

INTERNATIONAL JOURNAL OF HUMAN COMPUTING STUDIES

Vol. 6 | Issue 2 **| pp. 53-68 | e-ISSN:** 2615 – 8159 **| p-ISSN:** 2615 - 1898 **Available online @**
https://journals.researchparks.org/index.php/IJHCS

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Human Stress Detection Through Sleep by Using Machine Learning

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Abstract: An individual's capacity to learn, concentrate, make sound decisions, and solve problems is all profoundly affected by stress. Recently, researchers in the fields of computer science and psychology have begun to focus on stress detection and modelling. Affective states, the sensation of the underlying emotional state, are used by psychologists to quantify stress. Human stress classification has mostly relied on user-dependent models, which can't adapt to different users' needs. This necessitates a substantial amount of effort from new users as they train the model to anticipate their emotional states. Urgent action is required to address prevalent childhood mental health concerns, which, if left untreated, can progress to more complex forms. Analysis of medical data and problem diagnosis are now areas where machine learning approaches shine. After running Features on the complete set of characteristics, we were able to minimise the number of attributes. We compared the accuracy of the chosen set of attributes on several ML methods..

Keywords: Human Stress Detection, Through Sleep, Using Machine Learning, AI researchers, Algorithm Using Python

Citation: Rajasekaran G, P.Velavan, B. Vaidianathan. Human Stress Detection Through Sleep by Using Machine Learning. *International Journal for Human Computing Studies,* **2024**, *6(2),* 53-68.
https://doi.org/10.31149/ijhcs.v6i2.5 248

Received: 12 January 2024
Revised: 02 April 2024
Accepted: 28 May 2024
Published: 31 August 2024

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1. Introduction

The term "artificial intelligence" (AI) describes computer systems that are able to learn and do tasks normally performed by people. Any computer system that can learn and solve problems in the same way a human brain can is also considered a mind. Machines that exhibit intelligence in contrast to how people and other animals naturally think are known as artificial intelligence (AI) [7]. The study of "intelligent agents," or systems that can sense their surroundings and act in a way that maximises their chances of accomplishing their objectives, is the primary focus of prominent AI textbooks. Major AI experts disagree with the popular understanding of the word "artificial intelligence" that uses it to represent robots that can learn and solve problems in the same way that humans can. Using historical data to make predictions is the essence of machine learning [8-12]. One branch of AI, machine learning (ML) enables computers to pick up new skills automatically, without human intervention. Implementing a basic machine learning algorithm in Python is a good place to start when learning about machine learning, which is primarily concerned with creating computer programmes that can adapt to new data. In order to train and make predictions, specific algorithms are utilised [13-19].

This process involves feeding an algorithm with training data so that the algorithm may make predictions on new test data using this training data. There are essentially three subfields within machine learning. Learning can be either supervised or unsupervised, and reinforcement learning is one of the latter. If a person needs to classify data before a supervised learning computer can learn it, the programme can be fed the data and the labels together.

Labels are not used in unsupervised learning. It supplied the algorithm for learning. In the end, this algorithm has to figure out how to group the input data. RL also receives feedback from its surroundings, either positive or bad, and uses it to get better [20-24].



Figure 1: Process Of Machine Learning [5]

The ability for computers to comprehend and interpret human speech is known as natural language processing, or NLP. A robust NLP system might learn from human-written sources, including newswire stories, and provide user interfaces that use natural language. Data retrieval, text mining, query response, and machine translation are some of the more basic uses of NLP. In order to build syntactic representations of text, many existing methods rely on word co-occurrence frequencies [25-31]. "Keyword spotting" search tactics are common and easy to scale, but they're also stupid; for example, if you type in "dog," the search engine may only return results that contain the term "dog" and not "poodle." Words like "accident" are used by "lexical affinity" tactics to determine the tone of a document. Combining all of these and other techniques, modern statistical NLP systems can frequently reach satisfactory accuracy at the paragraph or page level [32].

Building a stress detection ML model that can outperform current supervised ML classification models in terms of accuracy in result prediction through algorithm comparison is the primary objective. Patient stress detection integrated with computer-based prediction has the potential to enhance prediction outcomes while decreasing errors, according to the project's scope [33-37]. Given that data mining and other data modelling and analysis techniques can create a knowledge-rich environment, this approach has promise for greatly improving the quality of stress detection prediction. In order to get the most accurate results when forecasting stress, we will be evaluating several supervised algorithms in an effort to build a machine learning model that could one day replace the updatable supervised machine learning classifications and models [38-41].

Literature Review

Ykhlef and Alsagri [1] Facebook, Twitter, and Instagram, among others, have changed the world in an irrevocable way. More and more, people are sharing their online identities and revealing their level of connectivity. Social networking offers many great benefits, but it also has some obvious drawbacks. High levels of social media use are associated with an increased risk of depression, according to recent research. Utilizing machine learning techniques, this study seeks to identify Twitter users who may be suffering from depression by analysing their network behaviour and tweets. To achieve this goal, we used characteristics retrieved from a user's network activity and tweets to train and evaluate classifiers that can determine if a user is depressed. The accuracy and F-measure scores for identifying users suffering from depression were found to increase in direct correlation with the number of features utilised. To identify mental health issues like depression early on, this strategy employs a data-driven, predictive approach. The primary contribution of this work is to investigate the characteristics and their effect on depression level detection.

In their study, Sharma et al. observed that Suicide was a factor in the deaths of 78 million persons in 2017, out of a total of 792 million (or over 10% of the world's population) who dealt with a mental illness. Because of the established link between one's home environment and the development or exacerbation of mental health issues, the already severe mental health crisis brought on by the COVID-19 pandemic has taken a quantum leap forward. Furthermore, the ever-present public shame associated with caring about mental health means that persons with mental health illnesses are neglected in terms of diagnosis and treatment in today's culture. Predicting suicidal thoughts (and other diagnostic methods) has recently been attempted in the data science community, however all have met with significant failure. To start, there are a lot of privacy and reusability without consent ethical concerns with large data, particularly when it comes to social media feeds.

The numbers might also be skewed because some persons with mental health diagnoses don't seek treatment. By predicting the response to a separate question—whether or not individuals are seeking mental health treatment—using anonymous datasets, we handle both of these issues in our study. In addition to statistical analysis, we employ a number of machine learning and deep learning classifiers and predictive models to make very accurate predictions.

The third one, Sandhya, These days, people talk about their mental health more in academic settings than in their everyday lives. A person's mental health is measured by their overall well-being. Less physical labour will be required of people as a result of the rising usage of technology. Additionally, workers in any industry are more likely to suffer from mental health issues due to the constant stress they experience on the job. Peer pressure, anxiety, tension, sadness, and countless more are all examples of such weaknesses. Right now, we're using a dataset that contains survey responses from people working in the IT sector. Their responses are used to derive the outcome. Whether or if the individual requires assistance will be the result here. In order to acquire the findings, many machine learning approaches are employed. Additionally, this forecast emphasises the significance of IT workers getting frequent mental health exams to monitor their well-being. A medical service should be offered by the employers, and the affected employees should also profit from it.

Sushmita [4], Professionals are better able to address mental health issues and enhance patients' quality of life when they are diagnosed early. As a result, children's fundamental mental health concerns require immediate attention because, if left untreated, they might progress to more serious disorders. When it comes to medical data analysis and diagnosis, machine learning approaches shine. In order to diagnose five common mental health issues, this study assessed eight different machine learning algorithms using various accuracy metrics. In order to train and test the approaches, a data set of sixty cases is collected. In order to diagnose the problem, twenty-five qualities from the papers are crucial. Applying feature selection techniques to the complete collection of attributes reduced the number of attributes. There was a comparison of the complete and selected attribute sets' accuracy using different machine learning approaches. The outcomes clearly show that the three classifiers—Perceptron, Multiclass Classifier, and LAD Tree—gave superior results, with just a little variation in their performances across the complete set of attributes and the set of attributes.

Existing System:

An innovative JCCB-FSC approach to identify decision-making stress. To model the way stressed-out medical students make decisions, we employed the TSST and BART experimental paradigms. Rather than focusing on generalised stress levels, as in earlier studies, our goal was to identify stressful situations during decision-making and offer guidance for future medical personnel on how to identify stressful situations when making decisions. A number of elements influence decision-making, and stress is one of them. As a result, enhancing physicians' decision-making performance requires early stress awareness. One promising method for stress detection is functional near-infrared spectroscopy, or fNIRS. Nevertheless, the majority of earlier research just relied on individual-level fNIRS parameters for categorization, neglecting to account for the connections among brain-corresponding channels that could offer unique features [42-47]. A generalised dataset would be formed by combining stress data from several sources. The data will be loaded, checked for cleanliness, and the dataset will be trimmed and cleaned for analysis in this section of the report. Two halves, the training set and the test set, make up the data set used for making predictions. At most cases, the Training and Test sets are divided into two halves in a ratio of seven to three. Applying the data model built with machine learning algorithms to the training set allows one to make predictions about the test set depending on the accuracy of the test results. Due to its proficiency in pre-processing outliers, irrelevant variables, and a combination of continuous, categorical, and discrete variables, the ML prediction model is able to accurately forecast stress [48-51].

Free and open-source, Anaconda distributes R and Python with the goal of making package management and deployment easier for scientific computing applications (data science, machine learning, large-scale data processing, predictive analytics, etc.). The "Conda" package management system oversees the various package versions. With support for Windows, Linux, and MacOS, the

Anaconda distribution is home to over 1400 prominent data-science tools, and it has over 12 million users. More than 1,400 programmes, including the Conda package management and Anaconda Navigator, make up the Anaconda distribution. Not having to figure out how to install each library separately is a huge time saver. One can install each open source package separately from the Anaconda repository using the conda install or pip install commands that come with Anaconda. As a package manager, pip has many of the same capabilities as conda, and the two may usually complement one another [52-54]. The Conda build command allows users to create custom packages, which can then be shared with others using repositories such as PyPI, Anaconda Cloud, or others. Python 2.7 is pre-installed in Anaconda2 and Python 3.7 is pre-installed in Anaconda3. Nevertheless, any version of Python packaged with conda can be included in new environments.

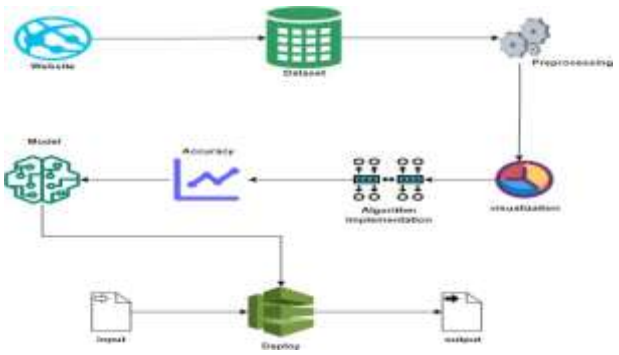


Figure 2: System Architecture [6]

The pre-processing procedure will ensure cleanliness after combining stress data from various sources to create a generic dataset. A labelled data set will be generated by removing noise, null, and unlabeled data. The next step is visualisation, which is the process of creating a visual representation for the user. The user can view the data in the graph model [55-61]. There are two sets of data used for making predictions: training and test. The training set is used to apply the data model that was generated using machine learning techniques. The accuracy of the test results are used to predict the test set. After that, we make a stress level prediction after deploying the model online.

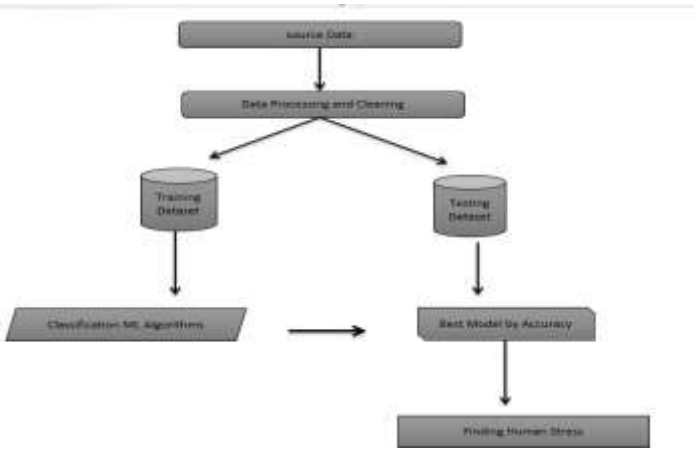


Figure 3: Workflow diagram

The pre-processing procedure will ensure cleanliness after combining stress data from various sources to create a generic dataset. In order to create a labelled data set, the noise, null, and unlabeled data will be eliminated. There are two sets of data used for making predictions: training and test. Applying the data model built with machine learning algorithms to the training set allows one to make predictions about the test set depending on the accuracy of the test results. After that, we make a stress level prediction after deploying the model online. When doing an overarching analysis of system requirements, use case diagrams are taken into consideration. Thus, use cases are

used to capture the functions when analysing system requirements. So, in a nutshell, use cases are just organised descriptions of system functions [62-69].

Class diagrams are visual representations of the system's static view that stand in for various components of the application. Class diagrams, then, stand in for the entire system. The class diagram's name ought to provide some useful information about the system's component. Prior to beginning, make a list of all the components and the relationships between them. Every class needs to have its responsibilities (attributes and methods) defined. The diagram will become more complicated if too many characteristics are stated, therefore it's best to keep them to a minimum. Make sure the developer or coder can comprehend the final product by adding comments whenever necessary to explain any part of the diagram. Last but not least, sketch out the diagram on some blank paper and make as many revisions as needed until you have the final version just right [70-75]. A specific system operation is called an activity. To build the executable system utilising forward and reverse engineering methodologies, activity diagrams are utilised, in addition to displaying the dynamic nature of a system. The message component is the sole element that is absent from the activity diagram. It is not possible to see the transmission of messages from one task to another. A flowchart is another name for an activity diagram. The graphics may give the impression of a flowchart, however that is not the case. Parallel, branching, concurrent, and single flows are among the many types shown.

A sequence diagram is a graphical representation of your system's logic flow that can be used for documentation and validation purposes. Analysis and design both make frequent use of them. Dynamic modelling, which seeks to discover your system's behaviour, makes use of sequence diagrams more than any other UML item. Visual representations of activities, interactions, and time are some other dynamic modelling strategies. When it comes to developing contemporary business applications, I believe that sequence diagrams, class diagrams, and physical data models are the three most crucial design-level models. One way to visually portray the interconnections between various entities in an information system is via an entity relationship diagram (ERD), which is sometimes called an entity-relationship model [76-81]. A relational database can be built upon an ERD, a data modelling technique that aids in defining business processes. In addition to assisting with the identification of information system needs throughout an organisation, entity relationship diagrams serve as a visual foundation for database design. Even after a relational database has been deployed, an ERD can be used as a point of reference for future debugging or business process re-engineering. The pre-processing procedure will ensure cleanliness after combining stress data from various sources to create a generic dataset. A labelled data set will be generated by removing noise, null, and unlabeled data. After that, the data is presented to the user in a graph or chart for visualisation purposes; this is known as graph modelling. You can think of the data you collect for making predictions as having two parts: the training set and the test set. The training set was used to train the data model that had been constructed using machine learning methods. The accuracy of the model's predictions was then used to make predictions for the test set. Deploying the model on a web page is the next step [82-89].

The error rate of the Machine Learning (ML) model, which is often believed to be near to the actual dataset error rate, can be obtained using validation approaches in machine learning. Validation methods might not be necessary if the data set is sufficiently big to be statistically representative. The problem with using data samples in real-world circumstances is that they could not be representative of the entire dataset. Determine if the data is a float or an integer, identify any duplicate or missing values, and describe the data type. When modifying the hyperparameters of a model, the data sample is utilised to offer an impartial assessment of the model's fit to the training dataset. Adding a skill from the validation dataset to the model setup makes the evaluation more biassed. If you want to test your model often, you should use the validation set. Machine learning engineers hone the model's hyperparameters with the use of this data [90-94]. The to-do list for data analysis, data gathering, and handling data quality, structure, and content can quickly become overwhelming. Knowing your data and its characteristics can aid in data identification and, in turn, in selecting an appropriate algorithm for model construction.

Pandas is a Python package that is used for data cleansing in many different ways. In particular, it can clean data and zeroes in on missing values, the most significant data cleaning activity. It would rather explore and model with less time spent cleaning data. It is possible that some of these

references are merely accidental. Sometimes, there may be more fundamental reasons why data is lacking [95-99]. From a statistical perspective, it is critical to be familiar with these various forms of missing data. How to fill in missing values, detect missing values, undertake simple imputation, and employ detailed statistical techniques to missing data is dependent on the type of missing data. Get a handle on where the missing data is coming from before diving into the code [100-106].

Data visualization:

Knowledge of how to visually represent data is a must for anyone working in machine learning and applied statistics. The field of statistics is primarily concerned with providing numerical explanations and estimates of data. One of the most useful sets of tools for developing a qualitative comprehension is data visualisation. This can be useful for discovering patterns, corrupt data, outliers, and more as you explore and familiarise yourself with a dataset. Data visualisations, when combined with domain expertise, allow for the expression and demonstration of critical links through plots and charts, which are more engaging and relevant to stakeholders than association or significance metrics [107-113]. It will suggest reading some of the books listed at the conclusion for a more in-depth look into data visualisation and exploratory data analysis, which are separate disciplines in and of themselves. Visual representations of data, such charts and graphs, can sometimes shed light on previously incomprehensible data. In both applied statistics and applied machine learning, the ability to rapidly visualise data samples is crucial. It will teach you how to visualise data in Python using the various plot types and how to use them to have a better understanding of your data.

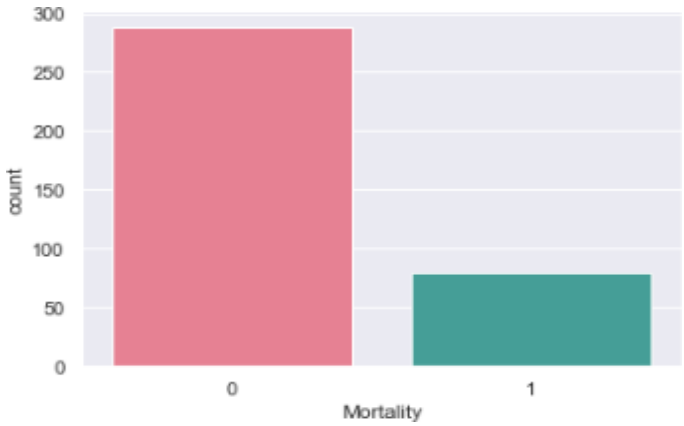


Figure 4: Mortality

Comparing algorithm with prediction in the form of best accuracy result

It is helpful to build a test harness to compare different ML algorithms in Python using sci-kit-learn, and it is essential to compare the performance of these algorithms consistently. By incorporating additional and diverse algorithms into this test harness, it can serve as a model for your machine learning challenges. The performance characteristics of each model will vary. To gauge each model's potential accuracy on unknown data, resampling techniques like cross-validation are employed. Based on these estimations, it should be able to select the top one or two models from your set [114-122]. It is wise to use various methods of data visualisation when we get a new dataset so that we can examine it from multiple angles. When choosing a model, the same idea applies. When deciding which machine learning algorithms to finalise, it's a good idea to employ multiple metrics for their predicted accuracy. One approach is to display the distribution of model accuracies together with its variance, average accuracy, and other features using various visualisation approaches. What follows is a detailed explanation of how to accomplish this in Python with sci-kit-learn. To ensure that machine learning algorithms are tested consistently on the same data, which is essential for fair comparisons, it is necessary to force each algorithm to be evaluated on a consistent test harness [123-127].

Performance Metrics to calculate:

False Positives (FP): A defaulter is someone who is expected to pay. In cases where the predicted class is yes and the actual class is no. If the projected class indicates that this passenger would live, but the actual class indicates that they did not, then.

False Negatives (FN): Someone whose payment is late or nonexistent. If the projected class implies that the passenger will die, but the actual class indicates that the person survived, then the predicted class is wrong.

True Positives (TP): A defaulter is someone who is expected to not pay. In other words, both the actual class value and the anticipated class value are yes, since these are the positively predicted values. Take the case where both the actual and anticipated class values suggest that the passenger made it.

True Negatives (TN): It is anticipated that the payer will be someone who defaults. This indicates that both the actual and projected classes have the same value of zero, as these negative values indicate accurate prediction. As an illustration, suppose both the actual and anticipated classes inform you that this passenger did not survive.

True Positive rate (TPR) = TP / (TP + FN) False Positive rate (FPR) = FP / (FP + TN)

Accuracy: What percentage of all predictions were accurate; in other words, the overall accuracy of the model's defaulter and non-defaulter predictions.

Accuracy calculation:

Accuracy = (TP + TN) / (TP + TN + FP + FN)

The simplest natural metric for performance is accuracy, which is just the percentage of observations that were accurately predicted relative to the total number of observations. One could assume that our model is the best if it has a high level of accuracy. Correctness is a wonderful metric, but it works best with balanced datasets in which the numbers of false positives and false negatives are quite close to one another.

Precision: The proportion of positive predictions that are actually correct. Precision = TP / (TP + FP)

The total number of positive observations that were accurately predicted relative to the total number of positive observations expected is called precision. This measure provides an answer to the question of how many passengers actually survived out of all those who are marked as having survived. A low false positive rate is associated with high precision. The precision we have, at 0.788, is quite good [128-131].

Recall: The percentage of positive values that were accurately anticipated from observations . (The proportion of actual defaulters that the model will correctly predict)
Recall = TP / (TP + FN)

Recall (Sensitivity) - Recall is the ratio of correctly predicted positive observations to all observations in actual class - yes.

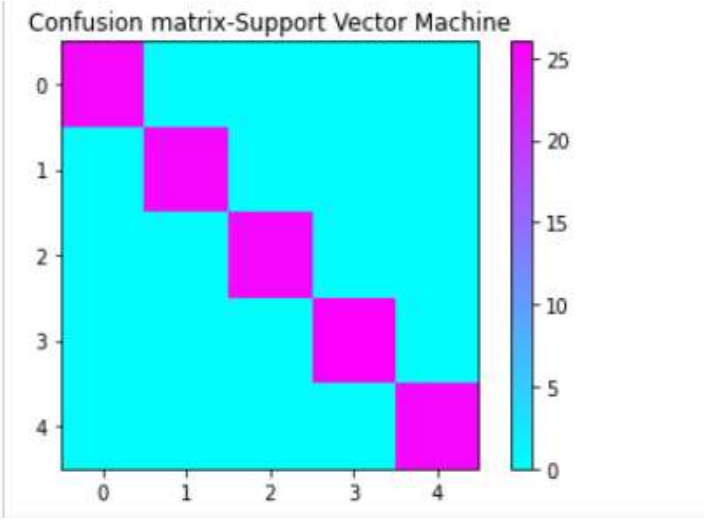


Figure 5: Confusion matrix-support Vector Meachine [5]

When Precision and Recall are combined, they form the F1 Score. Because of this, the score accounts for both the true and false positives. Despite its less intuitive nature, F1 is often more practical than accuracy, particularly in cases of unequal class distribution. When the costs of false positives and false negatives are about the same, accuracy is maximised. Evaluate Precision and Recall simultaneously if the false positive and false negative costs are significantly different.

General Formula:

F- Measure = 2TP / (2TP + FP + FN)

F1-Score Formula:

F1 Score = 2*(Recall * Precision) / (Recall + Precision)

The below four different algorithms are compared:

SVM:

When it comes to classification and regression, supervised machine learning algorithms like Support Vector Machine (SVM) come in handy. We claim that classification is the optimum approach for regression issues, but the SVM algorithm's goal is to locate a hyperplane in N-dimensional space that clearly assigns a class to each data point. Support vector machines (SVMs) are able to classify data points even when they aren't linearly separable since they map the data to a high-dimensional feature space [132-139]. The data is processed in a way that allows the separator between the categories to be drawn as a hyperplane after it is located. Web pages, email, intrusion detection systems, facial recognition software, gene classification, and handwriting recognition are just a few of the many uses for support vector machines. One of the reasons SVMs are used in machine learning is because of this. Whether your data is linear or non-linear, it can manage the classification and regression tasks [140].

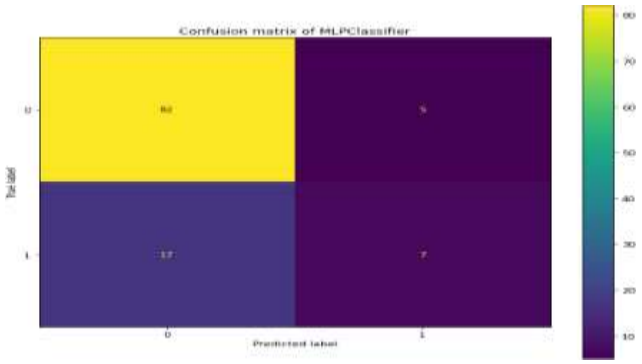


Figure 6: Module Diagram

The acronym "MLP" refers for "Multi-layer Perceptron," a type of classifier that uses a Neural Network. When it comes to classification, MLP Classifier is different from other methods like Support Vectors or Naive Bayes Classifiers. It all comes down to the underlying Neural Network. The implementation of MLP Classifier does not require any more effort than that of Support Vectors or Naive, which is a commonality with Scikit-other Learn's classification methods. To train a classifier on the original dataset, an AdaBoost meta-estimator first fits a copy of the classifier on the same dataset with the weights of the mistakenly classified instances changed so that succeeding classifiers concentrate on challenging situations. If you want your machine learning algorithm to perform better, you can use AdaBoost [141-147]. People who aren't very good at learning can benefit the most from it. When applied to a classification task, these models produce results that are slightly better than chance. A one-level decision tree is the most popular and appropriate method for AdaBoost. Learners progress in a sequential manner, which is the basis of its operation. Every learner after the first is a direct descendant of an earlier learner. Basically, it's a way to turn weak learners into strong ones. Although it differs slightly, the AdaBoost algorithm follows the same basic idea as boosting.

Introduction The data is continually split according to a given parameter in Decision Trees, a kind of Supervised Machine Learning (in which you describe the input and its associated output in the training data). Decision nodes and leaves are the building blocks of the tree [148-154]. There are many real-world similarities to trees, and it turns out that trees have impacted several areas of machine learning, including regression and classification. A decision tree is a graphical and explicit representation of decision-making and decision-making processes that can be utilised in decision analysis. Classification and regression are two applications of decision trees, which are supervised learning methods that do not rely on parameters. Using data attributes to infer simple decision rules, the goal is to build a model that can predict the value of a target variable [155-156].



Figure 7 : Decesion Tree

Conclusion

The process of analysis began with the cleaning and processing of the data, followed by the investigation of missing values, exploratory analysis, and, eventually, the construction and evaluation of the model. On the public test set of algorithms with better accuracy scores, the algorithm with the highest accuracy score will be found. The first one is utilised in the application

whose purpose is to assist in determining the human stress that the patient is experiencing. An example of a micro web framework that is created in Python is Django. This framework is considered to be a micro-framework due to the fact that it does not require any specific tools or libraries. It does not have a database abstraction layer, form validation, or any other components that are similar to those that are provided by pre-existing third-party libraries. The Django framework, on the other hand, allows for the addition of extensions that can add application functionalities as if they were built into the framework itself. Additionally, there are extensions available for object-relational mappers, form validation, upload handling, a variety of open authentication protocols, and a number of utilities that are commonly associated with frameworks.

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