

# Pakistani Media Fake News Classification using Machine Learning Classifiers

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**Abstract**— Identification of Fake News is import now a days because it is affecting our social life and opinions. Public misinformation detection is complicated task especially Pakistani media Fake News classification. We have seen Fake News in every aspect of life like politics, sports, business, entertainment and many more. For identification of fake news, we have done popular news websites scrap and develop our corpus of 344 News articles and labeled it manually Fake or True. We have investigated two feature extraction techniques like Term Frequency (TF) and Term Frequency-Inverse Document Frequency (TF-IDF). Seven different supervised Machine Learning (ML) classification algorithms are used and their results comparison have done. Best performance classifier K Nearest Neighbors (KNN) gives 70 % accuracy and logistic regression gives 69 % accuracy. Results can improved further by increasing number of articles in corpus.

**Keywords**—Fake News, ML, Classifier, BoW, TF-IDF, NLP

## I. INTRODUCTION

News on print media and electronic media are playing a key role in building people's opinions and beliefs. With the advancement of internet, that is due to different telecom operators across the Pakistan. Millions of users are using internet services in Pakistan on latest smart phones [1]. In Pakistan, people can access any news website anytime. Now news shifts momentum from print media to social media and online websites of news spreading agencies. Now Fake News problem has become a hot topic these days. Fake News problem is worldwide problem mostly after U.S general election (Allocott & Gentzkow, 2017) since 2016 [2].

In Pakistan, Fake News issue has observed in all type of news like political, sports, security, power sector, human rights, business, judiciary, foreign affairs, entertainment etc. Mostly Fake News issue has observed in political news type especially in general election 2018. People's opinions are change due to this. It is unethical to share the fake news and affect the people's point of view and their life's. It is tough for peoples to recognize true and fake news. They affected directly due to this. Mostly in general elections fake news unfold all around on social media, print media and news websites even on electronic media. Propaganda has created to effect people opinion and to manipulate the elections results. It is difficult task to distinguish between fake and real news in pool of news. When you have same type of news all around you. People going to belief in Fake News as it proliferates. Measuring of Fake News is complex and resource intensive [3]. News verification in era of technology is an important matter to identify fake news in certain streams of online resource. The newspaper articles, report

and editorial expose etc. are designedly deceptive to cross verify this technology is involved (Rubin, Conroy & Chen, 2015) [13]. Research from last four decades shows how humans are capable of detecting Fake News from text. A finding of Bond Jr, Charles F., and Bella M. DePaulo. reveals humans are only 4% better than a chance. They concluded this after 400 experiments on meta-analysis [8].

We present in this paper machine learning classification techniques using text analysis based vectorization techniques like Bag of Words (BoW) and Term Frequency Inverse Document Frequency (TF-IDF). We compared different supervised machine learning (ML) classification techniques like logistic regression (LR), Support Vector Machine (SVM), K-Nearest Neighbor (KNN), Random Forest Classifier (RFC), Naïve Bayes (NB) and Decision Tree Classifier (DTC). Data set has prepared by collecting Fake and True News from online available news websites. Data set has labeled manually fake or true. Fake News has collected from well-known News agencies in Pakistan. Experiments have done using libraries of Natural language toolkit for preprocessing of text data. Final classification has done using mentioned classifiers that are imported using scikit-learn library.

The paper has further divided as follows. In section II, related works that has done in recent past discussed. Section III describes Methodology, which includes model description, data preprocessing techniques (stop words removal, stemming), vectorization techniques count vectorizer or bag of words (BoW), term frequency-inverse document frequency (TF-IDF) and classification process. Data set description and experimental procedure are present in Section IV. Data normalization, word cloud representation of data and classifiers results summary has shown in Results Section V. The final Section VI includes Conclusion of all experiment results and future work.

## II. RELATED WORKS

Various studies have done on Fake News in the interest of society from last few years. We review some of published work. Large amount of News data is available online the credibility of News is vital issue now a days. For this reason, several studies had done to detect the Fake News on online available News sources like social media Twitter, Facebook and other News link available. Data collected from online resources and several Machine Learning approaches had discussed to predict the credibility of news article. On social media, major concern is detection of opinion spam, detection of News and microblog spam and online available information credibility [3]. Ahmed, Hadeer, Issa Traore, and Sherif Saad. In their online fake news

detection, the paper proposed a model that uses n-gram analysis and machine learning (ML) algorithms. They used feature extraction techniques of text data and train six different machine learning (ML) algorithms to get results. Experiment results shows linear support vector machine (LSVM) gives 92% accuracy with term frequency-inverse document frequency (TF-IDF) as finest text vectorization technique [4].

To distinguish between fake and true articles a study has done by Horne, Benjamin D., and Sibel Adali. According to their research, fake news titles have more nouns and verbs and few number of stop words. The extracted features from data and grouped into three categories as follows; first, evaluation of text data like quality of written language, noise factor, null values, punctuations and text visibility. Secondly, human behavior features such as personal concerns and hidden emotions in words focusing on certain personal concerns. Thirdly, Stylistic features such as syntax of the text, semantics of syntax and usage of verbs and nouns [5]. Fake News used as humor intentionally a research shows unique feature of satire news, which elaborates the style of reporting. They proposed support vector machine (SVM) based algorithm, which is tested on combination of articles like humor, negative effect, absurdity grammar and punctuation. They have significant result in satire News [6]. Wang, W. Y. (2017). In their research paper, they represented labeled benchmark data set. Collected data set has labeled manually which contains 12.8K articles. They look into fake news based on language semantic patterns. They designed convolutional neural network model and text data processing based deep learning model [7]. A system for identification of headlines with respect to their article bodies has presented in research paper [8]. Their approach in fake news classification targeted on clickbait detection scenarios. The research shows separating related headlines from unrelated headlines. They got accuracy score of 89.59 % on publically available data set. Information can be generated by anyone, which can lead to fake news. Detection of fake news has end up need of society due to the fact unfold of fake news unrest the society. A study provides a model of vectors, which has tested on Indonesian language. The features has extracted from language using vector model. Model used feature extraction methods like TF and TF-IDF. They used machine learning (ML) algorithm named support vector machine (SVM) for classification of news. Using vector model for feature extraction their model gives classification accuracy of 96.74 %. Used data set contains 2516 documents [9]. Spreading of Fake News with some intention that appeared as truth called hoax. This causes anxiety and panic in society. This can affect business, law and order situation, affects someone personal life especially in field of entertained and sports. Fake News about foreign affairs can affect county relation. It can affect stock exchange and people business badly. Tourism sector has affected with such type of news. Even spreading Fake News on health is affecting society. Social media and online news articles are big source for such type of news. A study on hoax news by Prasetyo, Agung B., et al. from Diponegoro University Semarang Indonesia has done. They developed Indonesian hoax filter based on vectorization technique TF-IDF. Documents classification have done using machine learning

algorithms like SVM and stochastic gradient descent (SGD). Each word in articles has extracted as feature. SVM used linear function and SGD used non-linear function that classify the extracted feature vector. Featured word vector classification has done using linear and non-linear lines by reducing vector in two dimensions. According to their research, SGD produced best results 86 % [10]. A study case shows a simple approach to detect fake news. News has tested using Naive Bayes classifier on Facebook news data set. Many of the subjects in the train data set used in this study include abortion, capital punishment. The classification accuracy on the test data set using naive Bayes is 74%. This study shows fake news classification had made with simple artificial intelligence method [11]. Conroy, Rubin, and Chen [13] conducts a survey and provides methods for finding Fake News. They discussed linguistic cue approaches using machine learning and second approach they discuss is network analysis approach. They survey the existing approaches and purpose hybrid approach. They conclude linguistic processing should have bases on multiple layers such as lexical, word and discourse level to get maximum accuracy. Network behavior should incorporate to authenticate the sources. Publically available data set should be in form of linked data format so that fact checking should have done without error. To evaluate the Fake News on Microblog is also a challenging task. Microblog is important way of communication in modern society. Jin, Zhiwei, et al. proposed a model that detects news truthfulness in three layers such as event, sub-events, and messages and disclose useful information in news truthfulness evaluation. They conducted experiments on two data sets and achieve more than 6 % accuracy and F-score 16 % over baseline methods [14]. Liu, Yang, and Yi-Fang Brook Wu. Proposed a model to identify fake news at early stage on social media. The proposed model detects fake news by classifying distribution paths. The proposed model of multivariate time series uses vector representation of each news article from data set. The user who involved in spreading the fake news a tuple of vector representation has made to identify. They build a time series classifier, which involves recurrent and convolutional network to detect the fake news. The proposed model gives the accuracy 85% on Twitter data set and 92% accuracy on Sina Weibo data set. Model detects fake news in just 5 minutes [15]. Long, Yunfei, et al. proposed a method to include speaker profiles for example speaker location, title and history in data set. The fake news detection model that uses Long Term Short Memory (LSTM) classification algorithm shows after adding the speaker profiles model gives 14.5% more accuracy over available fake news benchmark data sets. Speaker profile plays an import role in checking credibility of news articles [16].

### III. METHODOLOGY

#### 3.1 Model Description

We made corpus of news articles by manually visiting the online available web sources. Data set has labelled manually Fake News and True News. Collected data is in raw text format a lot of noise is available. For cleaning purpose, we perform text preprocessing. Before training the data on

machine learning (ML) algorithms, we extracted the features using count vectorizer and term frequency-inverse document frequency (TF-IDF). The extracted feature matrix data from both feature extraction techniques have next driven to machine learning algorithms. Seven different supervised Machine Learning algorithms like logistic regression, Support Vector Machine (SVM), K-Nearest Neighbor

(KNN), Random Forest, Naïve Bayes and Decision Tree Classifier have trained. The final trained classification model predicts the News from test data, which is unknown to train model. Final Classification of Fake and True news has done on these predictive models. Over all model layout has represented in below mentioned figure 1.

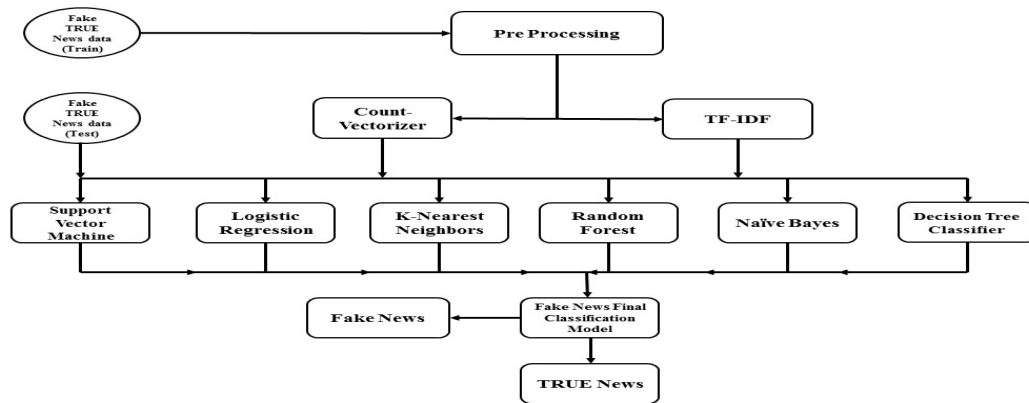


Fig.1. Fake News Classification Model Layout

### 3.2 Data Preprocessing

Data we mined from different internet sources is noisy. We have done analytics to clear noise and make correct sequence of data. Text preprocessing had done on according to research of Jurafsky and Martin text normalization [12]. We clean data like punctuation removal, stop-words removal, tokenization and lower casing. After this, size of data has reduced and irrelevant information removed. We created a function, which performs stops words removal, lower casing and tokenization. Tokenizer make separate sentences and from sentences word tokenizer make words.

#### 3.2.1 Stop words removal

Stops words have generally no meaning until they have used with other words. In text classification when features are extracted from text, stop words considered as noise. These set of words used in articles sentences to connect idea and sentence structure together. Prepositions, conjunctions and articles have considered stop words. For example words like by, for, from, how, of, on, that, the, too, was, what, when, about, etc. These words have removed. Total words count of all articles and after preprocessing unique word count in mentioned in figure 2.

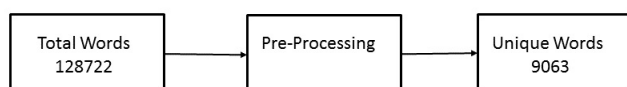


Fig.2. Pre-Processing Word Count Representation

#### 3.2.2 Stemming

Next step in text normalization is to modify the tokens in to basic words. Stemming is a technique to change the word into their actual form. Stemming has used to decrease the

classes of words in data. Stemming alters the affix of words. For examples word Pythonly become Python, We used commonly used Porter Stemmer Algorithm. As it gives good results in stemming. Words like extreme, extremely, government, transgender, minister changed to extrem, govern, transgend and minist respectively in our data set. The figure 3 shows the word cloud after applying Porter Stemmer Algorithm on our data set.



Fig.3. Words Representation after Stemming

### 3.3 Feature Extraction

Our corpus contains large number of sentences, phrase and words, which required high computation due to this learning process will be slow. Irrelevant noisy features in data decreases the performance of classifiers. To enhance the performance of classifier unnecessary feature reduction has required. It helps in reduction of text feature size as well. Dimensional vector which we can say our model classifier uses feature matrixes. Fake news classification depends on these feature extraction techniques. The methods term frequency (TF) -inverse document frequency (TF-IDF) have described below mentioned sections 3.3.1 and 3.3.2.

### 3.3.1 Term Frequency (TF)

Term frequency also called countvectorizer (CV) this approach uses bag of words (BoW) technique to assess the correspondence of documents. Each document contains bag of words, which have represented as length vector. Each word count has probability of word in the document. Word value is represented as one if it available in a document otherwise its value is zero. TF (BoW) weights of some words from corpus have shown in table I.

TABLE I. Term Frequency some Words with weights representation

Words	photo	voters	law	national
tf (bow)_weights	5.24849	3.8622	3.30258	2.60943

### 3.3.2 Term Frequency and Inverse document Frequency (TF-IDF)

In natural language processing (NLP), the term frequency-inverse document frequency (TF-IDF) have a weighted matrix. It has used to measure the significance of term in a data set. How much valued a term in a document. If number of words count have increased in the document, the importance of IDF is increased. Higher is the number of words high is the weight of term. It has counteracted by the frequency of word in data set. TF counts words such as “if”, “then” and “the” the IDF lower the impact of these terms. TF-IDF weights of some words has shown in table II.

TABLE II. TF-IDF some Words with weights representation

Words	route	western	eastern	lane
tfidf_weights	0.686817	0.327829	0.29178	0.150046

## 3.4 Classification

Classification process has shown in figure 1. First training data set had gone under process of text preprocessing. Data set has normalized after removing all noise such as stop words unnecessary characters. Feature are extracted using techniques TF-IDF. We have used seven different Machine Learning algorithms namely; Logistic Regression (LR) has used with random state Zero, Multinomial Naïve Bayes has used with alpha value 0.7. Support Vector Machines (SVM) has used with properties of Linear Kernel and Sigmoid Kernel with random state zero respectively. Random Forest Classifier (RFC) has used with default values. Decision Tree (DT) has used with value (criterion= 'entropy' and random state=0) and K-Nearest Neighbors (KNN) that also has used with default values (n\_neighbor=5, weights='uniform', metric= 'minkowski', p=2). We used Python as a programming language and imported natural language toolkit (NLTK) and skit-learn libraries for importing mentioned classifiers. We used pandas for reading coma-separated values. We split up data set into 80% train and 20% for testing purpose.

## IV. EXPERIMENTS

### 4.1 Data Set Description

Fake news detection is area of research these days and it is relatively new area as well. Few data sets are available as well online resources. We practiced our work on new corpus collected by us scraping web news articles that are available publicly. Our data set has entirely real world sources mostly

well-known news agencies available in country such as (Dawn, Dunaya, Sama, Ary, Geo) etc. online available links. We labelled data set collected by us on Pakistani media news manually. The data set contains total 344 news articles and 190 news article have labeled Fake News, which have 55.2% of total data set. Remaining 154 news articles labeled True News. Which shares 44.8% of total news articles of data. Build corpus contains news articles mostly of Sports, Politics, Health, Tourism, Business, Technology, Entertainment, Industry, Foreign affairs, Tourisms, Education, Security, Social media, Human Rights and Judiciary etc.

Following information is available for articles in data set

- Article title
- Article type
- Article text
- Article label
- Article date
- Article link

### 4.2 Experiment Procedure

We train mentioned machine learning (ML) classifiers on the data set our target is to predict articles are fake or true. We start our experiment by pre-processing of data. Data analytics is done using python libraries. Data set null values have cross-verified no null is found. Title and text word cloud have made to show the frequency of words in lower case. After that, features have extracted from text using bag of words and TF-IDF techniques by import python skit-learn libraries. Data set has divided into train and test set. Finally, machine learning (ML) classifiers have imported and confusion matrix had made to check the classification accuracy and misclassification.

## V. RESULTS

### 5.1 Data Normalization

We initially clean data by removing punctuations, email address, stop words, word tokenized, and perform stemming technique using porter stemmer and clean the overall text. The time taken to clean the data set and to normalization is 0.1047 min. we got the vocabulary of  $|V|= 9063$  words after performing mentioned data normalization. Average Length of data is 212.635 minimum document length is 17 and maximum document length is 895. Token has illustrated in form of histogram. Figure 2 in below mentioned histogram shows document length (tokens) and normed frequency.

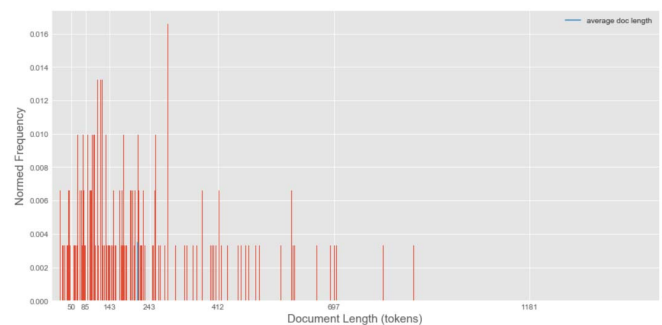


Fig.2. Plot of histogram of document length



## 5.2 Word Clouds

Word cloud have made to visualize the token of data set of title and text separately. Figure 3 shows the word cloud presentation of text data.



Fig.3. Word Cloud Representation (Text Data)

Worlds like Imran Khan, Nawaz Sharif, minister, Lahore, Karachi, china, media, government, president, information, and Pakistan and mostly used in text of News data set. Mostly political leaders are in limelight at time of election in Pakistan and News. Word cloud representation of title of news articles has shown in figure 4. Token of title of news articles shows the words repetition in data set. Our data set contains multiple type of news from Pakistani media. Title word cloud also shows the political news words frequency.



Fig.4. Word Cloud Representation (Title Data)

The title of News at mostly contains words like Imran Khan, fake News, Khadim, democracy, Maryam, tlp, people, and letter. Most News at the time of election period are political. Major headlines contains the names of top political leaders names and News. The word cloud of tile data set contains the most frequently used words.

### 5.3 Classifier results summary

We studied feature extraction techniques TF-IDF (described earlier). We applied machine learning (ML) algorithms and compared their results in below mentioned table III and table IV. Table III shows the classification summary of mentioned classifiers with precision, recall, fi-score. In this TF has used as feature extraction technique and ML classifiers have applied. As we can see, k-nearest neighbors (KNN) shows the best results in classification average/total precision, which is **70 %**. Results with Type Fake and True news also mentioned. We considered average/total score of classifiers to show performance from results.

TABLE III. SUMMARIZED CLASSIFICATION RESULTS USING TF (BOW)

Classifier Name	Precision	Recall	F1-score	Type
Logistic Regression (LR)	0.58	0.69	0.63	Fake
Logistic Regression (LR)	0.68	0.57	0.62	TRUE
Logistic Regression (LR)	0.63	0.62	0.62	avg/total
Naive Base (NB)	0.58	0.81	0.68	Fake
Naive Base (NB)	0.75	0.49	0.59	TRUE
Naive Base (NB)	0.67	0.64	0.63	avg/total
KNN	0.79	0.34	0.48	Fake
KNN	0.62	0.92	0.74	TRUE
KNN	<b>0.7</b>	0.65	0.62	avg/total
SVM(Linear Kernel)	0.63	0.53	0.58	Fake
SVM(Linear Kernel)	0.64	0.73	0.68	TRUE
SVM(Linear Kernel)	0.64	0.64	0.63	avg/total
SVM(Sigmoid Kernel)	0.46	1	0.63	Fake
SVM(Sigmoid Kernel)	0	0	0	TRUE
SVM(Sigmoid Kernel)	0.22	0.46	0.29	avg/total
Random Forest Classifier	0.56	0.78	0.65	Fake
Random Forest Classifier	0.71	0.46	0.56	TRUE
Random Forest Classifier	0.64	0.61	0.6	avg/total
Decision Tree Classifier	0.56	0.78	0.65	Fake
Decision Tree Classifier	0.71	0.46	0.56	TRUE
Decision Tree Classifier	0.64	0.61	0.6	avg/total

Table IV shows the classification summary of mentioned classifiers with precision, recall, fi-score. In this IDF has used as feature extraction technique and machine learning algorithms have applied. As we can see, logistic regression shows the best results in classification average/total accuracy, which is **69 %**.

TABLE IV. SUMMARIZED CLASSIFICATION RESULTS USING TF-IDF

Classifier Name	Precision	Recall	F1-score	Type
Logistic Regression (LR)	0.55	0.91	0.68	Fake
Logistic Regression (LR)	0.81	0.35	0.49	TRUE
Logistic Regression (LR)	<b>0.69</b>	0.61	0.58	avg/total
Naive Base (NB)	0.54	0.91	0.67	Fake
Naive Base (NB)	0.8	0.32	0.46	TRUE
Naive Base (NB)	0.68	0.59	0.56	avg/total

KNN	0.56	0.78	0.65	Fake
KNN	0.71	0.46	0.56	TRUE
KNN	0.64	0.61	0.6	avg/total
SVM(Linear Kernel)	0.59	0.81	0.68	Fake
SVM(Linear Kernel)	0.76	0.51	0.61	TRUE
SVM(Linear Kernel)	0.68	0.65	0.65	avg/total
SVM(Sigmoid Kernel)	0.46	1	0.63	Fake
SVM(Sigmoid Kernel)	0	0	0	TRUE
SVM(Sigmoid Kernel)	0.22	0.46	0.29	avg/total
Random Forest Classifier	0.55	0.81	0.66	Fake
Random Forest Classifier	0.73	0.43	0.54	TRUE
Random Forest Classifier	0.65	0.61	0.6	avg/total
Decision Tree Classifier	0.59	0.62	0.61	Fake
Decision Tree Classifier	0.66	0.62	0.64	TRUE
Decision Tree Classifier	0.63	0.62	0.62	avg/total

## VI. CONCLUSION

Fake news is relatively new research area. Not many public data sets obtainable. We need to work on building local news articles corpus to contribute in society. We tried to make our corpus which itself is a contribution. As the time progress, we face Fake News every day. We can enlarge our data set by adding more articles. Future researches can work on this.

In this research paper, seven machine learning (ML) algorithms for classifying Pakistani media fake news has implemented. The research shows, that artificial intelligence algorithm (Logistic regression classifier & KNN) shows significant results on such a major problem of fake news text classification. Logistic regression performs wells on feature extraction technique TF-IDF that shows the **69%** accuracy. The k-nearest neighbor (KNN) performs well on feature extraction technique like bag of words (BoW) and gives **70%** accuracy. Therefore, the outcome of this research recommend that ML algorithms can successfully use to tackle this serious problem. Obtained results might be significantly improved. It is possible to improve the data and increase the size of corpus with the time advancement. Applying alternative vectorization technique such as word2vec and deep learning models like LSTM for classification, this might be a topic for future research.

## REFERENCES

- [1] Imtiaz, S. Y., Khan, M. A., & Shakir, M. (2015). Telecom sector of Pakistan: Potential, challenges and business opportunities. *Telematics and Informatics*, 32(2), 254-258.
- [2] Allcott, H., & Gentzkow, M. (2017). Social media and Fake News in the 2016 election. *Journal of economic perspectives*, 31(2), 211-36.

- [3] Viviani, M., & Pasi, G. (2017). Credibility in social media: opinions, News, and health information—a survey. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, 7(5), e1209.
- [4] Ahmed, H., Traore, I., & Saad, S. (2017, October). Detection of online Fake News using N-gram analysis and machine learning techniques. In *International Conference on Intelligent, Secure, and Dependable Systems in Distributed and Cloud Environments* (pp. 127-138). Springer, Cham.
- [5] Horne, B. D., & Adali, S. (2017, May). This just in: Fake News packs a lot in title, uses simpler, repetitive content in text body, more similar to satire than real News. In *Eleventh International AAAI Conference on Web and Social Media*.
- [6] Rubin, V., Conroy, N., Chen, Y., & Cornwell, S. (2016, June). Fake News or truth? using satirical cues to detect potentially misleading News. In *Proceedings of the second workshop on computational approaches to deception detection* (pp. 7-17).
- [7] Wang, W. Y. (2017). "liar, liar pants on fire": A new benchmark dataset for Fake News detection. *arXiv preprint arXiv:1705.00648*.
- [8] Bond Jr, C. F., & DePaulo, B. M. (2006). Accuracy of deception judgments. *Personality and social psychology Review*, 10(3), 214-234.
- [9] Al-Ash, H. S., & Wibowo, W. C. (2018, July). Fake News Identification Characteristics Using Named Entity Recognition and Phrase Detection. In *2018 10th International Conference on Information Technology and Electrical Engineering (ICITEE)* (pp. 12-17). IEEE.
- [10] Prasetyo, A. B., Isnanto, R. R., Eridani, D., Soetrisno, Y. A. A., Arfan, M., & Sofwan, A. (2017, October). Hoax detection system on Indonesian News sites based on text classification using SVM and SGD. In *2017 4th International Conference on Information Technology, Computer, and Electrical Engineering (ICITACEE)* (pp. 45-49). IEEE.
- [11] Granik, M., & Mesyura, V. (2017, May). Fake News detection using naive Bayes classifier. In *2017 IEEE First Ukraine Conference on Electrical and Computer Engineering (UKRCON)* (pp. 900-903). IEEE.
- [12] Stolcke, A., Ries, K., Coccaro, N., Shriberg, E., Bates, R., Jurafsky, D., ... & Meteer, M. (2000). Dialogue act modeling for automatic tagging and recognition of conversational speech. *Computational linguistics*, 26(3), 339-373.
- [13] Conroy, N. J., Rubin, V. L., & Chen, Y. (2015). Automatic deception detection: Methods for finding fake News. *Proceedings of the Association for Information Science and Technology*, 52(1), 1-4.
- [14] Jin, Z., Cao, J., Jiang, Y. G., & Zhang, Y. (2014, December). News credibility evaluation on microblog with a hierarchical propagation model. In *2014 IEEE International Conference on Data Mining* (pp. 230-239). IEEE.
- [15] Liu, Y., & Wu, Y. F. B. (2018, April). Early detection of Fake News on social media through propagation path classification with recurrent and convolutional networks. In *Thirty-Second AAAI Conference on Artificial Intelligence*.
- [16] Long, Y., Lu, Q., Xiang, R., Li, M., & Huang, C. R. (2017, November). Fake News detection through multi-perspective speaker profiles. In *Proceedings of the Eighth International Joint Conference on Natural Language Processing (Volume 2: Short Papers)* (pp. 252-256).