

PROCEEDINGS OF
**INTERNATIONAL CONFERENCE ON INTELLIGENT SYSTEMS AND NEW
APPLICATIONS**

<https://proceedings.icisna.org/>

2nd International Conference on Intelligent Systems and New Applications (ICISNA'24), Liverpool, April 26-28, 2024.

Stress Detection with Natural Language Processing Techniques from Social Media Articles

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Abstract— Stress have significant effects on health and well-being. Therefore, NLP's ability to identify stress situations is critical to providing early intervention and support. NLP can extract meaningful clues from people's online communications and written texts; This makes it a powerful tool for detecting signs of stress. Identifying signs of stress early can help individuals improve their ability to cope with stress by providing appropriate support and guidance; NLP can automate this process. Considering these situations, this study tried to detect the stress states of the users using the Stress Detection from Social Media Articles dataset. Generative Pre-trained Transformer (GPT), Logistic Regression (LR) and Artificial Neural Network (ANN) methods were used for classification. Doc2vec method was used to convert texts into vector data. In the classification processes, the highest classification success was obtained from the ANN model with 80.34%. It is thought that this success can be increased with more data and different models.

Keywords— GPT, NLP, machine learning, doc2vec, stress detection

I. INTRODUCTION

Stress has become an inevitable part of modern life and can have significant effects on psychological and physiological health. In recent years, with the widespread use of digital communication tools such as social media platforms, there has been an increase in the tendency for people to turn to online platforms to express their experiences of stress. Social media provides an environment where people can share their emotional states, thoughts, and experiences, and has therefore attracted attention as a potential source for stress-related data collection and analysis. Identifying and analyzing stress in digital environments can help individuals understand their stressors and receive the necessary support and interventions [1]. However, identifying and assessing stress on social media is a complex process because individuals' expressions can often contain very diverse and complex emotional content. Developing models to detect people's stress levels through

social media can offer a new approach to defining stress and understanding the traces of this emotional state in people's online behavior. With the development of technology, the use of innovative techniques such as artificial intelligence and natural language processing is becoming widespread in the health and welfare sector. These techniques are used to understand people's emotional states and even predict their future reactions [2]. Reddit, one of the social media platforms, has become a medium that users frequently use to express their emotional states. The texts shared here contain important clues about people's stress levels. Analyzing Reddit data offers great potential for understanding and predicting people's stress levels. Reddit's large and diverse user base hosts a variety of content that reflects the emotional states of people with different life circumstances and experiences [2]. These contents include users' experiences with stress, their concerns, and strategies for coping with stress. GPT natural language processing API can be used as a powerful tool to analyze Reddit data and predict people's stress levels. This API can process large amounts of text data and understand the emotional tones within it. For example, the frequency of certain words or phrases can indicate the stress level of a particular user. Additionally, the tone of texts about a particular topic or event may also reflect overall stress levels. However, relying solely on text data may not be enough to accurately predict stress levels [3]. Therefore, other data sources should be integrated along with Reddit data. Predicting stress levels can provide individuals and societies with valuable information to improve their emotional well-being. For example, increasing stress levels on a particular issue at a particular time may indicate that public policies or support services related to that issue need to be revised. It may also help individuals develop personal stress management strategies. However, there are also some ethical concerns regarding the use of this type of technology. In particular, users' privacy and data security issues must be taken into account [4].

In conclusion, it can be said that Reddit data is a potential tool for predicting people's stress levels using the GPT natural

language processing API. However, ethical and privacy issues of this technology must also be considered and applied carefully when using it to improve people's emotional well-being. Various studies have been conducted in the literature to detect conditions such as mental health and stress. Alcibiade et al. conducted a study with the data they collected from 29 participants in the space mission between 2016 and 2019. Using heart rate, blood pressure and survey data, they made inferences about the participants' stress levels with NLP methods [5]. Inamdar et al. studied the classification of posts on a social media site as non-stressful and stressful. They used machine learning methods for classification. By using different NLP tools in their studies, they made the data suitable for use in machine learning methods. As a result, they obtained 0.76 F1 Score, 0.71 sensitivity and 0.74 recall value. They suggested that the methods they suggested could also be used on different social media platforms and could help solve the stress problem [6]. Yuan-Chi et al. aimed to develop an automatic stress detection application using tweets containing stress-related keywords and pre-created text patterns. They tried to achieve the best result by training multiple classifiers. They achieved the highest classification accuracy of 83.6% with the Bidirectional Encoder Representation method. They suggested that their proposed method could automatically identify stress in Twitter [7]. Winata et al. proposed a method to detect psychological stress using interviews. They tagged tweets according to their hash-tags. They used Long Short Term Memory (LSTM) for classification. They obtained 74.1% accuracy and 74.3 F1 Score from this method [8].

In this study, it is aimed to determine people's stress states from text data, based on studies in the literature. Materials and methods are given in the second part of the article, experimental results are given in the third part, and conclusions are given in the last part.

II. MATERIAL AND METHODS

A. Dataset: Stress Detection from Social Media Articles

The dataset used in the study contains 3123 rows of data. 378 of these data belong to 0 (No Stress) and 2745 belong to 1 (Stressful) class [9]. Contains user posts of the Reddit application. The dataset was downloaded from the kaggle.com platform [10].

B. Generative Pre-trained Transformer (GPT)

GPT or Generative Pre-trained Transformer is a model that has achieved quite impressive success in the field of artificial intelligence. GPT is a deep learning model that stands out in the field of natural language processing (NLP). The basis of GPT is the attention mechanism. The basic operation of GPT is as follows: Pre-training: GPT is pre-trained with large amounts of text data, usually from the internet. It contains a wide variety of texts collected from various sources. Using this dataset, the model learns the structures and contexts of the language. Transformation: The Transformer architecture, which forms the basis of GPT, uses a mechanism called attention mechanism. This is an artificial intelligence mechanism that can focus on

other parts of the text for text, allowing the model to understand the context surrounding a word and make more accurate predictions by taking that context into account. Generative Capability: GPT is a generative model that can be used to generate text. Since it is pre-trained, it can create new and logical texts starting from an introductory sentence. This can be used for many applications such as story writing, article creation, language translation [11].

C. GPT for NLP

The use of GPT for stress detection in the field of natural language processing (NLP) has led to significant progress in the fields of psychology and health. Since GPT has the ability to understand language patterns and emotional content in texts, it used to detect signs of stress. For example, by analyzing text in a person's social media posts, blog posts, or other written communication tools, it is possible to determine that person's stress levels. The use of GPT for stress detection generally involves the following steps: First, the model is pre-trained with a large dataset. In this training phase, a large data set containing stressful and non-stressful texts can be used. Using this dataset, the model learns language patterns, emotional expressions, and other symptoms that may be associated with stress. The trained model then analyzes specific text for use in real time. It evaluates whether words, sentences and expressions in the text are related to stress. The model can recognize anxiety, tension, uncertainty, and negative emotional expressions, which are common signs of stress. Finally, the model's output is evaluated to determine the stress level. This assessment can be made based on the frequency, intensity, and other factors of stress-related phrases in the text. The result is an assessment or rating that provides information about a person's stress level. The use of GPT for stress detection offers many useful applications. For example, it can be used to monitor individuals' stress levels and intervene when necessary. It can also be used by healthcare professionals to evaluate the effectiveness of stress management treatments [12].

D. Weights & Biases (W&B) API

Weights & Biases (W&B) is a tool and platform used in machine learning and artificial intelligence projects. The goal of W&B is to make it easier to train, monitor, and visualize the results of machine learning models. W&B's core functionality includes a variety of tools used to monitor the training and performance of machine learning models. These tools are used to record the model training process, monitor parameters, visualize results, and make comparisons between different experiments. The platform offers a variety of graphs, tables, and metrics to visualize model performance during and after training. This is an important tool to better understand and improve the training process of the model. Regarding the management of experiments, W&B makes it easy to switch between various experiments, such as different model configurations or hyperparameter settings. This allows improving the model by directly comparing the effects of different strategies and parameters. W&B offers community and sharing opportunities to make it easier for users to share

their models and results with others. This encourages collaboration and knowledge sharing in open source communities. W&B can be integrated with popular machine learning libraries and frameworks (TensorFlow, PyTorch, scikit-learn, etc.). This makes it easier to use W&B in existing projects. W&B's comprehensive documentation helps users learn how to use the platform and apply it effectively in their projects [13, 14].

E. DOC2VEC

Doc2Vec, also known as "doc2vec" or "Paragraph Vector", is a machine learning algorithm used to represent text documents and train the model on a set of text documents. It is based on Word2Vec and provides a framework for representing text documents by extending Word2Vec's word vectors. Doc2Vec is often used in NLP (Natural Language Processing) applications and can be used for a variety of tasks such as document classification, similarity finding, document clustering and sentiment analysis. Doc2Vec offers two different approaches. Distributed Memory Model of Paragraph Vectors (PV-DM): This model works to preserve the context of words in a document. Here, a single vector is created for each document and this vector contains the distributed representation of the words found in that document. Words are also represented by a set of vectors, like Word2Vec, and these vectors are randomly assigned initially and updated during training. Distributed Bag of Words (PV-DBOW): This model completely ignores the word order of the document and only selects a random subset of words within the document. Based on these selected words, the document vector is estimated. This model is useful when the word order of documents is not important. Doc2Vec typically works with large text data and is often used to extract meaningful features from large sets of text. In particular, it has been successful in tasks such as finding similarities between documents and document classification. Advantages of Doc2Vec include that it can be effective in documents where word order is important (in some cases) and that it can capture the semantic similarity of documents well. However, since it needs to be trained on large datasets, it usually requires a sufficient amount of data. Additionally, the training process can be quite computationally intensive [14].

F. Logistic Regression (LR)

Logistic Regression is a basic classification algorithm used in many machine learning applications. In particular, it is widely used in binary classification problems (i.e., when the outcome is a choice between two classes). This algorithm takes a linear combination of features in the dataset and predicts the probability that the result belongs to a particular class. The basic principle of Logistic Regression is to constrain the output by a curve called a logistic function or sigmoid function. This function compresses the input values into the range [0, 1] and allows us to interpret the output as probability. The training process of the algorithm is performed to capture the relationship between features and classes in the dataset. This is usually accomplished using an optimization algorithm to find the optimal model parameters. This optimization is often done

using a method called "gradient descent". The advantages of Logistic Regression include its simplicity, interpretability and speed. In particular, it can work well with datasets with large feature sets. However, Logistic Regression cannot model complex relationships in some cases and is more suitable for linearly separable classification problems [15].

G. Artificial Neural Network (ANN)

Artificial neural networks are a mathematical modeling of the neural networks of the human brain and are used to perform a variety of machine learning tasks. Artificial neural networks consist of many nodes (or called neurons) and connections between these nodes. Each node receives input data, applies weights to these inputs, applies an activation function, and can forward the result to other nodes. Artificial neural networks learn from data during the training process. In this process, parameters such as weights and biases are adjusted on the training data, usually using an optimization algorithm. Artificial neural networks can be used in many different applications such as image recognition, text classification, and voice recognition [16].

H. Performance Metrics

They are important tools used to evaluate the performance of the model in machine learning and statistical modeling studies. Some of the performance metrics are accuracy, precision, recall and F1 Score. Confusion matrix is a table used to evaluate the performance of a classifier model [11]. Typically, a confusion matrix consists of four main parts:

True Positives (TP): Number of true positive samples

True Negatives (TN): Number of true negative samples

False Positives (FP): Number of samples falsely classified as positives that are true negatives

False Negatives (FN): Number of samples incorrectly classified as negatives that are true positives

The confusion matrix visually shows which classes the model correctly or incorrectly classifies. An example confusion matrix is shown in Fig. 1.

		PREDICTED	
		0	1
ACTUAL	0	TP	FN
	1	FP	TN

Fig. 1. Confusion matrix

III. EXPERIMENTAL RESULTS

The data in the dataset used in the study was analyzed with the GPT tool and confusion matrix and performance metrics were obtained. In order to re-analyze the success of GPT, the texts were analyzed and converted into vector data using the doc2vec method. The converted data was classified with LR and ANN methods. Classifications were made using the cross validation method. Cross validation fold value is set to 10. The operations performed are shown in Fig. 2.

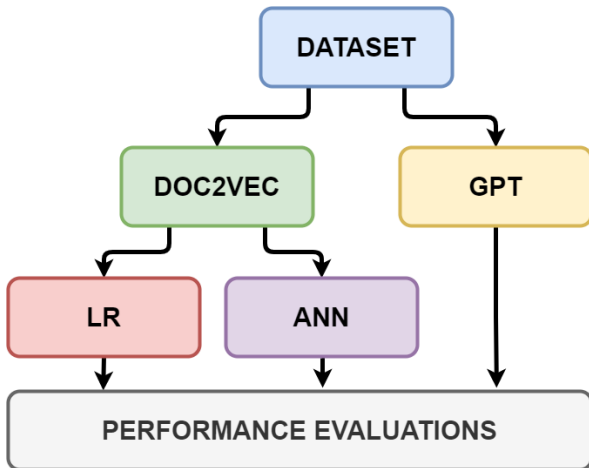


Fig. 2. Flow chart of this study

The confusion matrix in Fig. 3 was obtained from the classification made with GPT. The confusion matrix obtained from the classification with LR is given in Fig. 4, and the confusion matrix obtained from the classification with ANN is given in Fig. 5.

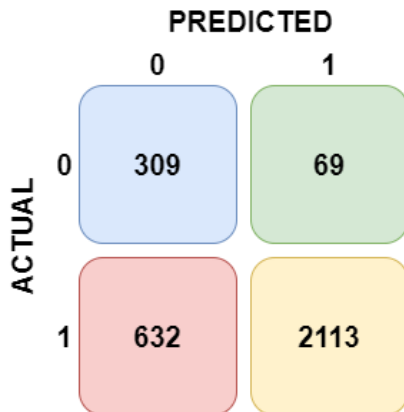


Fig. 3. Confusion matrix of GPT

In Figure 3, the GPT model correctly classified 309 samples as positive (TP). However, it classified 69 positive samples as false negatives (FN). Similarly, the model classified 632 samples as false positives (FP), but correctly classified 2113 samples as negative (TN).

In Figure 4, the LR model correctly classified 348 samples as positive (TP). However, it classified 30 positive samples as false negatives (FN). Similarly, the model classified 607

samples as false positives (FP), but correctly classified 2138 samples as negatives (TN).

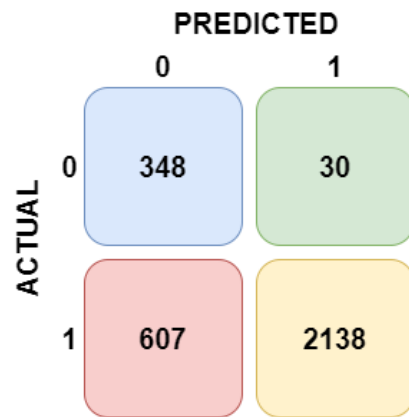


Fig. 4. Confusion matrix of LR

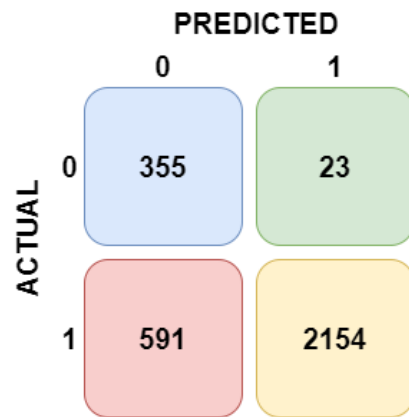


Fig. 4. Confusion matrix of ANN

In Figure 5, the ANN model correctly classified 355 samples as positive (TP). However, it classified 23 positive samples as false negatives (FN). Similarly, the model classified 591 samples as false positives (FP), but correctly classified 2154 samples as negatives (TN).

Performance metrics of the models were calculated with the help of the values in the confusion matrices. Table 1 shows the performance metrics of the models.

TABLE I.
PERFORMANCE METRICS OF ALL MODELS

	GPT	LR	ANN
Accuracy (%)	77.55	79.60	80.34
Precision	0.3284	0.3644	0.3753
Recall	0.8175	0.9206	0.9392
F1 Score	0.4685	0.5221	0.5363

The GPT model has an accuracy rate of 77.55% on the given dataset. This indicates that the model has generally acceptable performance. However, it has a lower accuracy value compared to other models. This may indicate that the model may learn patterns in the data set less effectively or may be less successful

at identifying a particular class than other models. The LR model performs slightly better, with an accuracy rate of 79.60%. This indicates that the model has a better ability to learn patterns in the data set and can perform more accurate classification. However, it still has a slightly lower accuracy than the ANN model. The ANN model has the highest accuracy with an accuracy rate of 80.34%. This shows that it is the model that learns the patterns in the data set best and makes the most accurate classification. Therefore, it can be said that the ANN model is a better option compared to other models for the given data set.

IV. CONCLUSION

In this study, machine learning models were used to detect stress situations from the comments made by users. Doc2vec method was used to convert texts into vector data. GPT, LR and ANN methods were used to classify the data. The highest classification success was obtained from the ANN model with 80.34%.

The quality and diversity of the dataset on which the model is trained directly affects the accuracy of stress detection. If the training data is not comprehensive or focuses on a specific population or culture, it may reduce the model's ability to generalize. Understanding the signs of stress in popular texts can be complex and ambiguous at times. Accurately analyzing the context of words and expressions is important to improve the accuracy of the model. This is especially true in situations involving the use of language, such as puns, irony or slang. To overcome these limitations, it is important to increase the diversity of the model's training data, take into account ethical principles, understand cultural differences, and use more sophisticated NLP and machine learning techniques to handle complex relationships.

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