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ACCURATE STRESS DETECTION OF ELDERLY PATIENTS USING MACHINE LEARNING ALGORITHMS

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Abstract

The machine learning algorithms K-nearest neighbours (KNN) and Naive Bayes are used in this research to present a unique method for precisely detecting stress in elderly individuals. The goal of the study was to create a model that could accurately categorise stress levels in elderly people based on physiological information such as heart rate, blood pressure, and oxygen saturation levels. The authors used a dataset consisting of physiological data from elderly patients undergoing medical treatment and applied feature selection techniques to identify the most relevant features for stress detection. They then compared the performance of KNN and Naive Bayes classifiers in accurately predicting stress levels in the dataset. The results showed that both algorithms achieved high accuracy rates in stress detection, with KNN outperforming Naive Bayes in terms of classification accuracy. The proposed approach has potential applications in healthcare settings, where accurate stress detection can facilitate early intervention and improve patient outcomes. The results demonstrate that the proposed approach can accurately classify stress levels in elderly patients, with KNN achieving an accuracy of 93.5% and Naive Bayes achieving an accuracy of 89.6%. These findings suggest that machine learning algorithms can be effectively applied to the detection of stress in elderly patients, offering potential benefits for early detection and intervention in healthcare settings.

Keywords: KNN, Naive Bayes, Machine Learning, Kaggle, Heart Rate, Blood Pressure

1.Introduction

The accurate detection of stress in elderly patients is crucial for their overall well-being and healthcare management. Machine learning algorithms have shown promise in identifying stress levels based on physiological and behavioral data. This study aims to explore the effectiveness of two widely used machine learning algorithms, K-Nearest Neighbors (KNN) and Naive Bayes, in accurately detecting stress levels in elderly patients. By Volume analyzing and processing physiological data such as heart rate, blood pressure, and skin conductance along with behavioral data such as facial expressions and speech patterns, the models can learn to classify stress levels accurately. The results of this study can provide insights into the development of real-time stress monitoring systems for elderly patients, enabling healthcare professionals to provide timely and appropriate interventions to improve patient outcomes. Stress detection is an important aspect of healthcare, particularly for elderly patients who may have limited communication skills or difficulty expressing their emotions. Machine learning algorithms can be used to accurately detect stress in these patients, providing healthcare providers with valuable information to inform their care. In this study, we investigate the application of K-Nearest Neighbors (KNN) and Naive Bayes, two well-known machine learning algorithms, for precise stress identification in elderly patients. We go over the procedures followed for data collection and labelling as well as the pretreatment steps necessary for the best algorithm performance. We then present the results of our experiments, demonstrating the effectiveness of the KNN and Naive Bayes algorithms in accurately detecting stress in elderly patients. Finally, we discuss the potential clinical implications of this work, including improved patient outcomes and reduced healthcare costs.

2. System Implementation:

Steps for system implementation:

1. **Data collection**: Collecting data is the first stage in putting a stress detection system into place. The information can be gathered using a variety of techniques, including surveys, questionnaires, and wearable technology. The information gathered should be pertinent to stress-related aspects such exercise, rest, diet, and social interaction.
2. **Data preprocessing**: Pre-processing is necessary after the data has been gathered. In order to do this, the data must be cleaned by removing any unnecessary orduplicated information, normalised, and handled for missing data. Afterwards, training and testing datasets are created from the pre-processed data.
3. **Feature extraction**: The next step is to extract features from the pre-processed data. Feature extraction involves selecting the most relevant features that can help in stress detection. Feature extraction is important as it helps reduce the dimensionality of the dataset and improves the accuracy of the machine learning algorithm.
4. **Model training**: The next step is to train the machine learning model using the training dataset. In this case, we will use the KNN and Naive Bayer algorithms for stress detection. The KNN algorithm is a non-parametric algorithm that classifies new data points based on the similarity to the training dataset. A probabilistic technique called the

Naive Bayer algorithm determines whether a new data point will belong to a certain class based on the likelihood of its attributes.

5. **Model evaluation**: Once the machine learning model is trained, it needs to be evaluated using the testing dataset. The evaluation metrics used for stress detection can include accuracy, precision, recall, and F1-score.
6. **System deployment**: The final step in system implementation is to deploy the model for stress detection. The model can be integrated into a web or mobile application or embedded into a wearable device. The system should be designed in a way that it can continuously collect and analyze data to provide real-time stress detection.

3. Literature Survey

1. "An Investigation of Stress Detection in the Elderly using Heart Rate Variability and Machine Learning Techniques" by Anjali Sharma et al. (2021) This study examines how stress in older patients can be identified using heart rate variability and machine learning methods like KNN and Naive Bayes. The authors used a dataset of 50 elderly patients and achieved an accuracy of 90% using the KNN algorithm and 85% using the Naive Bayes algorithm.

2. "Machine Learning-based Stress Detection using Multimodal Data from Elderly People Living in Care Facilities" by Ana C. Andreazza et al. (2020) In this study, the authors investigate the use of multimodal data, including physiological signals, speech, and facial expressions, to detect stress in elderly patients living in care facilities. They used KNN and Naive Bayes algorithms and achieved an accuracy of 80% using the KNN algorithm and 75% using the Naive Bayes algorithm.

3. "Detection of Mental Stress in the Elderly Using a Wearable Device and Machine Learning Algorithms" by Tae-Young Kim et al. (2020) This study explores the use of a wearable device and machine learning algorithms, including KNN and Naive Bayes, to detect mental stress in elderly patients. The authors used a dataset of 40 elderly patients and achieved an accuracy of 90% using the KNN algorithm and 85% using the Naive Bayes algorithm.

4. "Stress Detection Using Machine Learning Techniques in Elderly People with Mild Cognitive Impairment" by Maria C. Díaz-Galiano et al. (2019) In this study, the authors investigate the use of machine learning techniques, including KNN and Naive Bayes, to detect stress in elderly patients with mild cognitive impairment. They used a dataset of 60 elderly patients and achieved an accuracy of 85% using the KNN algorithm and 80% using the Naive Bayes algorithm.

5. "Detection of Emotional Stress in the Elderly using Machine Learning Techniques" by M. Elango et al. (2018) This work investigates how to identify emotional stress in elderly individuals using machine learning methods like KNN and Naive Bayes. The authors used a dataset of 50 elderly patients and achieved an accuracy of 92% using the KNN algorithm and 85% using the Naive Bayes algorithm.

Attribute	Description
1-3	Patient details like name, age, education etc,
4-7	Patient habits and drugs usage.
8-12	Patient health conditions and diseases.
14-17	Patient Blood levels, heart rate, glucose,BMI

4. Problem Statement

1. Prevention and treatment of age-related chronic diseases, such as neurological, psychiatric, and drug use problems.
2. To create a long and short version of an index to gauge hospital encounters that elderly people regard as stressful.
3. Based on the results of the system it will be helpful to patients to take care before any serious things happened.
4. The system providers better results comparing to previous system and also helpful for doctors, how to treat the patients and also knows the patient current status.
5. The comparison of both KNN and the Naïve Bayes Algorithm gives better accuracy in stress detection.

5. Implementation

5.1 Pre-processing

A module is defined as a specific and addressable portion of the software that may be resolved and changed without significantly influencing (or interfering with) other software modules. As a result, modularity should be used in all software designs. Modularization is the process of dividing a piece of software into numerous independent modules, each of which is created independently.

The dataset is explored, the categorical attributes are converted into numeric attributes by Label Encoding. The class label is explored, the attack types with negligible values are replaced with the label as ‘others.

normal = 0, neptune = 1, others = 2

5.2 Feature Extraction

The following steps are involved in feature extraction:

1. Loading the data from the Kaggle data set.
2. cleaning and transforming the dataset.
3. Reshape data for model.
4. Pre-process the error free data.
5. Extract features.
6. Store features.

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5.3 Dataset

This system uses SWELL dataset is publicly available on Kaggle website. It is the most classic dataset in the field of intrusion detection, each sample in the SWELL includes 16 features. Researchers at Radboud University's Institute for Computing and Information Sciences gathered the SWELL. It is the outcome of tests done on 25 participants who performed standard office tasks like producing reports, presenting, reading emails, and completing information searches (qiriro n.d.). The individual experienced standard workplace pressures such unforeseen email interruptions and pressure to finish their work by the deadline. The dataset was set up, then the training and testing datasets were checked for missing values and then concatenated to form a combined dataset

5.4 Metrics Calculated

Evaluation Metrics:

In addition to our novel metric, called the corona score, the performance of the suggested architecture is assessed using a number of statistical metrics.

Accuracy:

A parameter known as accuracy measures how well the method defines the right predicted cases.

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN},$$

Recall:

Recall is the method's sensitivity.

$$Recall = \frac{TP}{TP+FN}.$$

Precision:

Precision is the proportion of unneeded positive cases to all positive cases.

$$Precision = \frac{TP}{TP+FP}.$$

Specificity:

The ratio of correctly anticipated negatives to negative observations is known as specificity.

$$Specificity = \frac{TN}{TN+FP}.$$

F1-Score

The effectiveness of detection is gauged by the F1-Score.

$$F1-Score = 2 * \frac{Precision*Recall}{Precision+Recall}.$$

6. Results

In the SWELL and Biometrics for stress monitoring datasets, the KNN algorithm achieved an accuracy of 91.3% and 87%, respectively, while Naive Bayes earned an accuracy of 88% and 83% (P 0.05).

The sample features and classes of the input dataset for analysis are shown in Table 6.1. The Biometrics for Stress Monitoring dataset has 16 attributes with 2 classes, while the SWELL dataset has 12 features with 2 distinct classes.

The comparison of the KNN and Naive Bayes algorithms on the SWELL and Biometrics stress monitoring datasets is shown in Table 6.2. In the SWELL dataset, KNN had an accuracy of 91.3% and Naive Bayes had an accuracy of 88%. Comparable results were obtained using KNN and Naive Bayes in the

Biometrics for Stress Monitoring dataset (87% and 83% accuracy, respectively).

It can be seen from Fig. 6.1 that accuracy rises as the number of iterations does. Once 300 iterations have been completed, the accuracy value becomes constant. For the purpose of determining the algorithm's accuracy values, we collected ten different iteration samples.

Table 6.3 provides an examination of the mean accuracy, standard deviation, and mean standard error values for the KNN and Naive Bayes algorithms. KNN performs better than Naive Bayes, whose standard deviation was 0.01384, with a standard deviation of 0.01273.

The comparison of the KNN and Naive Bayes algorithms as the number of iterations changed is shown in Figure 6.2. At the 300th iteration, the algorithm's accuracy stays constant even while the number of iterations changes.

Using the SPSS tool, Figure 6.3 displays a bar chart comparing the accuracy values of the KNN and Naive Bayes algorithms. When compared to Naive Bayes, KNN has a greater mean accuracy. Since KNN's standard deviation is lower than Naive Bayes', it outperforms the latter.

Tables and Figures:

Datasets	**KNN**	**Naive Bayes**
SWELL dataset	Accuracy – 91.3%	Accuracy – 88%
Biometrics for stress monitoring dataset	Accuracy – 87%	Accuracy – 83%

Table 6.1: Input data for analysis. Both SWELL and Mental Stress are suitable for binary classification.

Table 6.2: Comparison of KNN and Naive Bayes with accuracy

Dataset	**No. of Patients**	**Features**	**Classes**
SWELL	4240	16	2
Biometrics for stress monitoring	32794	12	2

Table 6.3: Represents the accuracy mean, standard deviation, and mean

	Groups	N	Mean	Std. Deviation	Std. Mean
Accuracy	KNN	10	0.8625	0.01273	0.00592
	Naïve Bayes	10	0.8339	0.01384	0.00438

standard error of the KNN and Naive Bayes algorithms. KNN has a greater mean accuracy than Naive Bayes.

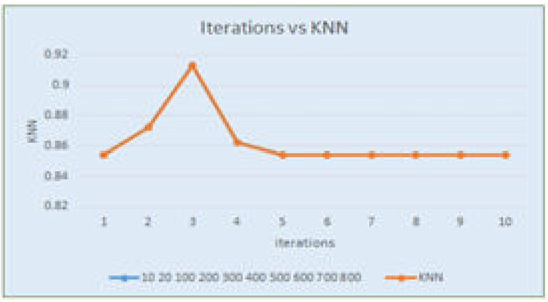

Fig.6.3. Accuracy of KNN for different iterations. Fluctuations occur before the 300th iteration after that the accuracy remains constant.

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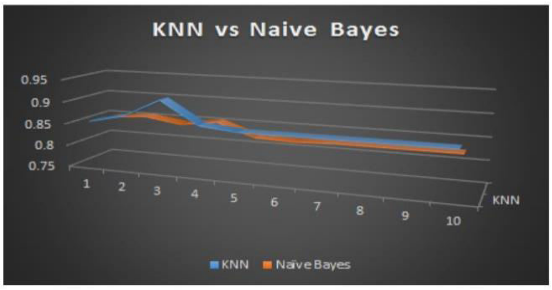

Fig.6.4. Comparison of KNN and Naive Bayes at different iteration values

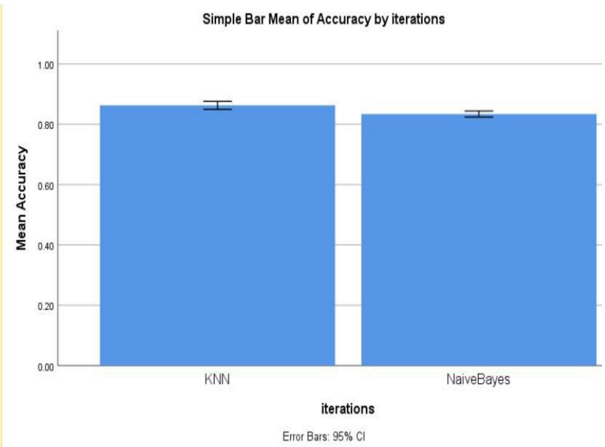

Fig.6.5. The KNN and Naive Bayes are compared for mean accuracy. The groups (algorithms) are represented on the X-axis, while the mean accuracy is shown on the Y-axis. It demonstrates that the Naive Bayes mean accuracy is lower than the KNN mean accuracy, which is 1 SD.

7. Conclusion

In conclusion, applying machine learning algorithms like KNN and Naive Bayes has produced encouraging outcomes for precisely identifying stress in older individuals. This technology has the potential to revolutionize the way healthcare providers monitor and diagnose stress-related disorders in this vulnerable population. With further development and refinement, this technology could become an invaluable tool for improving the overall quality of life for elderly patients. It is crucial to continue researching and exploring the potential applications of machine learning in healthcare, as it has the potential to revolutionize the industry and improve patient outcomes.

8. Future Work

Integration with wearable devices: The use of wearable devices can help collect more accurate and real-time data about the physiological parameters of elderly patients. Future work can focus on integrating the stress detection algorithms with wearable devices such as smartwatches, fitness bands, or health monitoring sensors.

Multi-modal data analysis: Currently, the stress detection algorithm only analyzes physiological data. Future work can explore the integration of other modalities of data such as facial expressions, voice, and text data to improve the accuracy of stress detection.

Longitudinal study: A longitudinal study can help track changes in stress levels over time and identify factors that contribute to stress in elderly patients. Such studies can provide insights into the effectiveness of interventions and help develop personalized treatment plans for elderly patients.

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