Data Augmentation for Hoax Detection through the Method of Convolutional Neural Network in Indonesian News

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Abstract: The concept of hoax or fake news refers to the intentional spread of false information on social media that aims to confuse and mislead readers to achieve an economic or political agenda. In addition, the increasingly diverse and numerous actors in the field of news writing and dissemination have led to the creation of news articles that need to be recognized whether they are credible or not. Furthermore, hoax can harm the social and political aspects of Indonesian society. Central Connecticut University released a study entitled The World's Most Literate Nations in 2016, where Indonesia ranked 60th out of 61 countries, indicating that Indonesian media literacy still needs to improve in critically evaluating information and distinguishing between fake news and valid news. Based on this description, the research will create the Synonym-Based Data Augmentation for Hoax Detection using the Convolutional Neural Network (CNN) method and Easy Data Augmentation (EDA). This research resulted in an accuracy of 8,.81, indicating that it can be stated to be accurate in detecting hoax news.

Keywords: CNN; Data augmentation; Detection; EDA technique; Hoax

Introduction

The concept of "hoax" refers to the intentional spread of false information on social media that aims to confuse and mislead readers to achieve an economic or political agenda (Nayoga et al., 2021; Santoso et al., 2020). In addition, the increasingly diverse and numerous actors in the field of news writing and dissemination have led to the creation of news articles that need to be recognized whether they are credible or not (Nayoga et al., 2021; Santoso et al., 2020; Utami, 2019b). According to the National Intelligence Agency (BIN), nearly 60% of news information in Indonesia is false (Ghinadya et al., 2020; Herrero-Diz et al., 2022; Mufid et al., 2019; Spera et al., 2019).

Furthermore, hoax has endangered the social and political aspects of Indonesian society. Persecution of people with mental disorders (Christina Gregory, 2017) and harm reputation of Indonesian politicians during the general election are the result of hoax (Gusfa et al., 2020; Utami, 2019a). Central Connecticut University released a study entitled World's Most Literate Nations

in 2016, where Indonesia ranked 60 out of 61 participating countries (Fuadi, et al., 2020). This ranking indicates that Indonesian media literacy still needs to improve in critically evaluating information and distinguishing between fake news and valid news (Jormand et al., 2021; Khidhir, 2019).

Several studies detect hoax by applying deep learning, as research conducted by Nayoga et al. (2021) which discusses Hoax Analyzer for Indonesian News using Deep Learning Models, through the Deep Neural Network (DNN) method, Long Short-Term Memory (LSTM), Bidirectional LSTM (BI-LSTM), Gated Recurrent Unit (GRU), Bidirectional GRU (BI-GRU), and 1-Dimensional Convolutional Neural Network (1D-CNN) as well as the Support Vector Machine (SVM) and Naïve Bayes classification algorithms resulting in the DNN model as the superior to classifiers in a supervised text classification task, with 1D-CNN achieved the best results (Borisov et al., 2022; Buhrmester et al., 2021; Hao et al., 2022; Montavon et al., 2018; Salahuddin et al., 2022; Tang et al., 2020; Wu et al., 2022). Other research conducted by (Apriliyanto et al., 2020; Shao et al., 2022;


Singh et al., 2021; Youssef et al., 2022) which discusses Hoax Detection in Indonesian Language using Long Short-Term Memory Model so that the detection of hoax news in Indonesian using the LSTM method has been successful.

According to the research that has been carried out, this research also created the synonym-based data augmentation to detect hoax in headlines using the Convolutional Neural Network (CNN) method (Albashish, 2022; Anton et al., 2021; Defriani et al., 2022; Putra et al., 2021). Previous research has examined the Bidirectional LSTM method using foreign language news with an F1- score of 0,2423 (Ghinadya et al., 2020). However, the data used in this study were based on foreign language news, so the results produced in relatively low accuracy percentages, with a macro F1 score of only 0.24. To further improve the augmentation process based on the previous studies, this research used Indonesian News data using the CNN method. This method is widely used in the augmentation process (Nayoga et al., 2021). In the process, hoax detection used text as the main input for Natural Language Processing (NLP) which requires the same corpus of language as the information provided. Therefore, the non-English text corpus, including the Indonesian language text corpus has less vocabulary compared to the English text corpus so that only a few non-English hoax detectors are available. Hence, this study used the CNN method for detecting hoax in Indonesian and employed data augmentation to improve the CNN accuracy in detecting hoax in Indonesian.

Method

The research method employed in this study is quantitative research (Semiawan, 2017; Sugiyono, 2019), and the dataset used consists of hoax news and factual news obtained from local news publishers, such as detikNews, Kumparan, Kompas, Liputan6, Sindonews, Republika, Tempo, Tribunnews, Wowkeren, Kapanlagi, data Mendeley, Okezone, and TurnbackHoax.id. The data used amounted to 1000 data in Indonesian with 700 valid news and 300 hoax news. Furthermore, the data were then preprocessed: case folding, normalization, tokenizing, filtering and steamming. After obtaining a clean dataset, the result of the preprocessing process, the next step is to split the data into training and testing data. Then, the next process is to perform data augmentation using the Easy Data Augmentation (EDA) technique. This stage was done so that the machine could learn and recognize the origin of various kinds of words. After the data augmentation process, the next step is to detect hoax news using the CNN method. In this stage, the features derived from words tokenization

were included in the convolutional layer and the results were aggregated into representative figures. After that, the next process is to evaluate to measure system performance using confusion matrix. As a result, the output of this study is obtained, namely the classification of the test data in the form of documents classified as hoax and documents classified as true. The planned system can be seen in Figure 1.
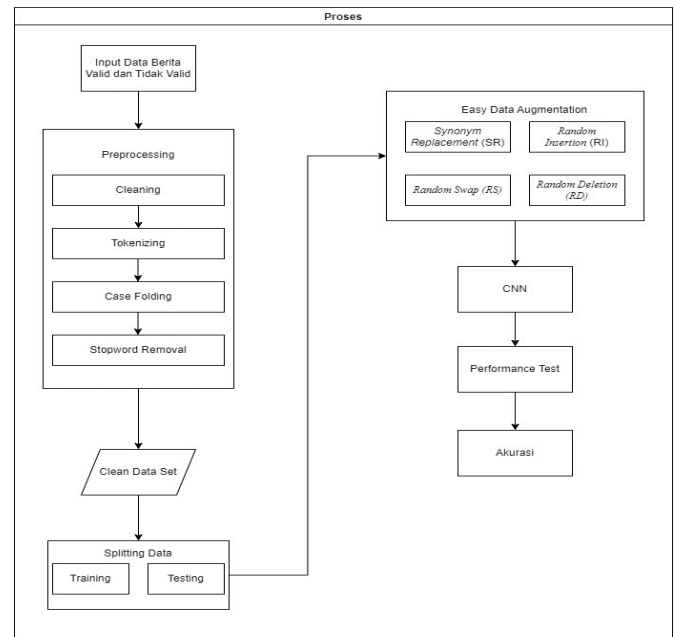
Figure 1. System design using EDA

Augmentation

This study used the EDA technique, which consists of four operations: random deletion (RD), random insertion (RI), random exchange (RS), and synonymous replacement (SR). In this study, the original sentence became more than four more sentences from the previous dataset. Table 1 is an example of a sentence generated by EDA.

Table 1. Examples of EDA Result Sentences

	Sentence
Not Using EDA	Prospective students of the Faculty of Medicine have taken an exam in the morning at 09.00 WIB
Synonym Replacement (SR)	Prospective students of the Faculty of Medicine have taken a test in the morning at 09.00 WIB
Random Deletion (RD)	Prospective students of the Faculty of Medicine have taken the test at 09.00 WIB
Random Insertion (RI)	Prospective students of the Faculty of Medicine have taken the entrance exam in the morning at 09.00 WIB
Random Exchange (RS)	Prospective students of the Faculty of Medicine have taken an exam in the morning at 09.00 WIB

Parameter recommendations for the use of EDA tools can be seen in Table 2. Parameter Alpha (α) means "how many percent of words in a sentence are changed by each augmentation". N_{aug} is the number of additional sentences generated using EDA per original sentence (Wei, J. & Zou, 2019).

Table 2. Recommended Parameters

N_{train}	α	N_{aug}
500	0.05	16
2000	0.05	8
5000	0.10	4
More	0.10	4

Convolutional Neural Network (CNN) Method

The implementation of the CNN method begins with pre-processed input news. Features derived from word tokenization will be included into convolutional layers. It is the layer where the input layer will be abstracted into a feature map consisting of kernels/filters (can be more than one).

The results of convolution are combined into representative numbers and fed into a fully connected layer. This fully connected layer refers to the layer where each neuron is connected to the neurons in the previous layer. Before being connected to all neurons in a fully connected layer, each activation of the previous layer converted into one-dimensional data. Then, the resulting weights for each feature in the text can produce a classification decision.
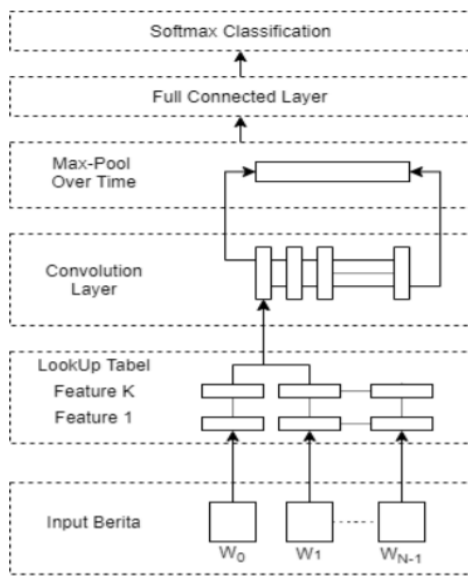

Figure 2. CNN Architecture for text processing

Last, the weight obtained is input into the fully connected layer. Its part of the CNN network goes through its own backpropagation process to determine the most appropriate weight (Kurniawan et al., 2021). Each neuron will receive a weight, in this case "fact news" or "fake news". Finally, neurons assigned the value of each label, and make a decision or classification results.

In this research, a CNN 1D was implemented and used in this experiment to match the dimensions of the text input data. CNNs extracted features from data vectors simultaneously rather than sequentially like RNNs, resulting in much faster data processing. The hyperparameters set for the 1D-CNN model are: 128 filter sizes with 5 default kernel sizes and steps. The ReLU activation function is used for the 1D-CNN model architecture. The pooling layer used is GlobalMaxPooling 1D to sample feature maps before further processing by the classifier. The architectural illustration of the 1D-CNN model for this study can be seen in Figure 3 (Nayoga et al., 2021).
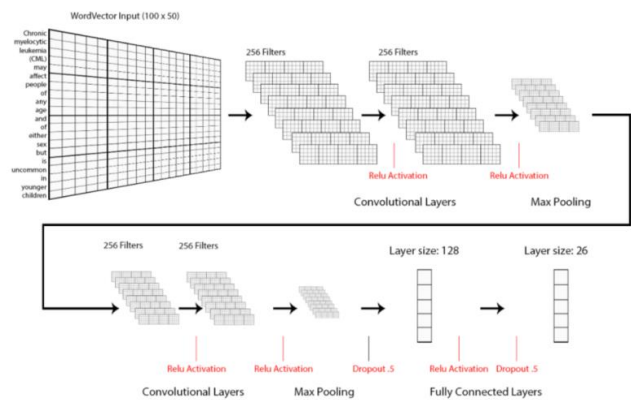
Figure 3. The illustration of 1D-CNN architecture model

Result and Discussion

Method used is the Convolutional Neural Network (CNN) method with the implementation of data augmentation. The flowchart implemented of the algorithm CNN with the application of data augmentation can be seen Figure 4.
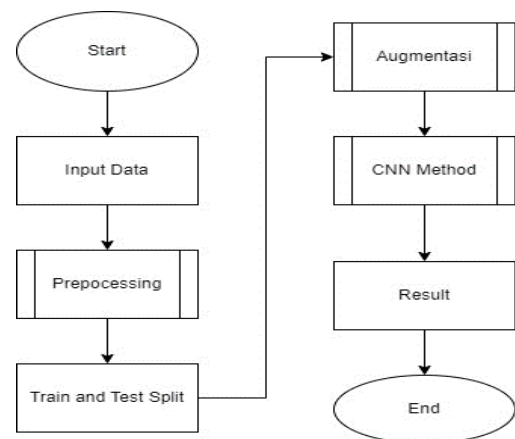
Figure 4. *CNN flowchart* with data augmentation

Based on Figure 4, there are steps in detecting hoax news using CNN with data augmentation. The first stage is dataset input. The dataset in this study is divided into two classes: positive and negative. In this study, data collection was carried out using web scraping techniques using the Python library, *newspaper3k*.

After that, the second stage is data preprocessing. The third stage is to split the data by dividing the data, namely data training and data testing through Split Validation tools. In this study, the distribution of training data and testing data was 70% data for training data and 30% data for testing data. The results of dividing the train and test data can be seen in Table 3.

Table 3. Results Distribution of Data Train and Test

| Stem	Label
kadrun see hot and cold photos	1
good afternoon friends fb information rezeky where yesterday took part in the smartphone promo event jne June special order smartphone vivo v pro price rp thought the price of rp hp vivo pro, curious fb friends, join the inbox admin whatsapp	1
see rule the country	1
italy state-of-the-art health care facilities fail to control corona think the president's joke wins the burial ground of corona victims	1
stupid police open quickly please look	1
china police persecutes uighur women neck strangulation with feet literacy says persecution ham silence thousand language police take turns looking at savages	1
Jokowi is ready to step down	1
Irina, the wife of an it expert, Hermansyah, a former prostitute	1
nezar patria pki cadres palace night meeting curfew accused alfian tandjung	0
Palson semi container truck take it	0
contact immunization sick vaccine effects mr	0
so many times the persecution of West Java clerics hr Bogor clerics ust sulaiman slashed Bogor madmen Muslims in line meetings always on alert	0
the dangers of rambutan food drinking sweet tea because of airway obstruction	0
as a result of playing the trending snake game now, be careful, gaeeees	1
article slap news dot blogspot dot com appear article title report pdip sukmawati hold strong people article write merdekaind	1

Table 4. Color Information on Train and Test

(yellow)	Data Trains
(blue)	Test Data

The fourth stage in this study is to carry out data augmentation, where at this stage, the researchers used the Easy Data Augmentation (EDA) technique. This was done so that the machine could learn and recognize the origin of various kinds of words. There are several stages in carrying out the Easy Data Augmentation (EDA) technique; the first stage is Synonym Replacement (SR). It is a method that creates new data by selecting words in sentences randomly and then replacing them with synonyms of the selected words. The second stage in the EDA technique is Random Insertion (RI) which chooses words in sentences randomly and then replaces them with synonyms of the words chosen and insert the word at a different position in the text. The third stage in the EDA technique is the Random Swab (RS), which is random exchange and not using synonyms to create a new sample. The final stage in the EDA technique is Random Deletion (RD), which is random deletion words in the text with a certain probability determined by the parameters.

From the results of the augmentation above, the sum of all techniques is carried out to get the final result of the technique used. Next, a similarity measurement is carried out with a vulnerable Cosine similarity value of -1 to 1, where the two texts are stated to be similar when the angle between the vectors is close to zero with a cosine value close to 1. Thus, each news or data with a similarity value of 1 means no change in the words before and after the augmentation.

The fifth stage in this study is to detect using the CNN method. At this stage, the Convolutional Neural Network (CNN) algorithm will be applied to classify hoax and valid news. In the training model, the researcher adds Adaptive Moment Estimation (Adam) to optimize the training data, this was done to optimize the results of the accuracy of the algorithm used. In conducting the fit model, the researcher used the epochs = 5 epochs. An apoch means how often the network will look at the entire data set, while the batch_size = 64, meaning the batch_size is the number of training examples in one forward or backward pass. The larger the batch_size value, the more memory is required. The results of the CNN accuracy algorithm can be seen in Figure 5.
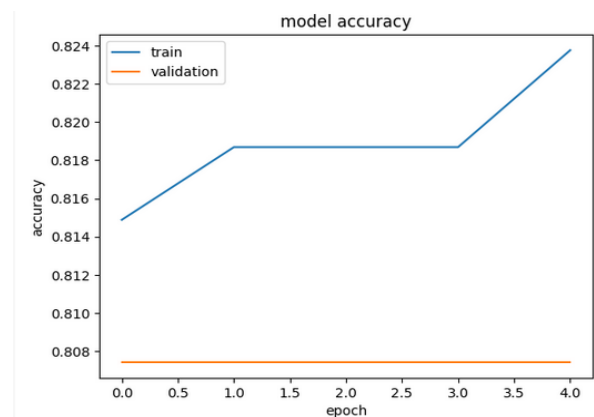
Figure 5. Result of CNN algorithm accuracy

Meanwhile, the function used to display the loss model data in graphical form is loss function. Loss model is the value of the loss calculation function of the training dataset, then displayed in graphical form so that it is known how much the loss value decreases or can be interpreted function used to see the performance of the CNN model. Loss results the CNN algorithm function can be seen in Figure 6.
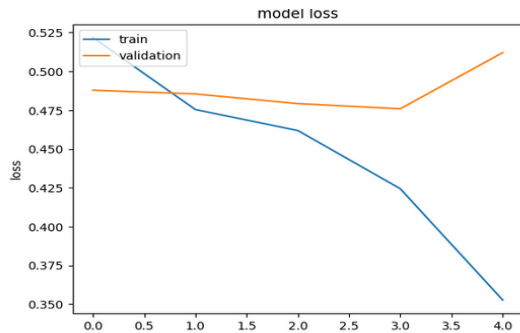

Figure 6. Loss result of CNN algorithm functions

The sixth stage is to carry out an evaluation that aims to measure the work of the model. Evaluation method applied is confusion matrix. The results of the confusion matrix can be seen in Table 5.

Table 5. Calculation of Confusion Matrix _

Parameter	Calculation	Results (%)
accuracy	$\frac{(TP+TN)}{(TP+FP+FN+TN)}$ x 100 = $\frac{(21+1029)}{(1029+17+201+21)}$ x 100%	82.81
precision	$\frac{TP}{(TP+FP)}$ x 100% = $\frac{1029}{(1029+201)}$ x 100%	83.66
recall	$\frac{TP}{(TP+FN)}$ x 100% = $\frac{1029}{(1029+17)}$ x 100%	98.37
F1-Score	$2\frac{Presisi*Recall}{Presisi+Recall}$ * 100% = $2\frac{83.66\%*98.37\%}{83.66\%+93.37\%}$ * 100%	90.42

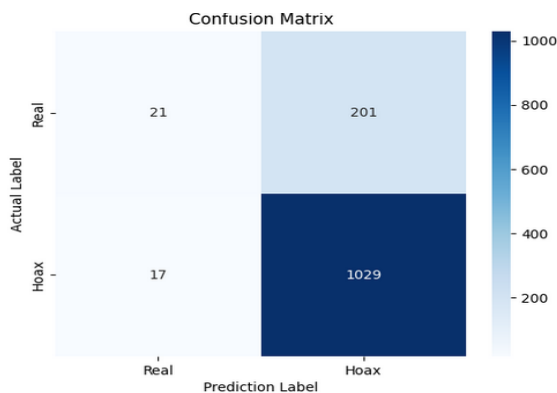The results of the confusion matrix in tabular form can be seen in Figure 7.

Figure 7. Results of confusion matrix in tabular form

The results of the confusion matrix in percentage form can be seen in Table 6.

Table 6. Results

Yield	Result
Accuracy	82.81%
Precision	83.66%
Recall	98.37%
F1-Score	90.42%

From the results of the research that has been done, Easy Data Augmentation for Fake News Detection uses the Convolutional Neural Network Method for Indonesian News to get reasonably good accuracy results from previous research.

Conclusion

The conclusion in this study states that the implementation of the Convolutional Neural Network (CNN) algorithm with the data augmentation can increase awareness regarding circulating information and help avoid hoaxes. This conclusion is based on the testing results, which achieved an accuracy of 82.81%, indicating its effectiveness in detecting fake news. As for suggestions for further research development , it is necessary to apply other algorithms or by using other augmentation techniques to compare the accuracy with the findings of this study.

Conflicts of Interest
In writing this article, we sincerely declare that there are no relevant conflicts of interest that could affect the objectivity and integrity of the results.

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