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Sequential Modeling of News Headlines and Descriptions for Multi-Class Classification

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Abstract*—Automatic classification of news content plays a vital role in organizing and filtering data for various applications such as news recommendation systems and media monitoring. This study investigates the use of Recurrent Neural Networks (RNN) and sequential modeling for multi-class classification of news data. A dataset consisting of 12,000 news sentences, categorized into four distinct classes politics, economy, sports, and technology was utilized for training and evaluation. The research focuses on comparing the performance of RNN models without optimization techniques and RNNs enhanced through optimizer implementation and sequence modeling. The baseline RNN model, trained without any optimizer or sequence enhancements, achieved a classification accuracy of 89%. By incorporating optimizer functions and leveraging sequential dependencies in both news headlines and descriptions, the proposed model demonstrated a 1% improvement, achieving an overall accuracy of 90%. These findings indicate that even a slight enhancement in modeling temporal dependencies and optimization can result in measurable gains in multi-class classification performance. The sequential combination of news headlines and descriptions is shown to be an effective strategy for capturing contextual features that improve the model's predictive accuracy. This research contributes to the field of natural language processing by highlighting the effectiveness of sequential modeling and optimization in neural network-based text classification systems.*

***Keywords** : Classification, News, RNN, Sequential, Optimizer*

I. INTRODUCTION

Based on data from the Press Council, there were 1,711 media companies in Indonesia that had been verified as of January 2023. Of that number, digital media dominated with 902 companies. This rapid growth is in line with the media transition from print and conventional to digital. So this also has implications for the number of news published online increasing exponentially every day. Online news platforms present various information covering various topics such as politics, economics, technology, entertainment, and sports. However, the diversity and large volume of this data pose challenges in grouping and presenting news efficiently to readers. Therefore, news classification based on categories is one of the important solutions to improve user experience and the efficiency of news recommendation systems. So far, most approaches to news classification have only used the title or content of the news separately, without considering the sequential relationship between text elements such as the title and description of the news. In fact, the title and description are two components that complement each other in conveying the core information of an article. An approach that combines the two sequentially is believed to improve understanding of the context and, ultimately, accuracy in news classification.

In the scientific field of Natural Language Processing and Machine Learning, especially in sequential models such as Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU), and Transformer, it is possible to model text sequences more effectively. These models are able to capture temporal and semantic dependencies in text, which are important in understanding the overall context of news. This study aims to explore the sequential modeling approach to news headlines and descriptions together, in order to improve multi-class classification performance. By utilizing the power of sequential models, it is hoped that the classification system can be more accurate in understanding and grouping news into the right categories.

Several previous studies have corroborated the research position that the application of a hybrid model combining RNN, BiLSTM, and GRU to address long-term reliance on unstructured text resulted in an average F1 score of 0.76, showing an increase in accuracy compared to other architectures [1]. Another hybrid model is a combination of CNN and LSTM for text data [2]. The combination of TF-IDF weighted Word2Vec, BiLSTM, and Attention mechanism to enhance the semantic representation of text can achieve 91.26% accuracy, 90.98% recall, and 91.12% F1-score, demonstrating its effectiveness in multi-category classification [3]. The combination of RNN with BERT is also able to improve context understanding [4] in multi-class text classification [5]. The application of the FAST-RNN model optimized for high efficiency and accuracy in detecting multi-class hate speech achieved 98% accuracy on multi-

class [6]. In addition, with the integration of discrete-numeric schemes into RNN architectures to improve performance in natural language processing tasks compared to standard models [7]. Challenges with unstructured data can also be addressed with BiLSTM RNNs and GRU [8], or combined with applying attention mechanisms can improve results [9]. The relatedness of unstructured data also has an impact on data imbalance, where this capability can be overcome by the CNN-LSTM hybrid model [10] for multi-class data [11]. ResNeXt and RNN hybrid model for multi-class sentiment classification [12]. RNN can also be used for hierarchical multi-scale dense connection processing for text classification [13].

II. RESEARCH METHODS

The following are the stages of research carried out this is :

a. Literature Study
   Reviewing previous research on: Multi-class text classification. RNN algorithm for multi-class classification.
b. Data Collection
   The data used for the research is open-source news data. The general data structure is: title (headline) and description or content label and category.
c. Preprocessing Data and Training
   The processes carried out to prepare text data ready for use include: Tokenization. Lowercasing. Stopwords removal. Stemming or Lemmatization. The model is trained with a predetermined number of epochs to obtain the best value.
d. Modelling Classification
   Using sequential models like RNN Recurrent/Transformer layer, Dense layer (output with softmax for multi-class)
e. Model Evaluation
   Referring to the accuracy value with visualization results using the training vs validation plot Analisis dan
f. Conclusion
   Interpretation of results and analysis of the models applied to perform classification.

The details of the flow are shown in Figure 1.

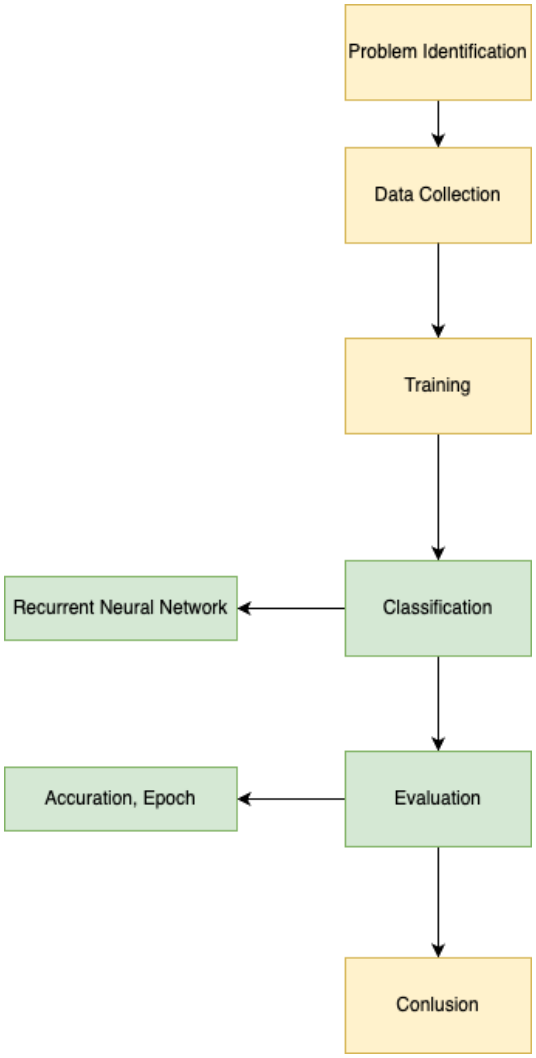

Figure 1. Research Stage

III. RESULT AND ANALYSIS

The data used in this research is shown in detail in Table 1.

Table 1. Raw Data

Title	Description	Index
Sister of man who died in Vancouver police custody slams chief (Canadian Press),Canadian Press - VANCOUVER (CP)	The sister of a man who died after a violent confrontation with police has demanded the city's chief constable resign for defending the officer involved.	1
Jones Advances in Long Jump Johnson Out, "ATHENS, Greece	Marion Jones made her Athens debut in virtual anonymity, quietly advancing to the long jump final. Allen Johnson had the attention of everyone in the stadium, for all the	1

	wrong reasons..."	
Johnson Helps D-Backs End Nine-Game Slide (AP)	Johnson Helps D-Backs End Nine-Game Slide (AP),"AP - Randy Johnson took a four-hitter into the ninth inning to help the Arizona Diamondbacks end a nine-game losing streak Sunday, beating Steve Trachsel and the New York Mets 2-0."	2
Retailers Vie for Back-To-School Buyers (Reuters),"Reuters	Apparel retailers are hoping their\back-to-school fashions will make the grade among\style-conscious teens and young adults this fall, but it could\be a tough sell, with students and parents keeping a tighter\hold on their wallets."	3
MOM 2005 Released to Manufacturing	Microsoft on Wednesday announced the release to manufacturing of Microsoft Operations Manager (MOM) 2005 and MOM 2005 Workgroup Edition, a new edition that the company previously called MOM 2005 Express.	3
U.S. Justice Department Cracks Down Internet Crime	"The FBI seized computers, software and equipment as part of an investigation into illegal sharing of copyrighted movies, music and games over an Internet ""peer-to-peer"" network, Attorney General John Ashcroft announced Wednesday."	4
Oracle Overhauls Sales-Side Apps for CRM Suite (NewsFactor)	NewsFactor - Oracle (Nasdaq: ORCL) has revamped its sales-side CRM applications in version 11i.10 of its sales, marketing, partner relationship management and e-commerce application."	4

The amount of data used is balanced with 3,000 data in each class or as many as 12,000 data as shown in Figure 2.

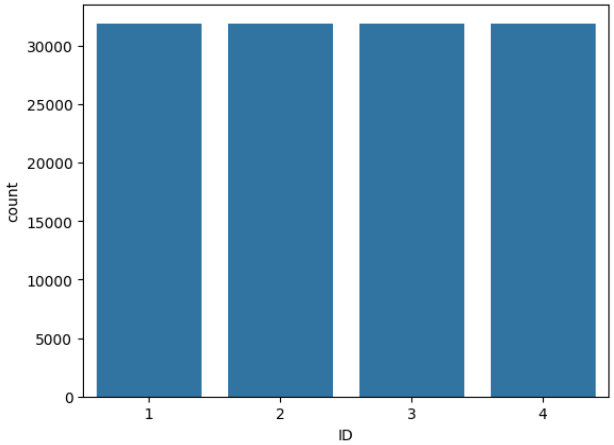

Figure 2. Data Distribution

From the data above, the following pre-processing stages are carried out :

Tokenization
This process will break the text into words that the process indicates Table 2

Table 2. Tokenization

Corpus
'the' 'sister' 'of' ' a' ' man' ' who' ' died' ' after' 'a' 'violent' 'confrontation' 'with' 'police' 'has' 'demanded' 'the' 'citys' 'chief' 'constable ' 'resign' 'for' 'defending' 'the' 'officer' 'involved'

Stopword Removal
This process removes common words that do not have high information value in the Table 3

Table 3. Stopword Removal

Corpus
'sister' 'man' ' who' 'died' 'after' 'violent' 'confrontation' 'police' 'has' 'demanded' 'citys' 'chief' 'constable ' 'resign' 'defending' 'officer' 'involved'

Stemming
The process of cutting words into their basic form is shown in Table 4

Table 4. Stemming

Corpus
'sister', 'man', 'die', 'violent', 'confront', 'police', 'demand', 'city', 'chief', 'constable', 'resign', 'defend', 'office', 'involve'

Lemmatization
Proses pengembalian kata ke bentuk leksikal dasarnya pada Table 5

Table 5. Lemmatization

Corpus
'sister', 'man', 'die', 'violent', 'confrontation', 'police', 'demand', 'city', 'chief', 'constable', 'resign', 'defend', 'officer', 'involve'

Recurrent Neural Network Implementation

Scenario 1 : Without Optimizer
In scenario 1, without using the optimizer, the best accuracy value is 89%. Details of the accuracy validation and loss validation values are shown in Figure 3 dan Figure 4.

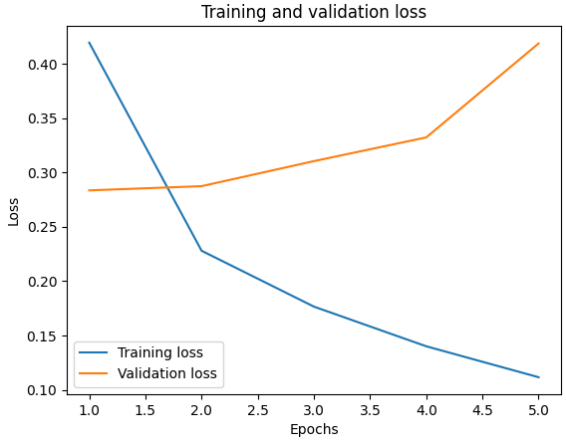

Figure 3. Loss Value

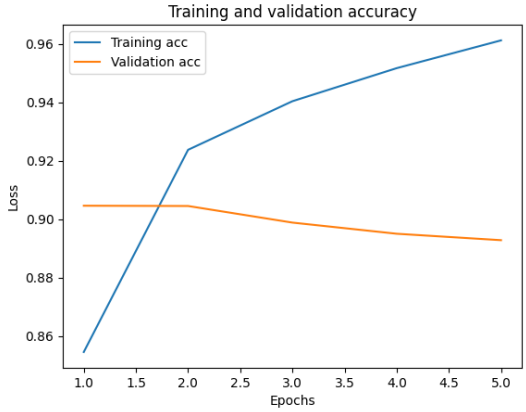

Figure 4. Accuracy Value

Scenario 2 : With Optimizer
In scenario 2, using the adam optimizer with a sequential model produces the best accuracy value at 90%. Details of the accuracy validation and loss validation values are shown in Figure 5 dan Figure 6.

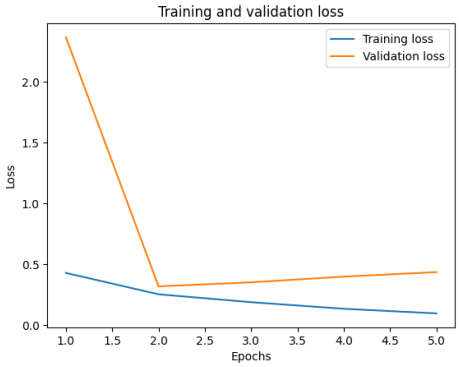

Figure 5. Loss Value Optimizer

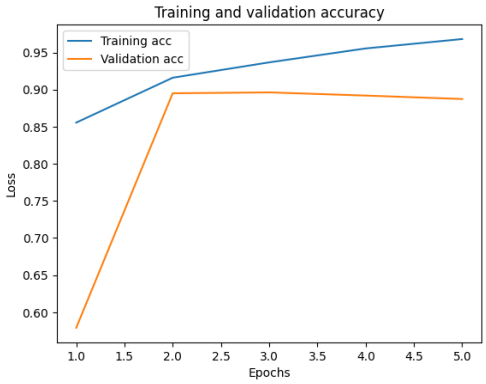

Figure 6. Accuracy Value Optimizer

Comparation
With the 2 scenarios used, an increase in accuracy of 1% was seen by applying the Adam Optimizer in performing the classification..

Testing
Testing was carried out with sentences with 90% accuracy and the detailed results are shown in Table 6.

Table 6. Testing Sentence

Sentence	Prediction
Breaking news in technology and science	3
Breaking news in NBA competition basketball	1

VI. CONCLUSION

The final results of this study show that the best accuracy of the Recurrent Neural Network (RNN) without any optimizer is 89%, and after applying sequential modeling and introducing an optimizer, the accuracy increases by 1% to reach 90%. This improvement is primarily attributed to two factors: first, sequential modeling enables the RNN to capture contextual dependencies between the news headline

and its description, allowing the model to extract more comprehensive semantic features from the input text. Second, the inclusion of an optimizer enhances the model's learning efficiency by dynamically adjusting the gradient updates during training, helping the network converge more effectively and avoid issues like vanishing gradients. Together, these enhancements allow the RNN to better generalize across all four news categories politics, economy, sports, and technology resulting in improved overall classification performance.

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