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Human Stress Detection Based on Sleeping Habits Using Machine Learning Algorithms

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ABSTRACT: Stress, which is a more and more common part of contemporary life, may have a serious negative effect on a person's physical and mental health. Determining and tracking stress levels is therefore essential to improving general health and quality of life. The "Human Stress Detection Based on Sleeping Habits Using Machine Learning with Random Forest Classifier" project offers a cutting-edge and successful method for determining a person's degree of stress by looking at how they sleep. Utilizing the robust features of the Python programming language, the research makes use of the Random Forest Classifier method, which is renowned for its adaptability and precision in classification assignments.

I.INTRODUCTION

Stress is another name for the particular strain that is placed on the human body in response to various stimuli. When under stress, the human body releases stress hormones. Stressors can be classified as psychological, physiological, relative, absolute, or both [1]. Furthermore, stress can induce or worsen a number of physical disorders in addition to having an impact on your attitude, relationships, energy level, and ability to accomplish your duties. As a result, sleep is crucial for maintaining human equilibrium. Sleep disruptions have been linked to several medical, psychological, and social issues. Chronic sleep deprivation is increasingly frequent in many countries. It's critical to comprehend the role that the body's stress systems play in helping the body adapt to a constantly changing and stressful environment.

This study's main objective is to determine how sleeping patterns affect human stress levels. The specific goals are also to identify the advantages of using a model to identify human stress, the relationship between human stress and sleeping habits, the main sleeping behaviors that influence an individual's stress, the techniques that can be used to identify human stress, and, lastly, the ability to identify human stress based on sleeping habits.

Here, we may evaluate people's sleeping patterns and stress levels while instructing them on how to identify stress in people before, during, and following sleep. Most research currently available uses a small number of independent factors to predict human stress during and after sleep. However, with so few independent factors, it is challenging to predict human stress. We were able to take into account a lot more attributes by increasing the amount of attributes in our study. A few things to think about include blood oxygen level, heart rate, stress levels, body temperature, limb movement rate, breathing rate, and snoring range. In order to get around the drawbacks of the current methods, we also raised the number of categorization

II.LITERATURE REVIEW

Stress is considered a mental illness [3], and in the twenty-first century, it has emerged as a public health emergency [4]. It is also seen to be one of the special aspects of our existence, and everyone experiences it as an inevitable part of life at some time [5]. For optimal physiological and psychological health, sleep is necessary. Lack of sleep has been associated with a higher risk of heart disease, type 2 diabetes, depression, attention deficit hyperactivity disorder (ADHD), cognitive problems, and subpar performance. According to the study [6], getting too little sleep has a bigger effect on how you feel the next day. Above all, we are forecasting how human tension is detected during sleep here]. In addition to these products, they also sell SaYoPillow, a sleep aid that tracks and regulates a person's stress levels. The primary goal of SaYoPillow is to accomplish "Smart-Sleeping," which is a thorough sleep that meets the ideal body requirements for sleep. SayoPillow proposed a real-time physiological signal detecting to adjust the quality of sleep by considering parameters like heart rate range, snoring range, respiratory rate range, number of hours of sleep, oxygen in blood range, eye movement rate, duration of Rapid Eye Movement (REM), change in body temperature, and limb movement rate.

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DeeviRadha Rani and Geethakumari G proposed a An Efficient Approach to Forensic Investigation in Cloud using VM Snapshots [1]. The technique of Forensic investigation of VM using snapshots as an evidence that can be shown as a proof in front of court of law. In that mechanism, software stored and maintained snapshots of running VM selected by the user which acted as a good evidence. VM can be created by the user as per his choice from the physical machines that are available. Any cloud software similar to that of Eucalyptus instead of request of a user, takes the snapshots of the machines stores till terminated. Snapshots can be stored only till it reaches the maximum but when once maximum is reached the snapshots which were taken long before gets deleted. So the huge storage management of snapshots of VM becomes difficult as it affects the performance of the system.

Relevance to current Research

The review research [11] was finished in many phases, including data collection using the closest terms found in the Web of Science database and network visualization design based on previous data. They employed three publishers, four journals, five study papers, and the four closest keywords to examine the job. The results showed that SVM had a 91.18% system sensitivity and had properly categorized the signals. This work offered a more comprehensive and important account of the direction that future investigations will go.

Gaps in Literature

Ref. No	Major attributes	Classifier/ Method	Findings	Limitations
[7]	Sleeping habits	IoT cloud	A cutting-edge device called the Smart-Yoga Pillow (SaYoPillow) is being suggested in order to fully realize the idea of "Smart-Sleeping" and to help with understanding the connection between stress and sleep	Used IoT cloud method only and the EHR systems are currentlycentralized and vulnerable to a single point of failure.
[8]	Average speed and acceleration, Standard deviation of vehicle speed, Positive kinetic energy, Weather and traffic state, Time, Weekday	Linear Regression, SVM, and Naïve base	Proposed an algorithm to estimate the optimum speed based on the stress level for each road section.	Through visual inspection, the EEG signal was manually cleaned of artifacts.
[9]	User contextual information	Random forest, SVM, K-Nearest Neighbor (KNN)	An ML system that analyzes participants' stressed-out EEG signals is proposed.	Presents a portion of the relevant literature for several of the individual cases but does not provide an exhaustive analysis of each of the individual cases.
[13]	Eight features using ECG signals	SVM, Linear discriminant analysis and Naïve base, KNN	Examine and discuss the studies that have employed machine learning-based stress detectionalgorithms.	Focused on psychological stress. However there is still a need for more research into physiological stress detection.

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[14]	RESP, ECG/HRV, GSR data, body temperature and physical parameters	Linear Regression, SVM, Randomforest, Neural Network, KNN	The most relevant sleep measures were found using a variety of physical and biophysiological features from wristband sensors and chest strap devices to differentiate between high, low, and moderate stress.	They could only identify changes in sleep postures involving the upper body using the Zephyr posture sensor and there are just ten subjects available.

III. METHODOLOGY

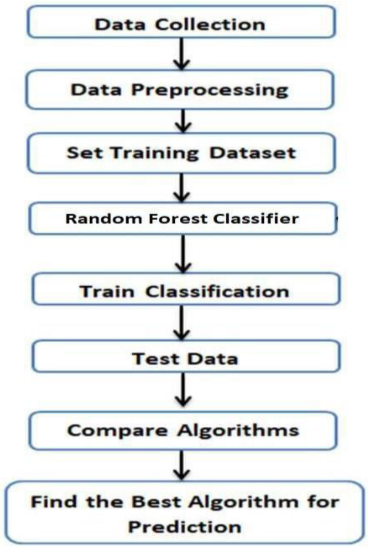

Fig 1. Methodology used

The primary goal of this research is to forecast human stress by analyzing sleep-related behaviors. There are three primary phases in the suggested method. They are categorization, preprocessing, and data collecting. An explanation of the study's architecture is provided above Fig. 1.

Data Collection

Following the identification of the study problem, we employed secondary data in our research strategy. The dataset was gathered under the seven sleeping habits and was taken from the 'Kaggle' [15] website. The study's definition of its scope was "people in society," and about 500 participants answered the questionnaire. The dataset contains seven variables, including blood oxygen level, heart rate, respiration rate, body temperature, limb movement, and snoring range. It is seen in Fig. 2. These variables help identify the relationship between an individual's stress level and sleeping patterns.

Fig. 2. Attributes used

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Data preprocessing

This process identifies data that is missing or irrelevant, replaces, amends, or removes it until it is replaced, changed, or erased. The data preparation process is used to eliminate poor, erroneous, and incorrect data from the raw dataset. Data reduction, data transformation, and data purification are used in the preprocessing of the data. . The ranker indicates that the snoring range has the greatest impact on the dependent variable out of all the independent factors. The dependent variable is most significantly impacted by the respiration rate next. The dependent variable is least affected by sleeping hours as well. Lastly, seven independent variables are used: limb movement, eye movement, blood oxygen level, body temperature, respiration rate, heart rate, and snoring range. One dependent variable that is employed is the degree of stress. Four distinct stress levels were present in the original dataset that was gathered, but for our method, we merged the first and second stress levels as the low-level stress and the third and fourth stress levels as the high-stress level.
Additionally, the majority of the dataset's numeric values are rounded to the closest whole integer or decimal point.

Classification
The preprocessed data is categorized and evaluated The CSV file format is used to store the input data gathering. The data collection is split into 20% and 80% categories for training and testing data. The WEKA software's several algorithms are used to generate the forecasts.The model was developed with human stress as its focus, taking into account sleep patterns that people classified as either 1-low/normal or 2-high. After dividing the training and testing data, the decision tree, Naive Bayes, SVM, Random Forest, logistic regression, and MLP classification algorithms were employed to determine which classification model performed best using the testing data

Low and High stress levels are the two categorization groupings that are employed. Based on the data, Naïve base had the highest accuracy. It is a probabilistic machine learning model that addresses classification issues. The Bayesian theorem and the presumption of predictor independence serve as the foundation for the classification. Fig. 3 shows how findings are obtained.

IV. Design

Class Diagram

A class diagram in the Unified Modeling Language (UML) is a form of static structural diagram that depicts the structure of a system by displaying the system's classes, properties, operations (or methods), and class relationships. It specifies which classes have information.

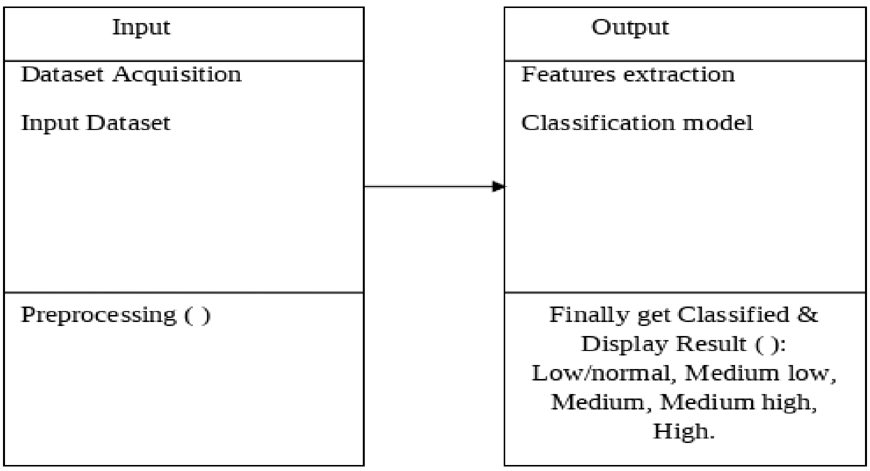

Fig 3: CLASS Diagram

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ACTIVITY DIAGRAM

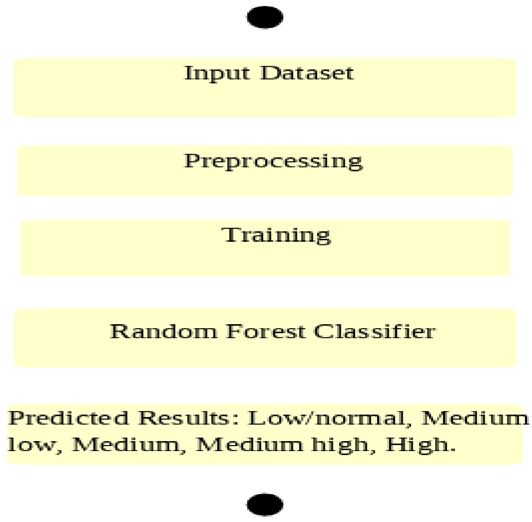

Fig 4 Activity Diagram

V. RESULTS AND DISCUSSION

On a computer with an Intel® Core (TM) i5-5005U CPU operating at 2.00GHz and 4.0 GB of RAM, Microsoft Windows 10 was installed. The WEKA 3.9.5 software serves as the testing and training environment. A data set for the assessment and experimentation procedure was created utilizing the 504 data that was gathered via the Kaggle website [15].

Decision Tree (J48), Naive Bayes, MLP, Random Forest, SVM, and Logistic Regression were employed in this study for assessment and comparison. Fig. 4 displays the accuracy results of various cross-validation techniques.

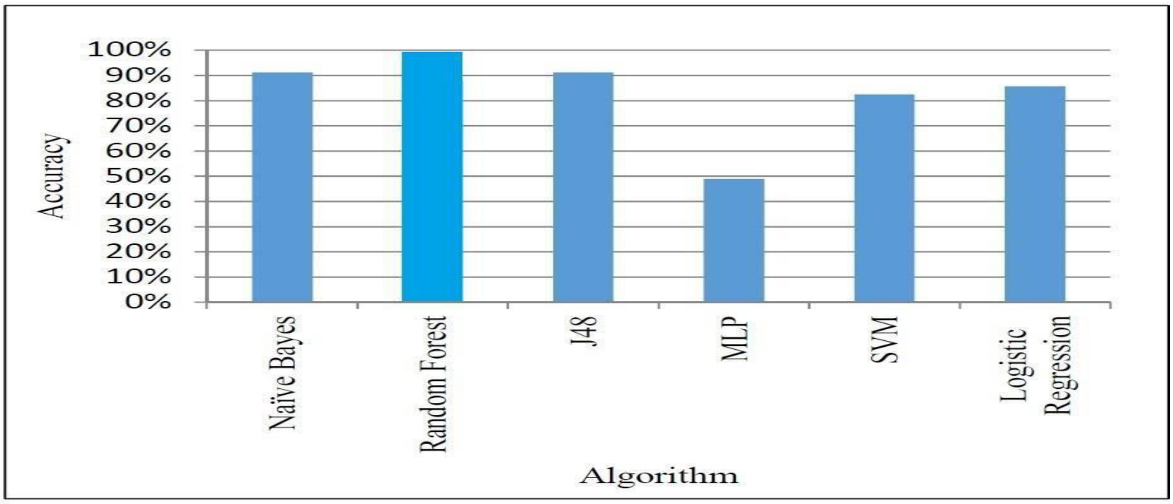

Fig 5 Accuracy results of these algorithms

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TABLE II RECALL, PRECISION AND F-MEASURE OF ALGORITHMS

Algorithm	Precision	Recall	F-measure
Naïve Bayes	0.916	0.916	0.916
Random Forest	0.879	0.879	0.879
Decision Tree	0.916	0.913	0.913
MLP	0.501	0.49	0.486
SVM	0.847	0.825	0.82
Logistic Regression	0.857	0.857	0.857

Fig 6 Precision-F measure

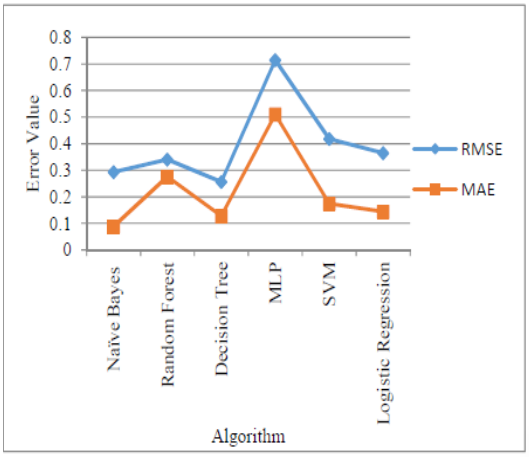

Fig 7 RMSE and MAE error values

According to the assessments above, the most effective algorithm for forecasting human stress is Naive Bayes. Along with the greatest accuracy, precision, recall, and f-measure scores, it also has the best RMSE and MAE error values

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VI. SCREENSHOTS

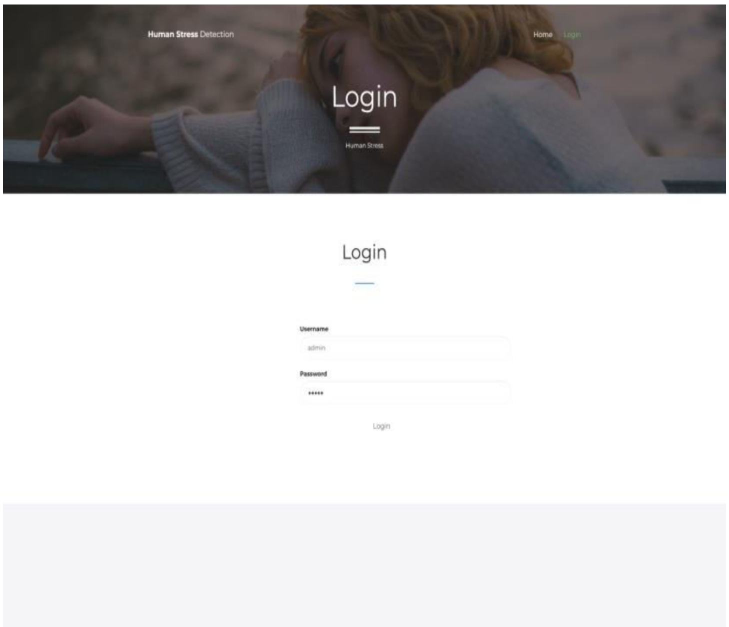
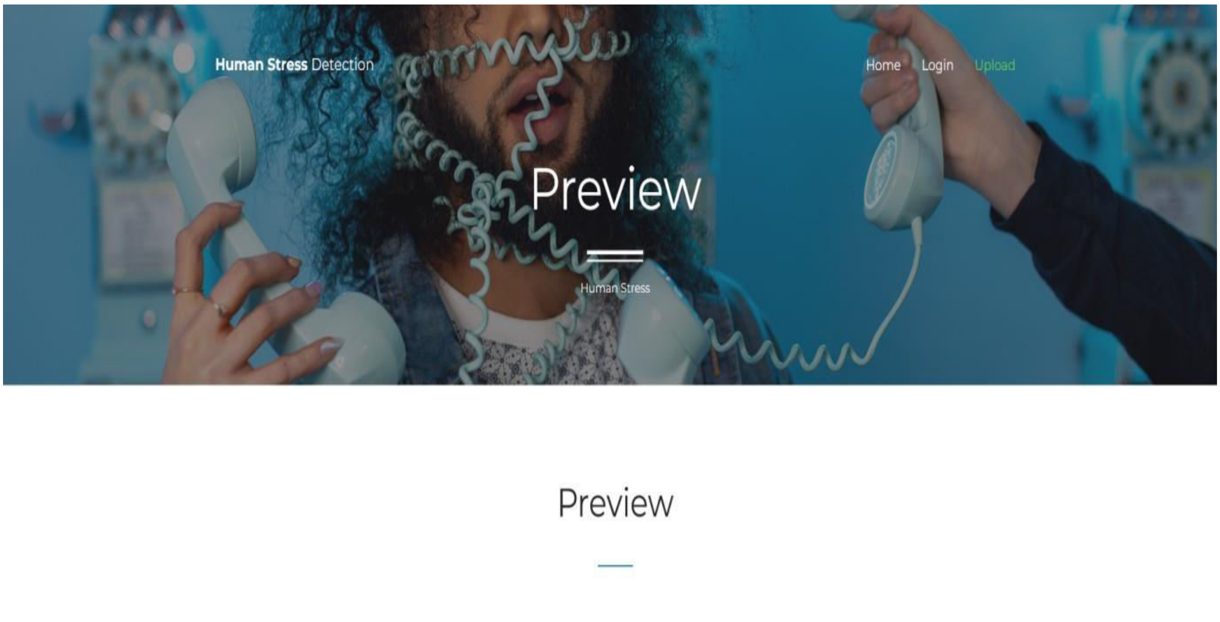


Fig 8 Login Page



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Id									
1	93.800	25.680	91.840	16.600	89.840	99.60	1.840	74.20	3
2	91.640	25.104	91.552	15.880	89.552	98.88	1.552	72.76	3
3	60.000	20.000	96.000	10.000	95.000	85.00	7.000	60.00	1

Fig 9 Preview page

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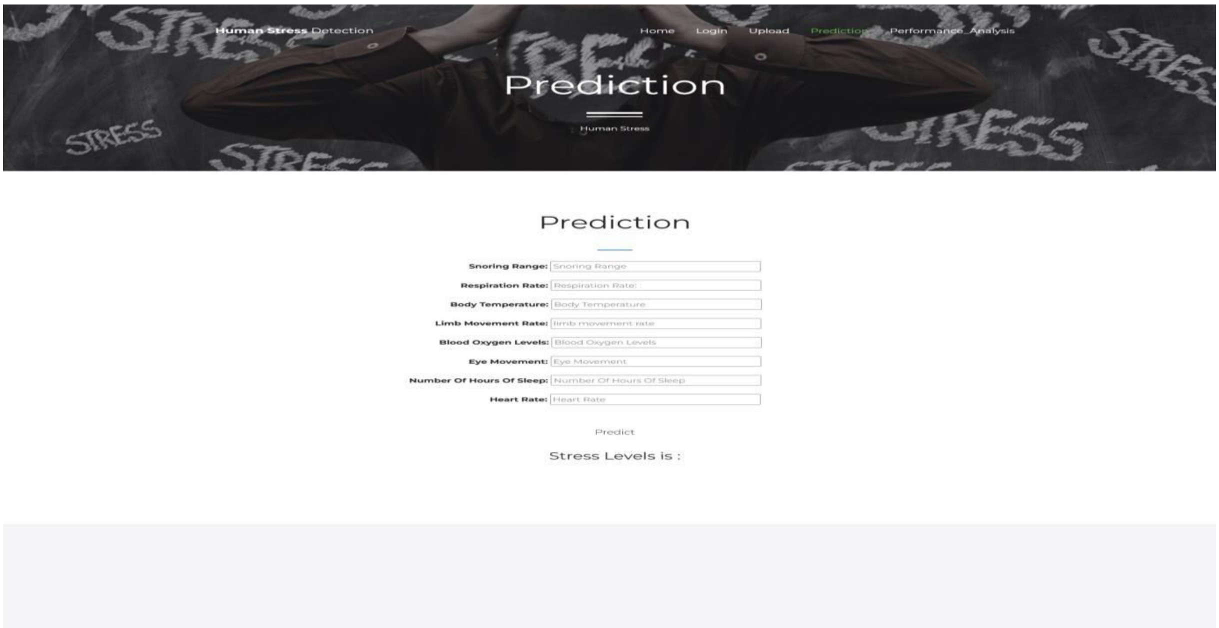

Fig 10 Prediction page

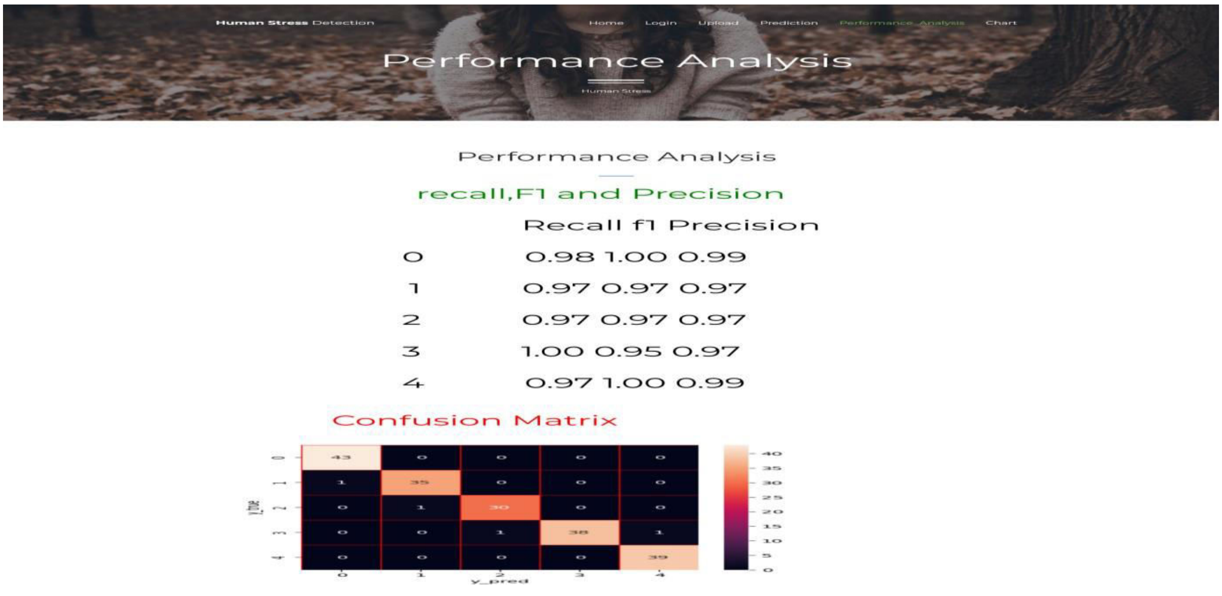

Fig 11 Performance Analysis

VII.CONCLUSION AND FUTURE WORK

Human stress varies based on several factors, thus it's critical to recognize one's own degree of stress in order to prevent unneeded issues. This study aims to identify how sleeping patterns affect human stress levels. We also found the advantages of employing a model to identify human stress and the link between stress and sleep. In order to do this, we used sleep to gather information about seven behaviors and human stress levels.

Six different machine learning algorithms, including Random Forest, MLP, Logistic Regression, Decision Tree, Naïve Bayes, and SVM, were assessed based on people's stress levels and sleeping patterns. Ten-fold cross-validation is used for the evaluation.

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Random Forest is the best algorithm for predicting human stress and performs better than the other five, according to the assessment findings. The Random Forest method's 99% accuracy is matched by the best recall, precision, and f-measure values, as well as a reduced error rate in MAE and RMSE values. As we talk about the usefulness and possible uses of this research, we might use this model to determine an individual's stress level by including their sleeping patterns, which acted as the study's independent variables. We can handle that individual based on the outcome of their stress level.

We want to multiply the data in the future and use the ensemble learning method—which incorporates all six algorithms—to improve the accuracy of the results. Here, we were unable to apply deep learning and neural network approaches due to insufficient data. As a result, we want to use such techniques by growing our dataset, which will subsequently be used to increase the current accuracy.

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