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Sentiment Analysis on Hate Speech Post 2024 Election for Elected President Using a Hybrid Model

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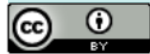
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Abstract. One of the important events in the democratic life of a country is the general election. In addition, the possibility of hate speech appearing on social media increases as political tensions increase. This hate speech can take the form of negative comments, insults, or even threats against the elected president. This research uses the content of tweets as a data source to analyze public opinion and sentiment towards the elected president. This research aims to analyze sentiment towards hate speech held by twitter users towards the elected president after the 2024 election by building a hybrid model using 3 algorithms, namely k-nearest neighbors, long short-term memory and naive bayes. The results of tests carried out with 12,000 tweet data that show the naive bayes method classification results have an accuracy of 72%, the long short-term memory classification results show an accuracy of 78%, the k-nearest neighbors method accuracy value is 83%, and the hybrid model accuracy value is 78%. Considering the accuracy values of the three algorithm method, by using a hybrid model we can increase the accuracy by combining the three algorithm models. from previously having the lowest accuracy of 72%, by using a hybrid model we can increase the accuracy to 78%.

Keywords: Election, Hybrid Model, K-Nearest Neighbors, Long Short-Term Memory, Naive Bayes

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INTRODUCTION

Elections are a significant event in the democratic life of a country. The 2024 election in Indonesia holds great importance as it will determine national policy direction and leadership for the coming years. This election is predicted to be one of the most heated presidential elections in Indonesia's history[1]. Social media has evolved into one of the primary sources of information and political discussion in recent years. However, with the increased use of social media, there has also been a rise in the spread of hate speech and misinformation. Hate speech is a serious issue in the political context[2].

To facilitate the collection of public opinions post-2024 election, data can be gathered from social media. One social networking site I'll utilize is twitter, which will simplify this research in obtaining the necessary data. Comments made by twitter users will serve as the data source[3].

In a previous study titled "Sentiment Analysis of Public Opinion on Presidential Candidates in Preparation for the 2024 Election Using K-Nearest Neighbor and Particle Swarm Optimization" particle swarm optimization (PSO) and the k-nearest neighbors (KNN) approach were used in the study for optimization. The study's primary goal was to examine popular opinion of presidential contenders. The study's findings indicated that although KNN had an accuracy of 65%, PSO optimization increased that accuracy to 95.19%[4]. A similar study titled "Sentiment Analysis Public Twitter on 2024 Election using the Long Short Term Memory Model" employed the LSTM approach to examine public opinion for the election of 2024. The accuracy of this study was 78%. 2.2% of respondents were positive, 37% were negative, and 10.8% were neutral[5]. In a study titled "Application of naive bayes Algorithm and PSO in Sentiment Analysis of 2024 Presidential Candidates" The three primary 2024 presidential contenders were assessed based on the opinions of the general population using particle swarm optimization and naive bayes methodologies. The dataset of Anies Baswedan had 63.02% accuracy, 65.13% recall, and 64.61% precision, according to the results. The dataset of Ganjar Pranowo had 85.43% precision, 87.46% recall, and 87.14% accuracy. The dataset of Prabowo Subianto had 83.17% accuracy, 83.17% recall, and 84.17% precision[6].

Based on previous studies, opinions on the vice-presidential and presidential contenders for the 2024 election are divided into several positive and negative categories. Since there have already been numerous studies examining sentiment towards presidential candidates in the 2024 election, this study will differ by focusing on the sentiment analysis of hate speech towards the elected president after the 2024 election. As a result, a hybrid machine learning model composed of KNN, LSTM, and naive bayes algorithms will be used for sentiment analysis. This study is titled "Sentiment Analysis on Hate Speech Post-2024 Election for Elected President Using a Hybrid Model." The research aims to achieve high accuracy and precision to provide more accurate information on hate speech towards the elected president after the 2024 election.

METHODS

Sentiment analysis is a technique for identifying and comprehending viewpoints or emotions conveyed in written communication[7]. Sentiment analysis can be used in presidential election contexts to detect hate speech aimed at the chosen president following the 2024 election. Machine learning is a useful technique for sentiment analysis[8]. Through the use of sentiment-labeled text data (positive, negative, or neutral), machine learning models can be taught to identify the traits and patterns of text that convey particular sentiments.[9] A hybrid machine learning model is used in this study, which makes use of long short term memory (LSTM), k nearest neighbors (KNN), and naive bayes. Several algorithms are combined in this hybrid machine learning model to produce more optimal outcomes[10]. After the 2024 election, this study will concentrate on tweets that express neutral, favorable, and negative opinions about how a person or group perceives the president who has been elected. Natural language processing (NLP) techniques will be applied to the research subjects in order to examine public opinions regarding the elected president following the 2024 election[11].

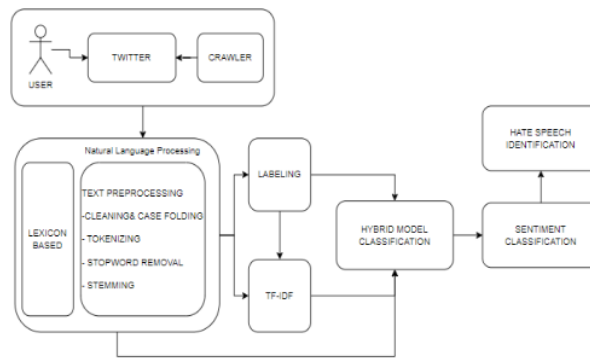


Figure 1. Architecture sentiment analysis

Crawling, as used in this study, is the practice of autonomously gathering data from webpages. We will utilize the python programming language to collect twitter data[12]. Labeling training and test data, text preprocessing, word weighting, classification using long short term memory (LSTM), k nearest neighbors (KNN), and naive bayes methods, and computing accuracy, precision, and recall are the procedures involved in data processing in this work. The best model will then be evaluated on data without sentiment labels when it has been determined [13]. Tokenizing, remove stopwords, cleaning, case folding, and stemming are some of the phases in the text preparation process. Individual words in their original form are the end product of this process[14]. Thirty percent of the text data from the earlier processing will be used for testing, and seventy percent will be used for training. Raw data without TF-IDF weighting will be utilized for the LSTM model. The model categorization will be carried out by creating and utilizing the proper parameters for each algorithm[15]. After that, the model will be trained to the training set of data so that it can pick up trends throughout the entire set. After obtaining the best model from the long short term memory (LSTM), k nearest neighbors (KNN), and naive bayes algorithms, this model will be implemented to classify text data that still lacks sentiment labels[16]. After these three models have classified the data,

we will perform a comparison of the sentiments provided by each model. Each sentiment output for the given dataset will be compared among the three algorithm models. If the three models choose different sentiments, the algorithm with the highest accuracy during testing will be selected[10].

After obtaining the sentiment analysis predicted as negative by the hybrid model, sentiments labeled as negative will be identified to determine whether these comments constitute hate speech against the elected president post-2024 election or not. The confusion matrix is one of the instruments used to assess a classification model's performance[17]. The hybrid model combines F1-score, recall, and precision. The author can demonstrate how many accurate and inaccurate predictions the hybrid model produced in comparison to the actual known values by using the confusion matrix. We use a three-by-three confusion matrix to classify positive, negative, and neutral sentiments[18].

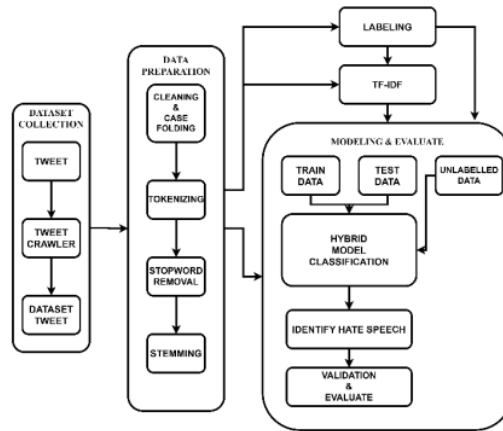


Figure 2. Research stage

Figure 2 is the flow of this research.

1. Collecting data :

The data was obtained from twitter using a crawling technique using the keyword “prabowo curang”, “prabowo pelanggar ham”, “prabowo tempramental”, “prabowo galak”, “prabowo jahat”, “prabowo tidak tahu malu”, “prabowo penipu”, “prabowo pembunuh”, “prabowo pembohong”, “prabowo pendusta”, “prabowo penghianat”, “prabowo penjahat”, “prabowo kejam”, “prabowo pelit”, “prabowo mati”, “prabowo korupsi”, “prabowo suap”, “prabowo licik”, “prabowo pecundang”, “prabowo munafik”, “prabowo pengecut”, “prabowo tukang tipu”, “Prabowo arogan”, “Prabowo manipulatif”, “Prabowo pelanggar hukum”, “prabowo bodoh”, “prabowo sombong”, “prabowo serakah”, “prabowo biadab”, “Prabowo pembual”, “prabowo busuk”, “prabowo kasar”, and “prabowo kalah” within the range of February 15, 2024, to June 30, 2024. The total number of data collected by combining all the keywords above is approximately 12,000 tweets.

2. Data preperation :

In this stage there are several activities carried out, namely cleaning & case folding, tokenization, stopwords removal, stemming, sentiment labeling and TF-IDF.

3. Modelling & evaluate :

The modeling and evaluation stage is the stage of building a hybrid model and evaluating it to get the best results.

RESULT AND DISCUSSION

In this study, data is collected from the social media platform twitter (X). The python programming language is used to retrieve tweets, which are stored in a CSV file format. And from the 12,000 crawled

15 data comments, only the data in the "Full_text" column will be used as the input feature, as this column contains the tweets from twitter users.

```
full_text
0 Kenapa kemenangan ngutang? Karena Jokowi yang cu...
1 @IrawanRommi @bengkeldodo @are_inismyname @pra...
```

Figure 3. Data about prabowo

The python programming language will be used to process the previously acquired and combined data. Because the data is more structured, this is done to make classification by the model easier.

Preprocessing text

1. Cleansing and case folding

The data will be cleaned throughout this process to remove different characters like whitespace, emoticons, URLs, digits, mentions, and hashtags. Additionally, the letters will be uniformly converted to lowercase.

```
cleaned_text
0 kenapa kemenangan ngutang karena jokowi yang cur...
1 emang yg ngatur stategi kalau dia...
```

Figure 4. Cleansing and case folding data

2. Tokenizing

The process of dividing text into manageable chunks in the form of words, phrases, or symbols known as tokens is known as tokenization. The goal of this tokenization is to make the processes of stemming, normalization, and stopword elimination easier.

```
tokenized_text
0 [kenapa, kemenangan, ngutang, karena, jokowi, ya...
1 [emang, yg, ngatur, stategi, kalau, dia, punya...
```

Figure 5. Tokenize data

3. Stopwords removal

The technique of eliminating words or tokens, including as conjunctions, prepositions, and articles, that have no bearing on sentiment is known as stopword removal. In order to improve the model's accuracy in predicting sentiment, stopword reduction aims to reduce the number of characteristics that have no bearing on sentiment.

```
Stopwords_removal_text
0 [kemenhan, ngutang, jokowi, curang, dipercaya,...
1 [emang, yg, ngatur, stategi, strategi, kalah, ...
```

Figure 6. Stopwords removal data

4. Stemming

The process of stemming involves deleting inserts, suffixes, and affixes to make words or tokens into fundamental words. In natural language processing (NLP) and text analysis, stemming is mostly used to reduce and harmonize disparate word forms with same underlying meanings. Stemmerfactory from sastrawi is the stemmer that is utilized in this procedure.

```
stemmed_text
0 [kemenhan, ngutang, jokowi, curang, percaya, n...
1 [emang, yg, ngatur, stategi, strategi, kalah, ...
```

Figure 7. Stemming data

5. Sentiment Labeling

The data resulting from the preprocessing process will be labeled to determine the sentiment class of the dataset. In this sentiment analysis, the target sentiment classes are positive, neutral, and negative. Data labeling is done using a lexicon-based method. This method uses a sentiment dictionary from inset

2. Creating hybrid model

At this stage, the author combines various machine learning models output. In this research, the LSTM, KNN, and naive bayes algorithms are combined to test 12,000 unlabeled sentiment data that has been prepared. Each sentiment output for the given dataset will be compared among these three algorithm models. If the three models choose different sentiments, the algorithm with the highest accuracy during testing will be selected. Therefore, LSTM will be prioritized if the three models choose different sentiments.

Negative: 10603
Neutral: 528
Positive: 869

Figure 12. hybrid model output

After testing using the hybrid model, it was found that out of the 12,000 data points tested, 10,603 were negative, 528 were neutral, and 869 were positive.

Accuracy of KNN : 0.83
Accuracy of Naive Bayes : 0.72
Accuracy of LSTM : 0.78
Accuracy of Hybrid Model: 0.78

Figure 13. Accuracy of KNN, LSTM, naive bayes and hybrid model

It was found that the accuracy of the KNN algorithm on the new data was 83%, for naive bayes it was 72%, and for LSTM it was 78%. The accuracy of the hybrid model was found to be 78%.

3. Confusion matrix 3 x 3

At this stage, a 3x3 confusion matrix will be used to evaluate the performance of the KNN, LSTM, naive bayes, and hybrid models. This will be demonstrated by comparing the model's number of accurate and inaccurate predictions with the known actual values, yielding an F1 score, accuracy, precision, and recall for the sentiment.

Here are the results of the 3x3 confusion matrix for KNN.

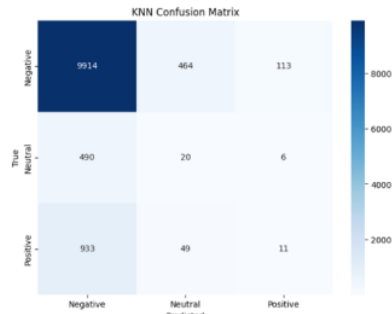


Figure 14. KNN confusion matrix

From figure 14 confusion matrix, the precision, recall and f1-score values of each sentiment class can be calculated as follows.

	negative	neutral	positive
Precisi	$\frac{9914}{9914 + 490 + 933} = 0.87$	$\frac{20}{464 + 2 + 49} = 0.03$	$\frac{11}{113 + 6 + 11} = 0.08$
Recall	$\frac{9914}{9914 + 464 + 113} = 0.94$	$\frac{20}{490 + 20 + 6} = 0.03$	$\frac{11}{933 + 49 + 11} = 0.01$
F1-score	$2 \times \frac{0.87 \times 0.94}{0.87 + 0.94} = 0.90$	$2 \times \frac{0.03 \times 0.03}{0.03 + 0.03} = 0.03$	$2 \times \frac{0.08 \times 0.01}{0.08 + 0.01} = 0.01$
Accuracy	$\frac{9914 + 20 + 11}{12000} = 0.83$		

Figure 15. Validate KNN model

Here are the results of the 3x3 confusion matrix for LSTM.

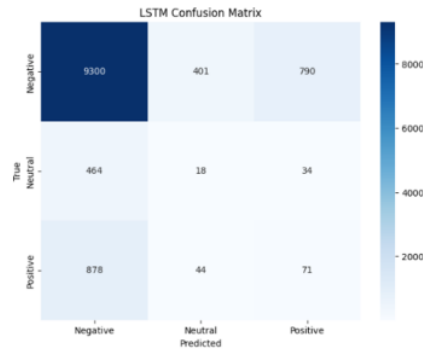


Figure 16. LSTM confusion matrix

From figure 16 confusion matrix, the precision, recall and f1-score values of each sentiment class can be calculated as follows.

	negative	neutral	positive
Precision	$\frac{9300}{9300 + 464 + 878} = 0.87$	$\frac{18}{401 + 18 + 44} = 0.03$	$\frac{71}{790 + 34 + 71} = 0.08$
Recall	$\frac{9300}{9300 + 401 + 790} = 0.88$	$\frac{18}{464 + 18 + 34} = 0.03$	$\frac{71}{878 + 44 + 71} = 0.07$
F1-score	$2 \times \frac{0.87 \times 0.88}{0.87 + 0.88} = 0.87$	$2 \times \frac{0.03 \times 0.03}{0.03 + 0.03} = 0.03$	$2 \times \frac{0.08 \times 0.07}{0.08 + 0.07} = 0.07$
Accuracy	$\frac{9300 + 18 + 71}{12000} = 0.78$		

Figure 17. Validate LSTM model

Here are the results of the 3x3 confusion matrix for naïve bayes.

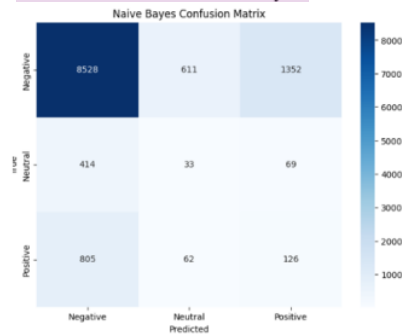


Figure 18. Naive bayes confusion matrix

From figure 18 confusion matrix, the precision, recall and f1-score values of each sentiment class can be calculated as follows.

	negative	netral	positive
Precisi	$\frac{8528}{8528 + 414 + 805} = 0.87$	$\frac{33}{611 + 33 + 62} = 0.05$	$\frac{126}{1352 + 69 + 126} = 0.08$
Recall	$\frac{8528}{8528 + 611 + 1352} = 0.81$	$\frac{33}{414 + 33 + 69} = 0.06$	$\frac{126}{805 + 62 + 126} = 0.13$
F1-score	$2 \times \frac{0.87 \times 0.81}{0.87 + 0.81} = 0.83$	$2 \times \frac{0.05 \times 0.06}{0.05 + 0.06} = 0.05$	$2 \times \frac{0.08 \times 0.13}{0.08 + 0.13} = 0.09$
Accuracy	$\frac{8528 + 33 + 126}{12000} = 0.72$		

Figure 19. Validate naive bayes model

Here are the results of the 3x3 confusion matrix for hybrid model.

		Confusion Matrix		
		negative	netral	positive
True Label	negative	9269	459	763
	netral	462	23	31
	positive	872	46	75
		negative	netral	positive
		Predicted Label		

Figure 20. Hybrid model confusion matrix

From figure 20 confusion matrix, the precision, recall and f1-score values of each sentiment class can be calculated as follows.

	negative	netral	positive
Precisi	$\frac{9269}{9269 + 462 + 872} = 0.87$	$\frac{23}{459 + 23 + 46} = 0.04$	$\frac{75}{763 + 31 + 75} = 0.09$
Recall	$\frac{9269}{9269 + 459 + 763} = 0.88$	$\frac{17}{462 + 23 + 31} = 0.03$	$\frac{75}{75 + 46 + 872} = 0.07$
F1-score	$2 \times \frac{0.87 \times 0.88}{0.87 + 0.88} = 0.88$	$2 \times \frac{0.04 \times 0.03}{0.04 + 0.03} = 0.03$	$2 \times \frac{0.09 \times 0.07}{0.09 + 0.07} = 0.08$
Accuracy	$\frac{9269 + 23 + 75}{12000} = 0.78$		

Figure 21. Validate hybrid model

In figure 21, The hybrid model's accuracy is 78%, which indicates that 78% of the time it properly classifies the data. Precision is defined as the difference between the actual data and the predicted findings, with 87% of the predictions being negative. By dividing the total number of true negative examples by the number of true negative predictions, recall is computed to represent how well the model retrieves data. The results show a negative recall of 88%. The f1-score is an important metric for measuring classification model performance. A high f1-score indicates good precision and recall, and the f1-score for negative this model is 88%.

Hate speech identification

At this stage, identification will be carried out on the negative sentences predicted as negative by the hybrid model. This identification is used to determine whether the sentences constitute hate speech towards the elected president after the 2024 election or not.

Total ujaran kebencian terhadap presiden terpilih: 5063
 Ujaran kebencian terhadap presiden terpilih (10 samples):
 - ['kemenhan', 'ngutang', 'jokowi', 'curang', 'percaya', 'ngutang', 'legitimate',
 - ['menteri', 'ngutang', 'jokowi', 'curang', 'percaya', 'ngutang', 'legitimate',

Figure 22. Hate speech identification

After performing hate speech identification, it was found that out of 10,701 data points labeled as negative sentiment by the hybrid model, 5,063 are instances of hate speech towards the elected president after the 2024 election.

Data visualization

At this stage, the results from the hybrid model will be visualized using bar charts, word clouds, time series, and radar charts for each sentiment class. Here is the sentiment visualization using bar chart.



Figure 23. Bar chart

Here is the sentiment visualization using word clouds



Figure 24. Word cloud for negative sentiment



Figure 25. Word cloud for neutral sentiment

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