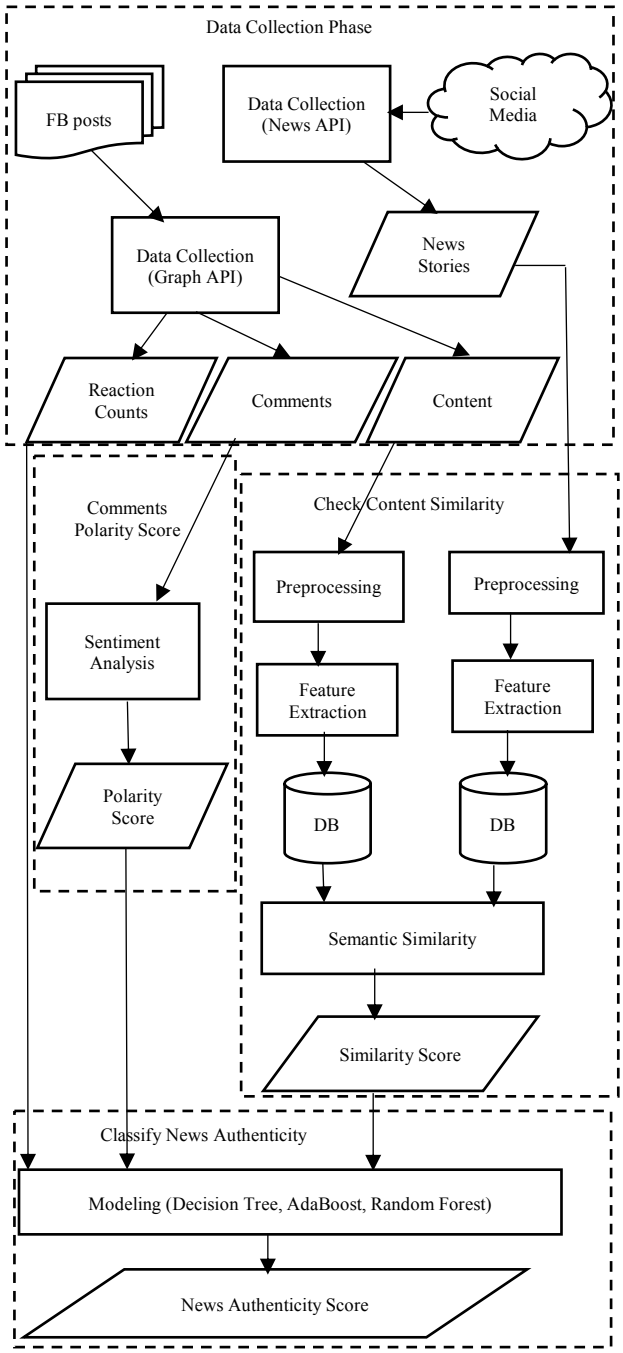


**Figure 1. Overview of Proposed System**

News comments and reaction counts are also useful factors to classify news as real or not. For instance, when we don't know a news post is true or not by our existing beliefs, we can get clues by reading the news post's comments and post's reactions. To know comments polarity score: positive (news is true), negative (news is false) and neutral, we use VADER: sentiment analysis tool in our system. Then, we define news authenticity by using three different classifiers: Decision Tree, AdaBoost and Random Forest classifiers based on news content similarity score, comment polarity score and reaction counts.

There are four main phases in our proposed system: collecting data, checking semantic similarity between news content, analyzing polarity score from comments and classifying news authenticity. The explanations of each phase are described below.

## A. Data Collection

Online news stories can be collected from various social media platforms such as search engine, news websites, Facebook and Twitter. However, it is difficult to know news authenticity manually because there is so much information and it now increased day by day. Thus, building comprehensive large-scale datasets and defining ground truth label of news are challenging task. Generally, determining authenticity of news is based on expert journalists, reliable sources and fact-checking websites. We discuss some available benchmark data repositories below which are focused on fake news detection system.

Vlachos and Riedel firstly proposed a fact-checking dataset for fake news detection system. This data repository includes only 221 news statements. This small dataset includes news content only which does not suitable for machine learning based models [13].

To tackle this problem, William introduced a fake claim benchmark dataset "LIAR" [14]. It is a large scale dataset which comprise 12.8K short statements with annotated ground-truth labels. However, LIAR does not contain the entire news content and it describes only short statement labeled with meta information for each news.

Another dataset called "BuzzFeed" [15] which collected a complete 1627 news articles from nine news agencies over a week in the US election. Every posts and links articles were fact-checked claim-by-claim by five journalists from BuzzFeed news team. The news articles are annotated labels into four categories: mostly true, mostly false, mixture of true and false and no factual content. Nevertheless, it only contained headlines and text with no social features from very few news agencies.

Santa and Williams created a news dataset "BuzzFace" [16] which extends on BuzzFeed dataset in 2018. The news in this dataset is concerned with politic which happened during 2016 US election. It included rich sets of feature such as Facebook-id, post-id, post-url, published-date, reaction count and comments that covered both news content and social context. It also defined news' labels into four categories as BuzzFeed news dataset.

Unlike the traditional news media, online news is real time and it can change at any time. Dynamic social features such as number of reaction count and news comments are become useful features to spot fake news on social media. Before "BuzzFace" is launched, there were no existing available datasets that cover both news content and news social features [17].To tackle the disadvantages of available

existing datasets, we need to build multidimensional dataset which help to develop fake news detection system.

In our proposed system, we use "BuzzFace" news dataset to detect political fake news from Facebook posts. Facebook-id and post-id are useful features which allow crawling news content, comments and reaction of news by using Facebook Graph API. To check content similarity, we use News API to collect political news articles from authentic news sources (websites). By using News API, we get news title, news-url, published-date and content from reliable news websites which are used to check content similarity with Facebook news content.

*Graph API:* The Graph API is HTTP-based API and it can use to get data into and out of the Facebook platform. It is composed of nodes, edges and fields. We can use nodes to get data about specific object such as Facebook users, photos, Facebook pages or Facebook comments. Edges are used to get connection between objects and fields are used to get data about an object [18].

*News API:* It is a simple and easy-to-use API for searching and retrieving nearly real time news stories from news sources and blogs all over the world. News content and metadata automatically access via this API using the API key. We fetch news stories from twelve most reliable news sources to check news authenticity. Each news site has own news API to acquire news categories [19].

## B. Checking Semantic Similarity between News Article's Contents

News stories from various news websites and Facebook are unstructured, big and noisy. Therefore, these data need to be preprocessing such as tokenization, stop word removal and stemming before checking semantic similarity of news content.

*Tokenization:* It is the process of splitting a stream of sentence into words phrases, symbols or other meaningful information. Tokenization aims to explore the words in the sentence. The resulting tokens become useful inputs for text mining and further processing.

*Stop Word Removal:* Stop words are frequently used or insignificant word in a text corpus that will be noise when these words used in text mining process. Thus, the words like pronouns, articles, conjunction and preposition need to remove from the sentence.

*Stemming:* After tokenization and stop word removal, we need to transform list of token into a standard form. Stemming is the process of transforming a word into its stem word. For example, the words "Speaking", "Speak" and "Speaker" transform into "Speak". Stemming provide classification task more efficient and faster.

After preprocessing steps, we need to calculate similarity between sentences. Similarity between sentences can be measured lexically or semantically. Lexical similarity approach is also known as string based similarity approach which depends on measuring similarity between sequences of characters. Semantic similarity method based on similar meanings of words between sentences. In our system, we implement semantic similarity approach using WordNet to compute similarity score between sentences. This approach is also called synonym-based similarity.

Word Net is a large repository English words which are grouped into synsets (group of synonyms). These synsets are constructed into a hierarchical structure which has conceptual relation between them. The WordNet pointer describes both lexical and semantic relationships between words. To check semantic similarity between two sentences, we first transform the sentences into bag-of-words form $T_1$, $T_2$ and create superset $T = T_1 \cup T_2$. After creating superset for two semantic vectors $T_1$ and $T_2$, lexical semantic vectors $V_1$ and $V_2$ are derived from the superset T. The entry value in $V_1$ or $V_2$ describes the semantic similarity of any word in $V_1$ or $V_2$ to any word in two sentences. Next, we would calculate semantic similarity score for every word ($w_1$-----$w_n$) using the value of corresponding vector entry. Then, small weight value $\delta$ ($0 < \delta < 1$) is given to words in the sentence due to their prevalence of usage. Finally, we get news content similarity score by computing cosine similarity from (1).

$$Sim(sentence1, sentence2) = \frac{V_1 V_2}{\|V_1\| \|V_2\|} = \sqrt{\sum_{i=1}^{n} V_{1_i}^2} \sqrt{\sum_{i=1}^{n} V_{2_i}^2} \quad (1)$$

## C. Analyzing Polarity Score from News Comments

New consumers' opinion or comments from Facebook news posts help to define news authenticity. Defining comments polarity score is generally based on set of lexicons or pre trained classifiers. In our system, we use sentiment analytical tool: VADER to know users opinion within the comments. VADER is a lexicon and rule-based sentimental tool which intend to extract opinion in social media text [20]. It relies on a dictionary which maps lexical features to know emotion intensities called sentiment polarity score. This score of a text obtain by summing the word intensity in the text. VADER defines how positive or negative score of a text comments in the Facebook news post.

## D. Classifying News Authenticity

Fake news detection on social media is a complex and difficult task. To solve this issue, we need to consider efficient supervised machine learning techniques to classify online news' authenticity. In our system, we utilize three different machine learning classifiers namely Decision Tree, AdaBoost and Random Forest classifiers.

*Decision Tree:* This classifier is a tree-like structure of possible outcomes of a series of related choices. There are three different types of nodes in structure: chance nodes,

decision nodes and end nodes. A chance node is a branch in a tree which shows a set of possible outcomes of the decision tree. A decision node is a decision to be made and an end node is the final outcome of decision tree. The tree starts with a single node which branches into possible outcomes. To select the best attributes in decision tree, it uses two measures: Entropy and Information Gain. Entropy is the useful measure which shows the uncertainly in the data values. It is used to determine how a decision tree can split the data. Information Gain is the measure which is used to choose attribute that best splits the data of each node in a decision tree. The tree is constructed top-down manner by using divide-and-conquer approach.

Although decision tree classifier is easy to interpret, visualize and no need to normalize column, it has few weak points. Decision tree can overfit due to noisy data when a tree is particularly deep. To tackle this problem, we use ensemble machine learning approach in fake news detection system. It is a composite model to get higher accuracy than using a single classifier (decision tree). There are two groups of ensemble methods are parallel ensemble methods and sequential ensemble methods. In our propose system, we use Random Forest classifier for parallel approach and AdaBoost classifier for sequential approach to classify news authenticity. We describe work flow between single classifier and ensemble classifiers in Fig 2.

*Random Forest classifier:* It is a strong modeling technique which operates a multitude of decision trees and thus improves the accuracy than a single decision tree. Their ability is to limit over fitting as well as error due to bias. It needs adjust parameters such as max-depth, min-samples-split, n-estimators and random-state to achieve the best performance; where max-depth is the maximum depth of a decision tree; in-samples-split is the minimum number of samples to split an internal node and n-estimators is the number of decision trees in the random forest.

*AdaBoost classifier:* It is used to boost the performance of decision trees on binary classification problems. A single classifier may classify the objects poorly. It is iterative ensemble method which combines low accurate classifiers into a high accurate classifier. The basic concept of AdaBoost is that weak models are added sequentially and trained the data sample in each iteration using the weighted training values.

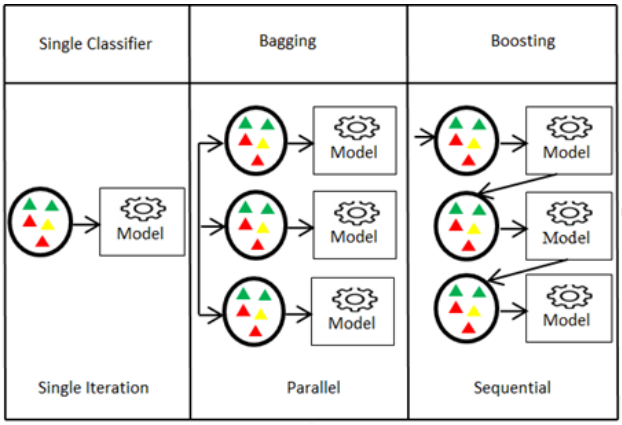


**Figure 2. Work flow between single classifier and ensemble classifiers**

## IV. System Evaluation

In this section, we first describe the nature of "BuzzFace" dataset which are used in our proposed model. Next, evaluation metrics are presented for fake news detection system and we compare the performance result of proposed system using three different classifiers.

### A. Dataset

We use BuzzFace news dataset to detect fake news in this system. It contains 1780 news articles with social features which are collected from Facebook news posts. It annotates the labels of the news articles into four categories: 77.81% of the 1780 news articles are labeled as mostly true, 12.87% are labeled as mixture of true and false, 3.99% are labeled as no factual content and the remaining as mostly false. Mostly true and mostly false mean that information in the news article is either accurate or inaccurate. Mixture of true and false is used when the information seems to be accurate or when the information is based on unconfirmed news article by authentic sources. No factual content is chosen when the information is opinion, satire or comics. Each news article includes both news content and news' social features such as reaction and news' comment with annotated label. According to 5-fold cross validation, we split the dataset 80% for training and 20% of the dataset for testing in this system.

### B. Evaluation Metric and Performance

The various evaluation metrics have been used in evaluating performance for fake news detection system. In this paper, we apply the following metric to predict the news is reliable or fake.

$$Precision = \frac{|TP|}{|TP|+|FP|}$$

$$Recall = \frac{|TP|}{|TP|+|FN|}$$

$$F1\ score = \frac{2.Precision.Recall}{Precision+Recall}$$

$$Accuracy = \frac{|TP|+|TN|}{|TP|+|TN|+|FP|+|FN|}$$ , where

True Positive (TP) means that predicted fake news pieces are actually annotated as fake news.
True Negative (TN) means that predicted true news pieces are actually annotated as true news.
False Negative (FN) means that predicted true news pieces are actually annotated as fake news.
False Positive (FP) means that predicted fake news pieces are actually annotated as true news.

Precision is a good measure when the false positive is high. The news consumers might lose to know news' authenticity if the precision is not high for fake news detection model. Precision shows about how our fake news detection model is out of these predicted positive. Recall calculates how many of the actual positive our model capture true positive. F1 is used to combine precision and recall which can provide overall prediction performance for fake news detection. In our evaluating system, the higher accuracy provides the better performance.

### C. Performance Result

This section describes the system evaluation using Decision Tree, AdaBoost and Random Forest classifiers. The experimental results show in Fig 3 by using these classifiers. We observe that the accuracy of Random Forest classifier is better than Decision Tree and AdaBoost classifier. In other word, the accuracy of bagging algorithm is better than single classifier and boosting method in our system.

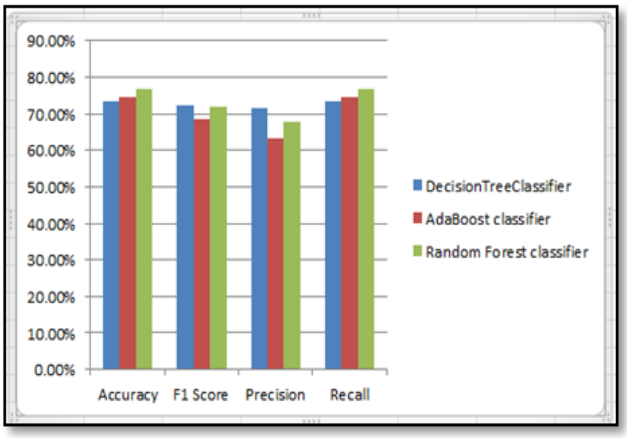


**Figure 3. The performance of fake news detection in term of precision, recall and accuracy using Decision Tree, AdaBoost and Random Forest classifiers**

## V. Conclusion

In this paper, we present a multidimensional fake news data repository that covers news content, social engagement and news stance. We describe how to collect news stories from different news sources using Graph API and News API and how to define annotate label for each news piece. The proposed model in this system is an idea to be more precise and achieve better performance than prior research which based on news content only. Moreover, we perform an exploration study on BuzzFace dataset by applying synonym-based feature extraction method and compare the performance of the system using three different classifiers. In future work, we wish to test hybrid classification methods to get better performance in classifying online news.

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