



AdaBoost Ensemble Learning on top of Naive Bayes Algorithm to Discriminate Fake and Genuine News from Social Media

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Abstract

There is a continuous increase in social media usage and a huge interaction takes place between users. In this context, fake news circulation or flood becomes a real thread for social media users from various perspectives. Fake news is defined as presentation of misleading information as true news. In this view, fake news is fabricated news that aims to manipulate public opinion to obtain a benefit. For example, increasing readership for profiting through clickbaits is such an aim. Social media users are manipulated through attention grabbing headlines or web-links to increase number of visitors. Therefore, an automated fake news identification model can be used by social media users to filter inadvertent web-traffic. For this goal machine learning algorithms are used in the literature as a solution for fake news problem. In machine learning literature, advancing performance of the base models is crucial. Ensemble learning is one of the key solutions to enhance model efficiency. In this work, we first generated a set of baseline machine learning algorithms and we tested them in terms of their fake news identification ability. We then made use of ensemble learning strategy to further enhance obtained results. More precisely, we obtained Naive Bayes Multinomial classifier as the best fake news predictor having 96.74 % accuracy. We then further improved this prediction ability to 98.2 % by applying an AdaBoost ensemble learning strategy.

Keywords: Fake News Identification, Ensemble Learning, Machine Learning, Text Mining, Social Media

Naive Bayes Algoritmasının AdaBoost Topluluk Öğrenme Modeli ile Sosyal Medyada Sahte ve Gerçek Haberlerinin Ayırt Edilmesi

Öz

Sosyal medya kullanımında sürekli bir artış yaşanmakta ve kullanıcılar arasında büyük bir etkileşim gerçekleşmektedir. Bu bağlamda yalan haber sirkülasyonu veya yayılımı, sosyal medya kullanıcıları için çeşitli açılardan gerçek bir tehdit haline gelmektedir. Yalan haber, yanıltıcı bilgilerin doğru haber gibi sunulması olarak tanımlanmaktadır. Bu görüşe göre, sahte haber, bir çıkar elde etmek için kamuoyunu manipüle etmeyi amaçlayan uydurma haberlerdir. Örneğin, tıklama tuzakları yoluyla kâr elde etmek için okuyucu sayısını artırmak böyle bir amaçtır. Sosyal medya kullanıcıları, ziyaretçi sayısını artırmak için dikkat çekici başlıklar veya web bağlantıları aracılığıyla manipüle edilmektedir. Bu nedenle, sosyal medya kullanıcıları tarafından yanlışlıkla web trafiğini filtrelemek için otomatik bir sahte haber tanımlama modeli kullanılabilir. Bu amaçla literatürde sahte haber problemine çözüm olarak makine öğrenmesi algoritmaları kullanılmaktadır. Makine öğrenimi literatüründe, temel modellerin performansını geliştirmek kritik öneme sahiptir. Topluluk öğrenimi, model performansını artırmanın temel çözümlerinden biridir. Bu çalışmada, önce bir dizi temel makine öğrenmesi algoritması oluşturulmuş ve bu algoritmalar sahte haber tanımlama yetenekleri bağlamında test edilmiştir. Daha sonra elde edilen sonuçları daha da geliştirmek için topluluk öğrenme stratejisi kullanılmıştır. Diğer bir ifade ile %96.74 doğrulukla en iyi sahte haber tahmincisi olarak Naive Bayes Multinomial sınıflandırıcısını elde edilmiştir. Daha sonra bir AdaBoost topluluğu öğrenme stratejisi uygulanarak bu tahmin yeteneği daha da geliştirilmiş ve başarı %98,2'ye çıkarılmıştır.

Anahtar Kelimeler: Sahte Haber Tespiti, Topluluk Öğrenmesi, Makine Öğrenmesi, Metin Madenciliği, Sosyal Medya.

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1. Introduction

The usage of social media has become very popular in recent years. While this situation offers many benefits, it also causes some negative situations to occur. The inability to control social media shares and the rapid spread of messages increase the problems that may arise. Fake news is one of the main problems that rise with the increase in social media practice. While this problem has effects on people's living negatively, it extends the solution process and makes the problems permanent.

Fake news researches for different languages have been published in literature. In this context, we will present the most recent literature that makes use of an ensemble learning. Hakak et al. proposed an ensemble classification model which consists of Decision Tree, Random Forest and Extra Tree Classifier for fake news detection. The authors obtained %99.8 training accuracy in fake news prediction (Hakak et al., 2021). In their work, Olaleye et al. used voting ensemble model with Support Vector Machine, Voted Perceptron, RepTree, and Decision Stump algorithms to classify COVID-19 fake news. They achieved 99.93% prediction accuracy with the use of 10-fold cross validation (Olaleye et al., 2021). Das et al. developed an automatic fake-tweet detection system through an ensemble model and they have got 98.31% in terms of F-1 Score (Das et al., 2021). Another study to predict fake-news for COVID-19 dataset is evaluated by Qasem et al. using ensemble learning for Arabic language. The authors obtained 92.63% F1-Score as their best prediction score (Noman Qasem et al., 2021). Bezerra prepared an ensemble model that consists of stylometrics, semantics and linguistic properties that gave a better predictor compared to content-based approaches alone (Ribeiro Bezerra, 2021). In another work, Aslam et al. used LIAR dataset to classify news as real or fake by using an ensemble-based deep learning model. They achieved 91.4% F1-Score from their experiments (Aslam et al., 2021). LekshmiAmmal and Madasamy obtained 88.13% F1-Score by using RoBERTa to predict fake news (Lekshmiammal & Madasamy, 2021). In one another work, Meel and Vishwakarma applied majority voting Ensemble method on fake news identification and they obtained 95.90% accuracy (Meel & Vishwakarma, 2021). Shushkevich and Cardiff created an ensemble model to classify Covid-19 fake news and achieved 94% in terms of F1-Score. The mentioned model contained Naive Bayes, Bidirectional Long Short Term Memory, Support Vector Machine Logistic Regression and Naive Bayes (Shushkevich & Cardiff, 2021). Apart from English there are studies in the literature for languages such as Arabic, Urdu, Turkish, Spanish to identify fake news with the use of use ensemble methods (Akhter et al., 2021; Al-Yahya et al., 2021; Guan, 2021; Onan & Tocoglu, 2020).

In this study, a machine learning model was designed to detect Turkish fake news. Within the scope of the study, a few machine learning algorithms were experimented as baseline. Furthermore, the performance of the baseline algorithms are evaluated with their AdaBoost Ensemble counterparts.

The rest of the paper is as follows: The proposed framework and the experimental setup are explained in Section 2. The experimental results are given in Section 3. The research is ended with conclusion in Section 4.

2. Material and Method

In this section, we explain the proposed AdaBoost ensemble based Turkish fake news detection methodology. Our pipeline

consists of subsections as data generation and the whole experimental setup. We then explained the evaluation and validation metrics. The study is then ended with conclusion.

2.1. Data

The fake news data is obtained from famous fake-news source Zaytung (Github, 2021) and the real news is collected from Hurriyet. The data consists of 2163 fake and 2296 real news totally.

2.2. Experimental Setup

Having obtained dataset, we pre-processed data to extract features in terms of vector space model. In this model the text is encoded with the use of term frequency-inverse document frequency (TF-IDF) approach (Kadhim, 2019). The encoded text is then used in machine learning train-test pipeline. While developing models, we preferred to use ten-fold cross validation scheme to evaluate the proposed framework.

The experimental setup mainly consists of two steps: i) selection of widely used machine learning algorithms from literature and ii) generation of AdaBoost ensemble counterparts of the algorithms from step (i).

For step one we selected Naïve Bayes (NB), Naïve Bayes Multinomial (NBM), Support Vector Machine (SVM) (Ozkaya, 2020), K-Nearest Neighbour (KNN), J48-tree and Random Forests (RF). We then obtained 10-fold cross validation based accuracies while detecting fake-news.

In step two, we generated AdaBoost ensembles of the algorithms selected and we re-evaluated 10-fold cross validation based performances of the ensembles.

The whole experimental setup is summarized in Figure 1.

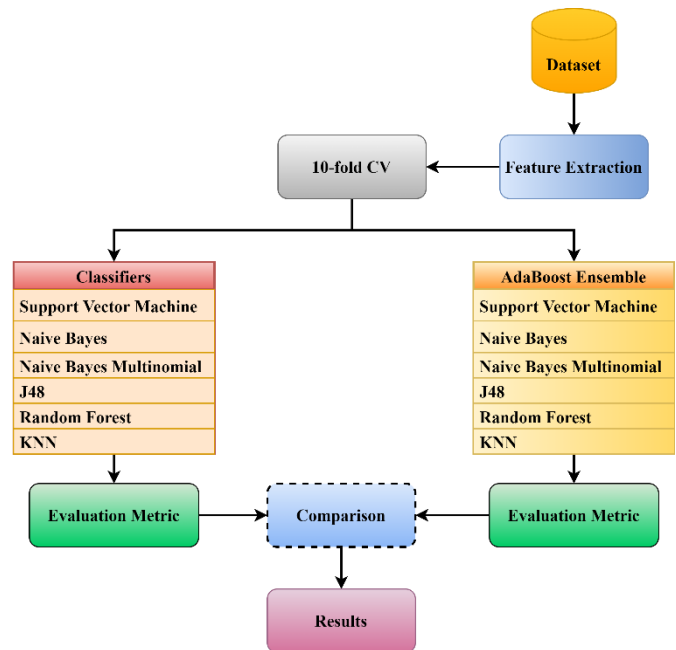


Figure 1. Experimental setup

2.3. Experimental Setup

Any classification comparison is realized with the use of evaluation and validation metrics such as Accuracy (Acc) and Kappa (Kp). For balanced datasets, Acc is calculated as in Equation 1.

$$Acc = \frac{TP + TN}{TP + TN + FP + FN} \quad (1)$$

In Equation 1, while True Positives (TP) and True Negatives (TN) correspond to correct predictions. False Negatives (FN) and False Positives (FP) correspond to incorrect predictions.

One of the statistical validation metric is Kp (Sasikala et al., 2017) and it is calculated with Equation 2. The metric generates values between [0,1] and for a classifier if the experiment generates value of above 0.7 then it is statistically meaningful.

$$K_p = \frac{p_0 - p_e}{1 - p_e} \quad (2)$$

3. Results

In this section, we present the experimental results for the proposed approach in terms of Acc and Kp.

The experimental results of the two approaches are given in Table 1.

Table 1. Experimental results

Algorithms	Classifiers		AdaBoost Ensembles	
	Acc	Kp	Acc	Kp
NB	.889	.779	.979	.957
NBM	.959	.917	.980	.960
SVM	.977	.953	.977	.953
KNN	.612	.204	.612	.204
J48	.917	.833	.955	.910
RF	.937	.875	.937	.874

As Table 1 is inspected in terms of Acc value, we may observe that AdaBoost ensemble of NBM algorithm is superior to remaining predictors. Furthermore, we also notice that AdaBoost ensembles of algorithms are either enhanced or retained their

4. Conclusions

Fake news detection is an essential research topic at the digital age and it becomes more important as the social media usage increases. Since fake news may manipulate the user opinions, determining the source of news is undoubtedly crucial. In this work, we made use of conventional algorithms to detect fake news in Turkish. In order to enhance the obtained results we proposed an AdaBoost ensemble approach. The experimental results show that AdaBoost ensemble learning may boost the performance of the algorithms in terms of classification accuracy. As a research direction, this work may be extended with other ensemble approaches.

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performances in terms of fake news identification. We additionally visualize the mentioned results in Figure 2.

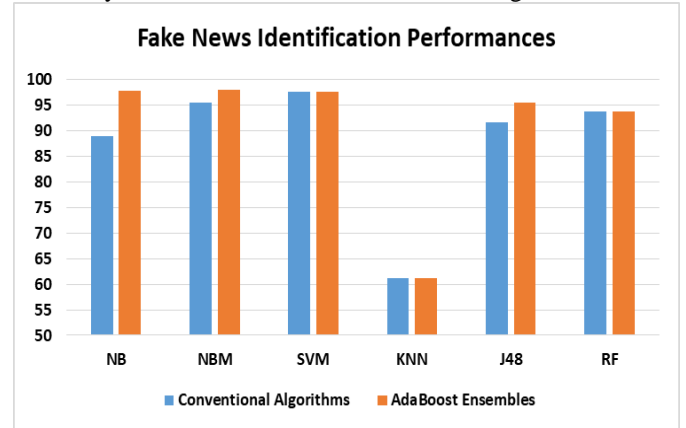


Figure 2. Accuracy of algorithms

We also statistically validate the obtained results with the use of Kp metric from Table 1 and we summarize the given results in Figure 3.

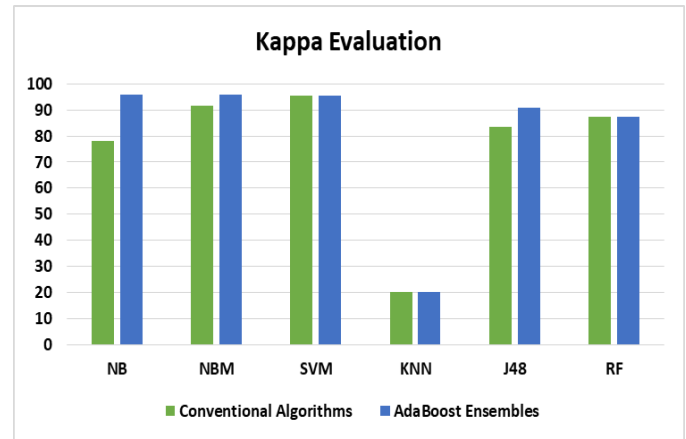


Figure 3. Kappa score of dataset

We can understand from Figure 3 that all classifiers and their ensembles except KNN have values above 0.7. We may conclude that the obtained results are statistically meaningful.

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