News Headlines Clickbait Classification Model Using Recurrent Neural Network with ELECTRA Pre-training Text Encoders

Feta Kalih Wigati
Computer Science Department
School of Computer Science
Bina Nusantara University
Jakarta, Indonesia 11480
feta.wigati@binus.ac.id

Raina Imtiyaz
Computer Science Department
School of Computer Science
Bina Nusantara University
Jakarta, Indonesia 11480
raina.imitiyaz@binus.ac.id

Pipiana Anggrai Juni
Computer Science Department
School of Computer Science
Bina Nusantara University
Jakarta, Indonesia 11480
pipiana.juni@binus.ac.id

Abstract—**Clickbait is widely used as online advertising to increase traffic by enticing people to click on links along with the massive amount of online content assumption. Therefore, the news headline's clickbait is often designed to employ sensationalism, exaggeration, and misleading information. Through this trick, they manipulate readers' emotions and biases that also reduce the quality and credibility of news. Considering the negative impact of clickbait applications, we feel it is important to develop a model that would classify news headlines into clickbait and non-clickbait groups, specifically news from Indonesia. Using the CLICK-ID dataset that covers Indonesian news headlines collected from 12 online news publishers with 15,000 annotated headlines in Indonesia. Based on the Natural Language Processing (NLP) task, in this paper, the model we created will apply a Simple Recurrent Neural Network (RNN), ELECTRA model. Although the accuracy of the model only reaches 50%, which failed to outperform other models that apply machine learning classifiers, LSTM, or GRU to various methods from transformers such as IndoBert, M-Bert, and RoBerta., we still hope our paper can be an evaluation and benchmark for future works in NLP task areas.**

Keywords—*Recurrent Neural Network, Transformers, ELECTRA, Clickbait Classification, Clickbait Detection, News Headlines, Text-classification, Natural Language Processing*

I. INTRODUCTION

As a form of adaptation by the media industry to the digital environment, along with the massive growth of digital media and the number of news consumers, the industry has become more competitive to write headlines with clickbait. The implementation of clickbait is one of the media industry strategies to capture readers' interest. Unfortunately, the rapid use of clickbait became misguided and widespread causing online readers to feel misguided and disappointed [1], [2]. This also leads to the potential of becoming hoax information and having a negative impact on journalistic practice.

Moving from our concerns about this issue, we want to build a model that classifies news titles into clickbait and non-clickbait groups. In this clickbait classification model, we are expecting the model to be a tool for detecting clickbait on news titles. Especially Indonesian news due to most models focusing on English news titles while Indonesian clickbait models are still only a few [2], [3], [4].

Using Recurrent Neural Networks (RNN) as a class of artificial neural networks designed to process sequential data, such as time series or text that have internal memory that allows them to store information from previous inputs. This memory allows the RNN to exhibit dynamic behavior and capture temporal dependencies in the data. RNN has been implemented in a variety of domains, including natural language processing, speech recognition, machine translation, image captioning, and time series analysis. The flexibility and ability of the RNN to capture temporal dependencies make it suitable for tasks where context and sequential information play an important role.

To address some of the challenges associated with RNNs, such as disappearing gradients or the inability to learn long-term dependencies, people used to apply Long-Short Term Memory (LSTM) or Gated Recurrent Unit (GRU) networks. LSTM variant introduces a gating mechanism that allows RNNs to selectively select and update information in their memory, thus enabling more robust modeling of long-term dependencies [5], [6].

As one of the fields of artificial intelligence, Natural language processing (NLP) has massively grown in recent years due to increasingly large amounts of textual data and the need to improve the communication between humans and computers. NLP is used to develop models or algorithms that can understand, recognize, and manipulate human language accurately and naturally [7]. One of the NLP models that are widely used in transformers can carry out a wide range of tasks with no fine-tuning needed from billions of records and parameters of raw unlabeled data [8]. Using transformers models, we try to build a model that would detect clickbait from news headlines using ELECTRA as the language model [9], [10].

II. RELATED WORKS

Fig. 1. Machine Learning grouped based on similarity

There is growing interest in developing models that detect clickbait. Not only clickbait news titles based in English but also news titles based in Indonesian are also being actively developed for detection models. Several

models were developed using machine learning classifiers, using LSTM or GRU to various methods from transformers such as IndoBERT, M-BERT, and RoBERTa.

Initially, the developed model implemented machine learning classifiers such as Logistic Regression, Naive Bayes (NB), Random Forest (RF), and many others. The Logistic Regression method allows us to obtain a graph between the independent variables and the target variable. While the Naive Bayes (NB) method is the most popular method which is suitable for large data sizes and requires short time [11], [12]. Finally, the random forest method has good accuracy, although the data is limited [11].

Apart from machine learning classifiers, there is also the development of a Convolutional Neural Network (CNN) which prepares vectors to represent objects, namely news headlines, to be grouped into clickbait and non-clickbait groups [11], [13]. Then there are Recurrent Neural Networks (RNN) which take advantage of the previous information to then be used to identify the currently studied data. The use of Recurrent Neural Networks (RNN) is generally implemented in conjunction with Long Short-Term Memory (LSTM) or Gated Recurrent Units (GRU) to overcome the limitations of the model to remember previous learning [5], [6], [11]. Then, the development of the Recurrent Neural Networks (RNN) model was then developed into the transformer's method. The use of transformers is shown in the development of the BERT model which eliminates features that are less related to the conditions so that it has better performance than Recurrent Neural Networks (RNN) [15].

The latest development of the BERT model is varied starting with the Multilingual BERT (M-BERT) which has an accuracy of 91.53 [16], then the IndoBERT model with an accuracy of 89.00 and succeeded in reducing memory usage [15] and the latest is the implementation of RoBERTa which focuses on hyperparameter tuning with an accuracy of 91.2 and gives more consistent output than the IndoBERT mode [12]. From here we are then interested in trying ELECTRA. Unlike RoBERTa which requires a large number of networks and datasets, ELECTRA is claimed to have far better performance with only a partial number of networks and datasets [17].

III. METHODOLOGY

In this study, we implemented several methodologies according to the flow in figure 2. The methodology itself starts from preparing the dataset that includes Data Collection, Exploratory Data Analysis, Data Preprocessing, then we do Modeling right before the Evaluation of the model performance that is compared by the accuracy score with several studies before.
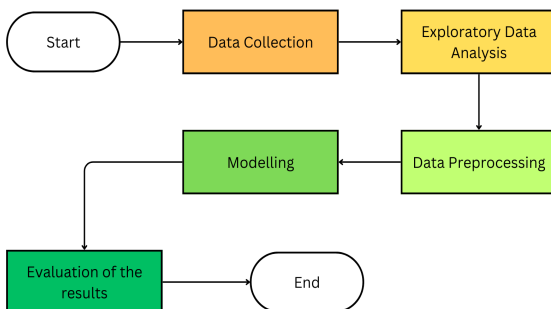

Fig. 2. Methodology flow chart

A. Data Collection

The dataset was taken from Indonesian news headlines, the CLICK-ID dataset. The dataset was obtained from 12 Indonesian online news publishers consisting of 15,000 titles labeled clickbait and non-clickbait. This dataset has a total of 6300 clickbait and 8700 non-clickbait [4], [18].

B. Exploratory Data Analysis

In this step, we apply some Exploratory Data Analysis and find out the problem of unbalanced data. So we decide to perform undersampling to minimize the class of the dataset to overcome the problem.
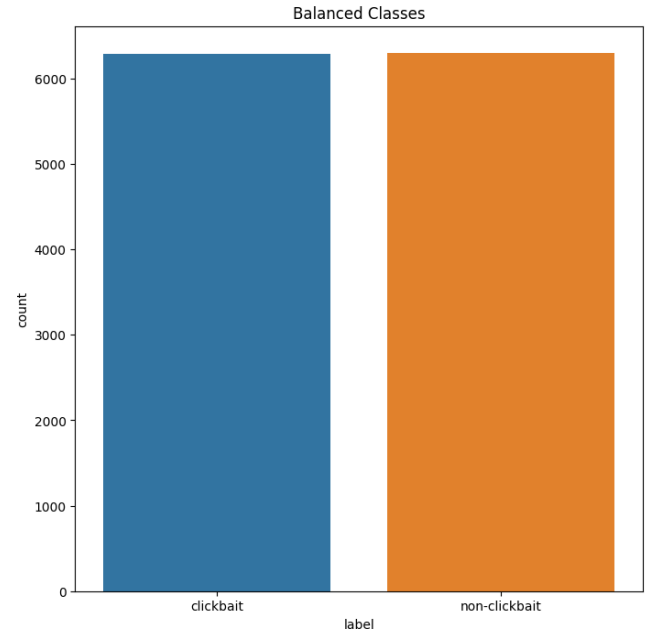

Fig. 3. Balanced Classes Diagram

Next, we identify words that appear frequently in headlines, headlines that fall into the category of clickbait, and non-clickbait. In all categories, it contains more stop-words. Stopwords are words that are considered to have no special meaning, but often appear in a case, which are uninformative components of the data [19].
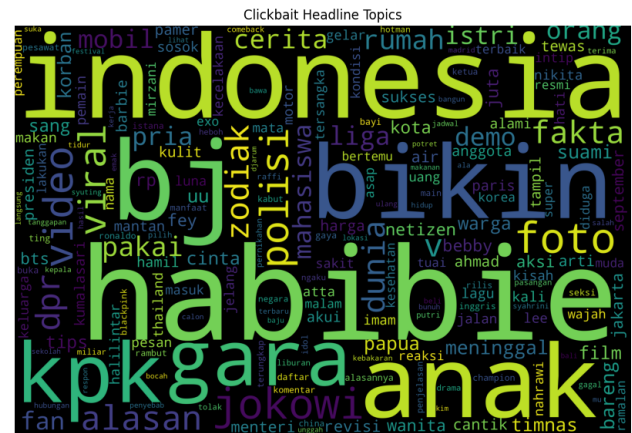

Fig. 4. Clickbait Headline Topics WordCloud

To overcome this problem, we process each text in all headlines using WordCloud with a dataset that contains a collection of stop-words in Indonesian. In the next stage, we re-identify the words that appear frequently in the headlines. The last step is to identify the special characters in each category and the frequency of special characters of headlines from all categories.
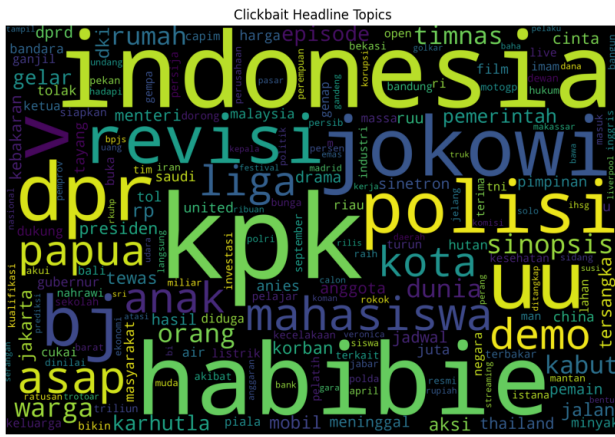
Fig. 5. Non-Clickbait Headline Topics WordCloud

After that, calculate the frequency of the words that appear frequently. Based on figure 6, the most topics or words are generated, namely 'bj' , 'habibie' in the clickbait data with a comparison of the number of frequencies that are far from other words.
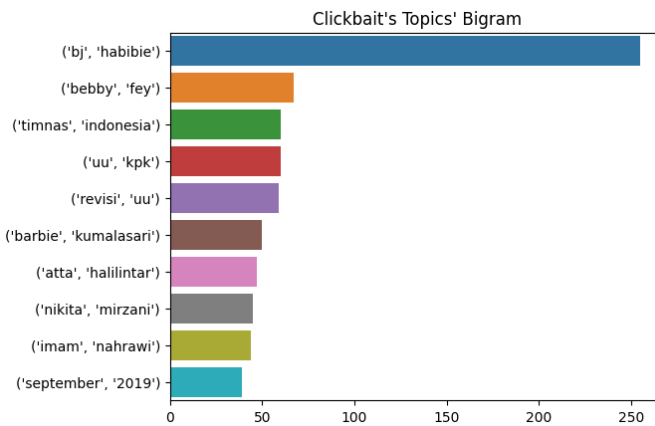

Fig. 6. Clickbait Topics Bigram

The frequency of topics is also carried out on non-clickbait data. Based on figure 7, the highest number of topics or words produced are the same as clickbait, namely 'bj;, 'habibie', but in this non-clickbait data the comparison of the number of frequencies with other words is not far away, followed by the topic of 'revision', 'uu'.
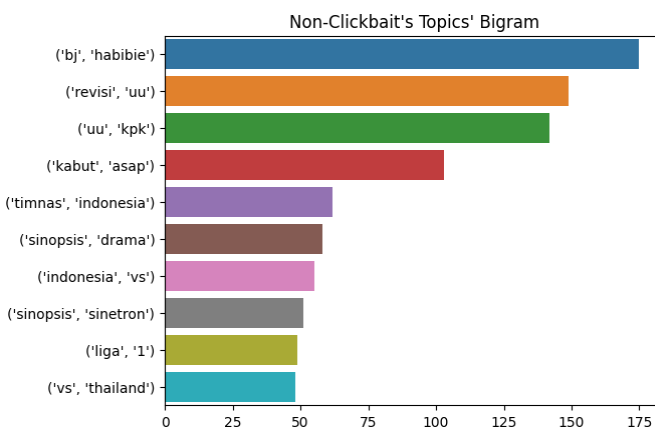

Fig. 7. Non-Clickbait Topics Bigram

C.   Data Preprocessing

Preprocessing data by specifying the ELECTRA tokenizer and encoding the text using. ELECTRA makes computing more efficient and can produce better performance, even if the number of computations is relatively

small [17]. The model can understand the input data by doing a tokenizer which has the aim that the dataset can turn words into unique numbers [20]. Split the data into training set, validation set, and test set before determining the model. To obtain optimal accuracy [21], the data distribution is done randomly by splitting the data into a ratio of 80:10:10.

C.   Modeling

Define the ELECTRA model, then do the RNN modeling architecture with four RNN layers and one output layer, after that compile the RNN, and view the summary of the model to train the dataset so that the model classifies clickbait or non clickbait headlines.
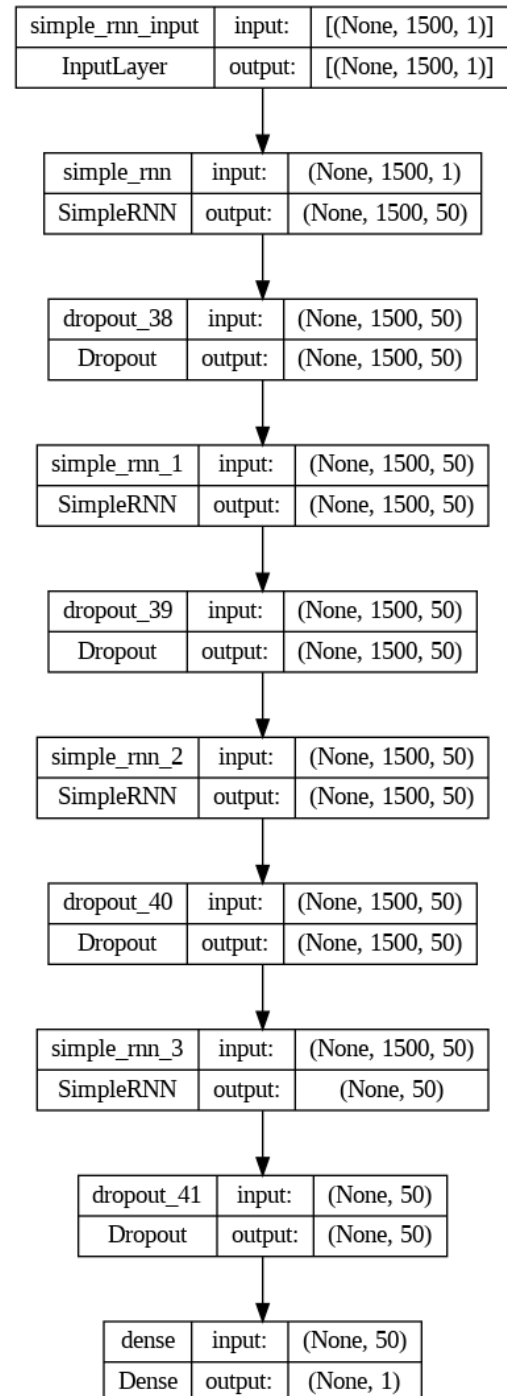

Fig. 8. Model Architecture

D.   Evaluation of the results

The last methodology is to evaluate the model whether the optimal model has been obtained. Make a plot on the model to identify the model so that it can be used as an identifier for this research, namely clickbait from headlines.

IV. RESULT AND DISCUSSION

Our model implements Transformers, using ELECTRA with 0.2 drop-out, four RNN layers with tanh activation, 32 batch, Adam optimizer, and mean square error as losses. The RNN model architecture on which our model accuracy reaches 50%. Compared to several papers before, that implement RNN using RoBERTa, our models are unable to outperform it. Also compared to previous methods such as BERT, IndoBERT, and Multinomial NB, our models receive quite low accuracy.

V. CONCLUSIONS AND FUTURE WORK

We are sure that our model needs improvements such as using more hyperparameters, and very large datasets/augmentation. In other words, ELECTRA provides fairly strong results across validations. Lastly, we are interested in implementing methods such as LSTM or GRU to handle more parameters and its impact on the model efficiency.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests. The establishing support played no part in the plan of the review; in the process of data collection, analysis, or interpretation; in the composition of the original copy, and in the choice to distribute the outcomes.

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