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A Review of Machine Learning Approach for Mental Stress Detection

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Abstract

Mental stress is a psychological disorder that has an impact on many parts of life, including sleep. People are affected by mental stress on a daily basis due to a variety of circumstances, including social ones. (financial difficulties, family and friendship concerns), the environment (poor weather, traffic, or noise), or scenarios such as giving a presentation in front of a large group or wedding planning. A manageable level of stress is good for a person's health and can encourage them; however, an excessive amount of stress or a strong reaction to stress might be dangerous. As a result, diagnosing and predicting mental stress has become a popular issue in the community. Using machine learning technology, this paper discusses and analyzes various methods for stress detection.

Keywords: Mental stress, Dangerous, Machine learning, Stress detection, Predicting mental stress

1. Introduction

Stress has become a common occurrence in our daily lives and is a well-known topic in public health. In today's highly competitive economy, stress has recently become a significant component of professional life. A person is continually presented with a range of problems in the workplace, including job insecurity, work overload, job dissatisfaction, and the desire to stay current. Lack of sleep, high blood pressure, infection susceptibility, and cardiovascular disease are all serious health consequences of stress. All of these circumstances lead to mental stress, which is now the major cause of a variety of disorders. Such negative consequences influence not only people's well-being and health,

but also the general productivity of the company. The logistic regression model was used to determine whether or not the person was stressed. In this situation of it and productivity, the binary logistic model was used to identify one dependent variable.

2. Literature Review

According to [1] Reshma Radheshamjee Baheti, and Supriya Kinariwala conducted a study on Stress is detected and analyzed using machine learning techniques. This study analysis the stress and relaxation level of a person from the English text which were commented on tweeter social medial. It was carried out in three key stages. Pre-processing removes non-alphabetic characters, special symbols, spaces, stop words, slang terms, and URLs in the first stage. After the pre-processed, the text further classified in the steps II by applying the Word Sense Disambiguation method. The WSD method uses POS tagging, N-Gram, and Shift- gram methods. In the POS tagging, the POS tagging was used to identify the Noun, Verb, Adverb, and adjectives. N-Gram method further classifies the bi-word, tri-words to find the associated meaning from the dictionary. After the WSD process the text given to SentiStrength [2]frame work -5 to +5 to estimate the quality of stress and reduction expressed in brief texts, even for informal language. Except for political texts, it has human-level accuracy for brief social network texts in English. TensiStrength reports two stress/relaxation strengths: -1 (no stress) to -5 (very high stress), 1 (no relaxation) to 5 (highly relaxed). It combines a lexical method with additional linguistic criteria to account for common ways of modifying the meaning of statements, such as negation, in order to detect stress or its partial opposite, relaxation, symptoms. In the lexical strategy, a sentiment words resource, such as Sent WordNet, is used. It also employs an algorithm to determine the presence of sentiment in a text based on the words contained therein. If the word good is classified as positive in a lexicon, publications including it are more likely to be classified as positive.

At the stage five, two algorithms were used to categories the texts into classes like happy, depressed etc. Naïve Bayes and Support vector machine (AVM) algorithms were used for this task. The Naive Bayes classifier is a simple classification system that splits data into groups based on the likelihood of events occurring. It's a common text classification technique. It performs well in a number of text classification tests, despite its

simplicity. It takes less time to train and requires less data.

Aditiya vevek thota and A. Dharun [3] investigated mental health disorders among technical professional and to identify the factors for the cause of the disorders. There were 750 responses collected from professional and 68 feature attributes associated in this study. After cleaning the dataset many attributes eliminated and only 14 features were selected. The textual responses converted as numerical values. In this dataset, 70% of the data was used to train the model and 30% was used to test it. The features and patterns in this study were analyzed using a variety of machine learning methods. It includes, KNN classifier, Logistic regression, Decision trees, Bagging, Boosting, Random forest classifier to determine whether or not the participant was stressed, a logistic regression model was used. In this case, one dependent variable was identified using the binary logistic model. But this model can support well for large size of sample data. In this study they have selected only 750 responses and only 70% used for the training. The KNN classifier used in this study to predict whether the person need treatment or not. The KNN algorithm is best to implement if the independent variables are less and in this study 14 variables were used it is fairly the result will not be satisfied and shows the percentage of 70% accuracy and it shows the highest false positive rate. Decision tree algorithm shows 0.70 accuracy and less false positive rate next to boosting algorithm. Decision trees algorithm's accuracy is depending on entropy selection so the best entropy selection can produce best classification accuracy. According to this study, using machine learning algorithms, the elements that cause stress may be recognized and any remedy to reduce stress in the workplace can be found.

B.Padmaha, V.V. Rama Prasad and K.V.N Sunitha [4] [5] A study of a machine learning method for detecting stress levels using data from a fitness tracker device. The logistic regression machine learning method was used to construct a model to assess the stress level individually utilizing data collected by sensor technologies and an online perceived stress scale questionnaire. Logistic regression is the best regression method to utilize when the dependent variable is dichotomous (binary). In this study the result factor is to analyses whether the stress has connection or not with the hypothesis. The data set contains 29 attributes and 3000 records, the sleeping pattern, physical activity, number of

working hours, and any variations in heart rate were all investigated among professionals in this study. Because of the large amount of data, the feature selection procedure was broken down into four steps: hierarchical clustering, multicollinearity, oblique principle components analysis, and variable importance plot. In the feature selection, highly discriminant attributes were considered. The multicollinearity process is a correlation matric to eliminate high correlation predictors.

The data was analyzed using three logistic models, and the low Akaike information criteria were employed to assess the models' relative quality. Among the attributes the finally concluded that the Body mass indexed was significant factor and positive indicator for stress.

Chandrasekar Vuppalapati1, Mohamad S Khan, Nisha Raghu, Priyanka veluru, Suma khursheed [6] used machine learning and mobile development technology to conduct a study to detect emotional stress. This work addressed the issue by developing and deploying a machine-learning-powered data-driven, electroencephalogram biosensor-integrated mobile application for stress detection and analysis. This EEG data has been used by Neurologist for the stress detection. A Bluetooth enabled Mind wave mobile headset device was fixed on the patient head to receive the brain electrical signals in the form of alpha, delta, theta, beta, gamma and Mu bands. To forecast the stress level, these data were fed into a machine learning algorithm. A mobile application collects data and sends it to cloud storage, where it is then retrieved for use in the machine learning model. There were three ML model used Logistic Regression (LRL) classifier, Support Vector Machine (SVM), and Naïve Bayes (NB) classifier and from the feature extraction some parameters were collected via the device from the brain signals, Absolute and relative power, coherence, phase log, amplitude asymmetry, and score standardization are all included. An EEG matrix was created and the parameters was aligned in the matrix. The LR classifier used to analyses the relationship between variable and it is a binary method depict a two stage where the person has stress or not. If the likelihood value I(x) is greater than 0.5, the individual is declared to be in a stressful condition. Else, it is declared to lie in the control category. The hyperplane is also employed in the SVM approach to forecast stress level when more than two control factors are applied. Support vectors, or data points that are closer to the hyperplane, influence the position and

direction of the hyperplane. These support vectors are used to improve the margin of the classifier. The hyperplane's location will vary if the support vectors are removed. These are the factors to examine while we construct our SVM.

Ravinnder Ahujaa, Alisha Bangab Jaype [7] conducted a study on Using a machine learning approach, university students' mental stress can be detected. The study mainly focused to collect data in two ways one is the students stress level before one week for the examination and the internet usage of the students. The data was gathered for the Perceived Stress Scale (PSS) exam, which consisted of 14 questions in total, including an emotive question to determine in which situations stress occurs, and so on. The questions were graded in five different ways. (a) Never (b) Almost Never (c) Occasionally (d) Fairly Frequently (e) Very Frequently. The weighted average approach is then employed, with each question being prioritized. The pupils are divided into three groups: those who are extremely anxious, those who are stressed, and those who are normal. Before applying the data into machine learning models, data should be clean, and features should be extracted to apply models. The dataset further grouped using the 10-fold- cross validation technique to select the training dataset and testing dataset. Four type of Machine learning algorithm were used in the study. Support vector machine, Naïve Bayes, Random forest and K-nearest neighbor. The researcher concluded that the SVM method shows a good accuracy and 100% of specificity. The random forest is a decision tree-like algorithm, with the Gini impurity or information gain/entropy as the measure of impurity for classification. The measure of impurity in regression is variance. As a result, when training a tree, it is possible to quantify how much each feature lowers impurity. The more an attribute reduces impurity, the more significant it is. In random forests, the impurity decrease from each feature can be averaged across trees to determine the variable's final significance. In practice, the SVM approach transforms an input data space into the appropriate format using a kernel. SVM uses a technique known as the kernel trick, in which a low-dimensional input space is transformed into a higher-dimensional space via the kernel. Kernel, in simple terms, adds new dimensions to non-separable issues to make them separable. It increases SVM's power, flexibility, and accuracy.

3. Approaches to detect Stress Level

In this section, we'll go through a few methods for detecting stress levels. These methods differ depending on the measurements used.

A. Stress Detection While Working or Studying

Students' ability to concentrate on their academics is harmed by high levels of stress, which can also lead to forgetfulness, restlessness, and weakness. Students' emotions, conduct, and attitude can be negatively affected by stressful academic settings such as heavy study weights. Students' performance may be harmed as a result of such circumstances, and they may be unable to achieve their academic objectives. Furthermore, job stress leads to employee disengagement and lower productivity. As a result, detecting stress at an early stage is critical for minimizing psychological and physical harm. [8] An application was created to capture accelerometer data from smart phones in order to measure the stress behavior of 30 respondents in their daily working contexts. During office hours, the user rates his stress three times on a 5-point scale. A high level of stress is indicated by a score of 4 to 5, a medium level of stress by a score of 3, and a modest amount of stress by a score of 1 to 2. To achieve great accuracy in recognizing subject physical movements and to extend battery life, the authors set a sampling rate of 5Hz. Using the forward feature selection method, the authors extract 34 characteristics from accelerometer raw data and select features that improve the classifier's accuracy. For classification, the authors use Naive Bayes decision trees classifiers, with overall classification accuracy of 71 percent using user specific models and 60 percent using the similar-users model. [9] The scientists examined data from university students' smart phones called "Student Life," which included call logs, accelerometers, audio (noise, talk, silence), and stress level surveys. They propose a stress detection technique that might be used to classify pupils as "stressed," "slightly stressed," or "not stressed." The ratios of stationary, silence, voice, and noise, days until midterm, answering epoch, conversation duration, epoch period, and deviation of voice, activity, silence, and noise are among the short-term, date-time, relative epoch features extracted. To classify the data and compare the findings to the questionnaire replies, the authors use classification methods such as random forest and SVM. The student-specific

model outperformed the baseline using a random forest classifier, achieving around 60% accuracy.

B. Blinking Detection for Stress Detection

A computer vision-based technology was developed in video recorded discussions to identify stress by auto patterns recognition for eyes blinking. Their method entails determining the eye region with a face tracker and then altering the color appearance of these areas. Offset characteristics, Shannon's entropy, and blinking time lapses are also employed. The proposed system establishes a correlation between stress perception and eye blink patterns. [10].

C. Detecting Stress by Measuring Nasal Skin Temperature

Temperature sensors are used by the authors [11] to detect the temperature of the nasal skin. The loss of blood flow produced by shrinking blood vessels has been demonstrated to cause a decrease in nasal skin temperature with increased stress levels. The author developed an application that analyzes data (acceleration and temperatures) to detect when the user is stressed. The authors use an accelerometer and three tiny temperature sensors put on the users' eyewear to evaluate their motion. For the parameters stress, mobility, and environmental temperature, the measures were 66.7 percent, 93.3 percent, and 100 percent, respectively. They advised that their technology collect daily life data for future studies.

D. Typing Behavior as a Stress Detector

In [12], the suggested method analyzes keyboard interactions in order to detect changes in cognitive status and physical in elder persons, as well as differentiate between stressed and calm states. After completing physical and cognitive challenging tests, Respondents of the study are asked to write a sample paragraph. The method examines the generated text's keystroke and text features. Three-fold cross-validation was employed with a step-wise logistic regression approach. Before applying machine learning, the data was standardized using Z-scores. In comparison to the control settings, the accuracy of categorizing cognitive and physical stress is 75% and 66%, respectively.

E. Human Voice Detection of Stress

In real-time, A smartphone running Android is used to detect stress in human voices. During an interior job interview with eight questions and an outdoor marketing exercise, voice data from 14 participants was captured via a Google Nexus One phone (stressed scenarios). Furthermore, the patients were told to read simple stories both within and outside the classroom (no stress). In addition, a background program was employed to gather GPS and accelerometer data. GSR sensors incorporated in a wristband called Affective were also used to collect data on skin conductance. In the marketing and employment interviews scenarios, the GSR reading increased, whereas in the neutral settings, it decreased [13]. For speaker segmentation, a participant wears a smartphone around his waist and a second phone on his shoulder. With the diagonal covariance matrix, the Stress Sense uses Gaussian mixture models. Stress Sense, a classifier, with an indoor accuracy of 81 percent and an outdoor accuracy of 76 percent. In [14] A classification system based on GSR and Speech was presented for determining a subject's acute stress period. HD handy-cam camcorders were used to record facial expressions, GSR, and speech. SVM classifiers are used in the model, as well as decision trees and K clustering. SVM obtained accuracy of 92 percent and 70 percent, respectively, using speech and GSR features. For the same person, the GSR signal changes every day. In [15] The authors utilize a deep learning model with seven hidden layers and the RelU activation function to predict the subject's stress state using an EEG data. The suggested approach correctly predicts the stress levels of 80% of the respondents.

F.Mobile phones and Wearable Sensors for Stress Detection

In [16], Stress is detected using a wrist gadget. The activity recognition classifier recognizes users' actions using accelerometer data and differentiates between stress and other situations that cause physiological arousal. A web application was created to collect laboratory data in which users were expected to complete mental arithmetic tasks within a certain time restriction in order to create pressure. The authors [17] gather data from three different sources: I mobile usage (messages, locations, and calls), (ii) skin conductance and accelerometer data from a wrist sensor, and (iii) a survey (general health, mood,

stress). The classification decides whether the person is stressed or not. Three surveys must be completed before the experiment may begin. A wearable sensor records an accelerometer and skin conductance. The technique properly identified stress 75% of the time, demonstrating that wearable sensors and mobile phone data were both beneficial for stress detection. Two of these features are the mean and standard deviation of mobility radius. The authors will collect a larger data set to better understand the dynamic effect of long-term data. In [18], The authors use the individuals' body temperature, GSR, and RR interval to evaluate mental stress in real time while they solve the Hanoi Tower. The results of the questioners, which were completed by the participants before and after the research, were used to validate the information gathered. From the gathered signals, the author extracted 27 features, with the largest mutual information being used to train the KNN classifier on 10 of them. The accuracy of the stress prediction is 89.8%. In [19], The creators designed the smart band to predict whether or not a person is stressed. The skin conductance and various pentameters of 12 people were measured using two electrodes, a skin conductance sensor, a 3-axis accelerometer, Bluetooth, and a microcontroller. A small quantity of electricity is delivered to the skin by the electrodes. The information is relayed via Bluetooth to a smartphone, which displays the user's stress level. Furthermore, the data is made available on the internet for physicians to use in order to improve treatment. The authors used logistic regression to predict whether or not the participant will be stressed. With regularization, the accuracy is 91.66 percent, while without it, it is 100 percent.

4. Methodology

Journal articles, conference papers, and related websites were used for this study. published in many databases such as IEEE Explore, ScienceDirect and Google scholar.

To find the appropriate dataset from this Database, the researcher used the search terms Mental stress detection while studying, Human Voice detection for stress, Mental stress while working, and Wearable Sensors for Stress Detection. As a result, 52 relevant publications are extracted and reviewed for these search terms.

5. Discussion and Conclusion

The term "machine learning" refers to both the academic discipline and a set of techniques that allow computers to do complicated jobs. ML is a combination of mathematics, statistics, and computer science as an academic discipline. It is nowadays being used in medical diagnosis for making decisions. Its need past experience data and thereby the machine is learned the pattern and making a model using mathematical and statistical methods to predict something. In the field of stress detection and control, the machine learning methods provides huge support in detection of persons who are suffering from mental disorders without knowing themselves without consulting a neurologist. There are several algorithms available, and an appropriate approach for analyzing and predicting is chosen based on the situation and dataset. As a result of the above studies discussed in the review mostly, linear regression, support vector machine method, Naïve Bayesian algorithm, random forest, and decision tree were used in their studies. For the accuracy of the test, the support vector machine method was utilized in the majority of the research. But, the algorithms depend on the dataset and feature selection when they produce results. Some algorithms work well with huge datasets, while others are better suited to a small number of independent variables. Machine learning increases and employed in many sectors and could be used for early detection or diagnosis. It's been used to smell the meaning of text in natural language processing. As a result of the above study, the use of a machine learning approach in health analysis, particularly in stress detection utilizing a small dataset, is highly supported.

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