SECTION: INFORMATION TECHNOLOGY AND CYBERSECURITY

AN APPROACH TO USING THE MBERT DEEP LEARNING NEURAL NETWORK MODEL FOR IDENTIFYING EMOTIONAL COMPONENTS AND COMMUNICATION INTENTIONS

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Emotions play a key role in text communication, helping people describe their feelings and sensations and determine the intent of their text messages [1]. Each of the six basic emotions has its specific manifestations in the text, which depend on the choice of marker words, punctuation marks and the size of the text message. Analyzing the emotions contained in the text helps to better understand the intentions of the author of the text message. To determine emotional components in text messages, it is necessary to use natural language processing methods [2, 3]. Further, on the basis of the determined emotional components, it is possible to formulate conclusions regarding communication intentions, which are transmitted by text messages [4].

The purpose of the work is to develop an approach to using the mBERT deep learning neural network model for identifying emotional components and communication intentions.

In accordance with the purpose of the work, a method of determining emotional components and communication intentions in text messages using natural language processing was developed, which consists of three steps. First, a text message is prepared for analysis, according to which the dominant emotion is determined in the second step and an expert opinion regarding the communication intentions in the third step.

The method uses the following input data:

– text message for analysis;
– mBERT deep learning model;
– datasets for model training;
– set of rules for forming an expert opinion.

A text message to analyze is any text that the user of the application wants to analyze. It is best to choose such texts in which the expression of emotions is well followed. Such texts are usually reviews of goods or services in e-commerce tools, or comments and posts on social networks. After all, it is in such text messages that people most often express their attitude to something, so they are filled with emotionally colored vocabulary.

Neural network model mBERT (Multilingual Bidirectional Encoder Representations from Transformers) is a multilingual transformer model that takes into account the context of words located both to the left and to the right of the selected word. This allows you to understand the meaning of each word in the context of the entire text. For this, the mBERT model uses multilayer transformers that are capable of analyzing text in two directions. Thus, after training on a large corpus of data, the model is able to understand both the context of text messages as a whole, and specific words and phrases that affect the expression of emotions in the text [5, 6]. The advantage of this model is the high accuracy of determining emotional components in text messages due to deep contextual understanding of the text. Also, this model is trained to work in 104 languages, including Ukrainian. mBERT is well suited for solving NLP tasks, in particular for identifying emotional components in text messages. Although the mBERT model is already trained on large data sets, in order to adapt it to a specific task, it is necessary to carry out additional training on the prepared dataset. For the method of determining the emotional components and communication intentions in text messages using natural language processing tools, a dataset will be used, which will contain text messages divided into 6 basic emotions: joy, surprise, anger, fear, disgust, sadness [1].

The first step of the method involves the preparation of a text message for analysis and machine translation of English-language datasets for model training. Given that the mBERT model is quite flexible and can work with texts without extensive pre-processing, some manipulation of the text is still necessary to make it understandable to the model.

First, you need to normalize the text, which includes bringing words to lower case and removing unnecessary characters. Lowercase words are necessary to avoid processing the same words written in different cases. Removing unnecessary characters such as punctuation marks or special characters will allow the model to focus only on the important parts of the text message.

Next, it is necessary to tokenize the text message. The mBERT model has a built-in tokenizer based on WordPiece, which does not require additional settings. The tokenizer breaks the text array into smaller units - tokens. This is one of the most important initial steps, because the text is converted into a format that the model understands. It is worth noting that tokenization in mBERT can break the text not only into individual words, but also into parts of words, which allows the model to better recognize new or unfamiliar words by breaking them into more familiar parts. For example, the word "uncontrolled" can be tokenized into the following parts: "un", "controll" and "ed".

The last step in the preprocessing of a text message is the coding of position vectors. After a text message is broken down into tokens, each token is encoded into

a numeric index that allows to remember the position of the token in the text. These indices are the input data for the mBERT model. Coding of position vectors is a very important step in the preparation of input text, because information about the order of words in a text message is critical for understanding the context.

Often, text preprocessing may include steps such as stop word removal and lemmatization. Stop words are general words that do not add significant meaning to the content of the text ("and", "or", "but") [7]. However, for the mBERT model, the removal of stop words is not necessary, because it can learn to ignore the extra noise on its own. As for lemmatization, it is the process of reducing words to their basic form (for example, "run", and "running" are reduced to the form "run") [8]. Deep learning models are able to recognize semantic relationships even in different word forms, therefore, for the mBERT model, lemmatization can be dispensed with.

In the second step of the method, a list of emotional components is formed and the dominant emotion is determined in the analyzed text message. However, first it is necessary to adapt the mBERT model to the task of determining the emotional components of a text message. To do this, the model needs to be trained on a previously prepared data set that contains texts with labels. During additional training, the model will learn to distinguish texts based on six basic emotions.

The trained model is able to determine the emotional components of a text message, forming a list of those emotions that appear in the text. Also, on the basis of numerical evaluations for each determined emotion, the dominant emotion of the text is determined, that is, the emotion whose manifestation is most pronounced.

In the last third step, an expert opinion is formed on communication intentions based on the determined dominant emotion. For example, if the dominant emotion is sadness, then the intention of communication can be: expression of grief, deep thoughts, boredom or even depression. For this, the model is trained on separately prepared data sets for each communication intention.

In addition, a list of words and phrases is formed, which have a significant emotional load and have the greatest impact on determining the intention of communication. In this way, the justification of the expert opinion is carried out.

As a result of performing the specified sequence of steps, the following output data of the method of determining emotional components and communication intentions by means of natural language processing will be obtained:

– list of emotional components and the determined dominant emotion of the text message;

– expert opinion on communication intentions;

– list of emotionally colored words and phrases.

To implement the method of determining emotional components and communication intentions by means of natural language processing, the mBERT deep learning model built on the architecture of transformers is used. The structure of the mBERT model is similar to most other transformers and consists of five main layers that interact with each other to create a powerful natural language processing tool (Figure 1).

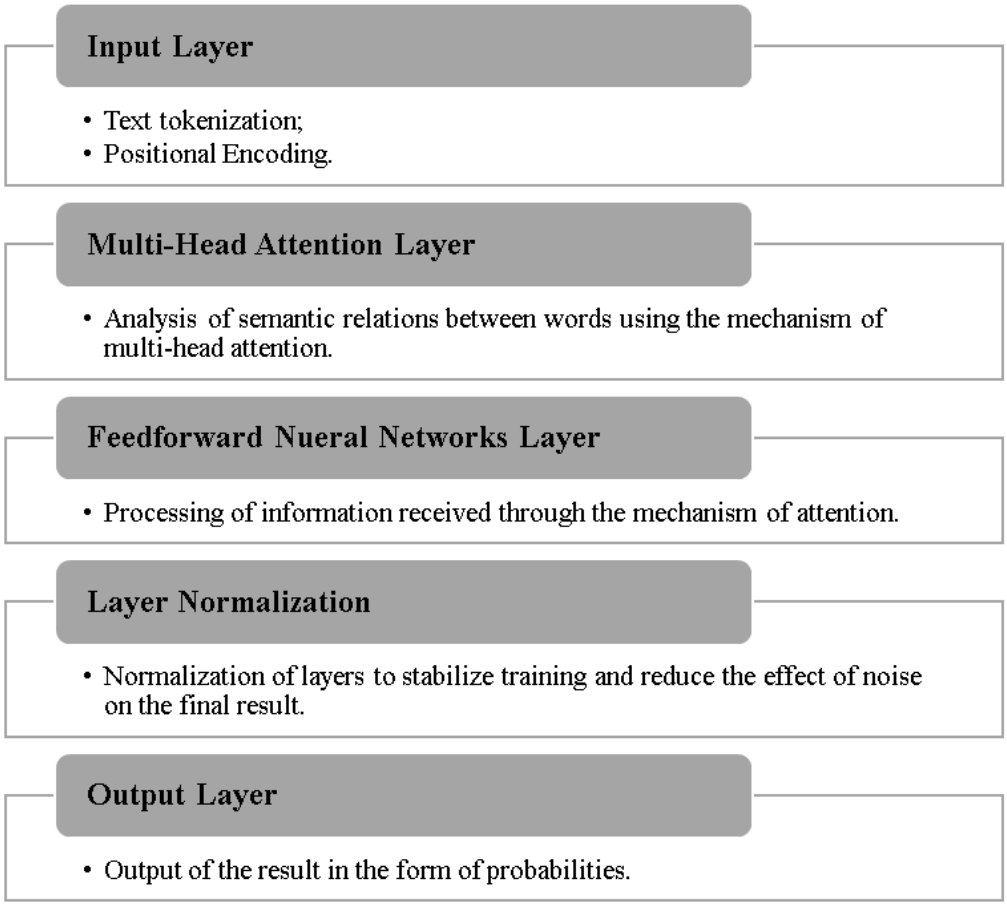

Figure 1. Architecture of mBERT deep learning model.

The first is the input layer, where text messages are processed. First, the text is split into tokens using a special built-in tokenizer. Tokenization in mBERT is based on sequential segmentation, with the help of which the model can process even unknown words by breaking them into parts. Next, in order to understand the order of words in the text, positional vectors are coded. To do this, a position vector is added to each token, which corresponds to the order of the token's location in the text message.

The multi-head attention layer is key to all transformer-based models, allowing it to process the connections between all the words in the text simultaneously. The attention mechanism in mBERT is that while processing each word, the model focuses on all other words of the text, which allows better analysis of the context by understanding how the analyzed word is related to other words in the text. As for multi-headedness, this means that the attention mechanism is divided into several heads, each of which analyzes different aspects of the connections between words, which makes it possible to consider different parts of the context in parallel.

After each layer of attention, the model transmits the received information through a layer of feedforward neural networks. This layer includes a two-layer neural network with activation functions that increases the ability of the mBERT model to perform complex non-linear transformations, allowing for a better understanding of the information received through the attention mechanism.

Next, it is necessary to perform layer normalization (Layer Normalization) in order to stabilize learning and reduce the impact of noise on the result. This makes it

possible to make learning more stable and improve the adaptability of the model to solving complex problems.

On the output layer (Output Layer) the result of text message processing is formed. First, the raw values of the probability of the text belonging to each of the categories are obtained, that is, the probability of the manifestation of emotional components in the analyzed text message. Next, with the help of the Softmax function, numerical values of the manifestation of emotional components are obtained and the main dominant emotion is determined, that is, the emotion with the greatest probability.

So, the problem of using the mBERT deep learning neural network model for identifying emotional components and communication intentions was considered. For this purpose, a method of determining the emotional components and communication intentions of text messages using natural language processing tools was developed, which is capable of determining the emotional components and dominant emotion of a text message and forming an expert opinion regarding the communication intentions based on the determined dominant emotion with justification in the form of a list of emotionally colored words and phrases To solve the task of identifying emotional components from text messages, the mBERT model revealed several key advantages, the main one of which is a deep understanding of the context, thanks to bidirectional learning and a multi-headed attention mechanism. This allows to capture complex emotional connections between words in the text, even if the context depends on the order of the words. Another feature of the mBERT model is its high adaptability to new words thanks to the sequential segmentation of words into tokens. This is especially relevant when analyzing text messages from social networks, where informal vocabulary is mostly used.

According to the results of the research, it is confirmed that the mBERT deep learning model architecture provides powerful tools for natural language processing, in particular, for solving the problem of determining emotional components and communication intentions from text messages. Thanks to the use of mechanisms of multi-headed attention, mBERT is able to capture the most subtle expressions of emotions in texts.

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ОПТИМІЗАЦІЯ ПРОЦЕСУ БЕЗПЕРЕРВНОЇ ІНТЕГРАЦІЇ ТА РОЗГОРТАННЯ У ХМАРНИХ СЕРЕДОВИЩАХ ЗА ДОПОМОГОЮ AWS CDK

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У сучасному світі швидка доставка програмного забезпечення та його постійне оновлення стають критично важливими для підтримки конкурентоспроможності компаній. Традиційні методи розробки, тестування та розгортання програмних продуктів часто не відповідають вимогам ринку, що постійно змінюється. Тому багато організацій звертаються до практик безперервної інтеграції та безперервного розгортання, щоб прискорити випуск програмного забезпечення, підвищити його надійність та знизити ризики. У цьому контексті особливого значення набувають хмарні технології, які