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Machine Learning approach for Electroencephalogram (EEG) Signal Classification

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Abstract: *Machine learning based EEG signal classification involves utilization of various ML algorithms to provide EEG signal categorization based on different cognitive brain activities. The EEG Signal Classification process is a predominant process used in clinical and biomedical research and brain-computer interface (BCI) system. The machine learning approach in this process provides better EEG signal classification that helps diagnosis faster and accurate. This paper proposed a comparative study between the machine learning based classifiers. Support Vector Machine (SVM) and K-nearest Neighbor (KNN) algorithms are implemented to classify the normal and abnormal EEG signals. 45 subjects are used as a dataset which consist of normal EEG signals and epilepsy (abnormal) signals. The performance parameters of the SVM and KNN classifiers are presented. The accuracy for the EEG signal classification is compared. The SVM based classifier provides better accuracy than the KNN classifier.*

Key Words: *Classification, Support Vector Machine, K-nearest Neighbor, EEG Signals, Accuracy.*

1. INTRODUCTION:

A significant improvement has been seen in biomedical signal analysis and medical research due to remarkable development in the computational science and artificial intelligence field [1].

A non-invasive procedure which is done for monitoring and diagnosis of human brain conditions is called electroencephalogram (EEG). The brain activities such as seizure disorders and epilepsy can be diagnosed by analyzing the such EEG signals. The EEG signal consists of electrical variations which are variations of brain activities that are produced by placing electrodes on to scalp to measure it [2][4].

In biomedical applications, the system needs to be accurate and less complex to have better findings which results in accurate diagnosis and treatment in diseases. Several techniques have been developed for this purpose. Artificial intelligence and machine learning has a potential to overcome the issues related to accuracy and ease of system implementation [2][3].

Support vector machine (SVM) is an effective machine learning algorithm used in bioinformatics. SVM provides a better class separation to wide range of dataset [4][5]. The main constituent of SVM is the presence of hyperplane and support vectors which separates the data in two separate classes with large margin.

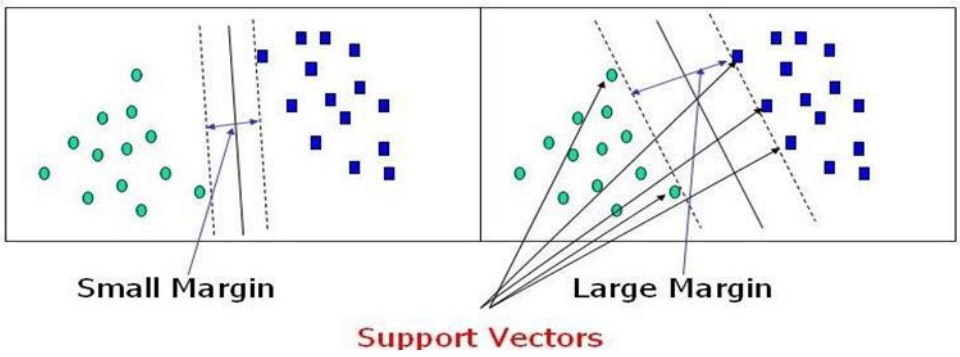

Figure 1. Support Vector Machine (SVM)

The k-nearest neighbor (KNN) is a another type of machine learning classification type uses both the principle of regression and classification of wide range of data. This algorithm is a supervised machine learning algorithm consist of iterative approach to find the nearest data values up to the k^{th} value of the data in given dataset [5][8][9].

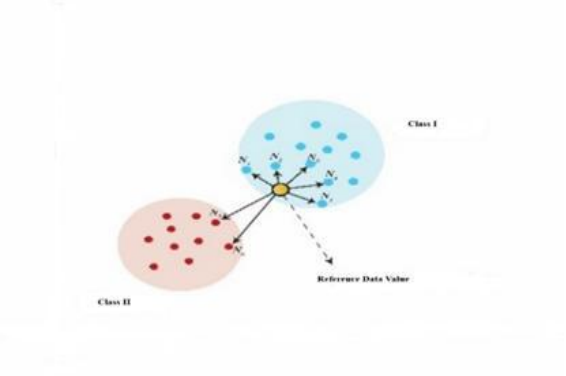

Figure 2. K-Nearest Neighbor

2. LITERATURE REVIEW:

Anushree Babloni [8] presented the implementation of KNN algorithm for EEG signal classification. The objective of the proposed concealed information test based on EEG signal. The data subjects are preprocessed using band pass filter. Nurul E'zzati Md Isa [9] in paper published presented the performance analysis of for EEG signal using K-nearest Neighbor. In this paper the authors have demonstrated the use of distance metrics of KNN classifier algorithm. The distances available in KNN are Euclidean, Manhattan and chebychev and minkowski distances. The results obtained from implementation using these distances showed that the KNN classifier has better accuracy for EEG classification for the Minkowski distance.
The paper titled Evaluation of Machine Learning Algorithms for Classification of EEG Signals by author Francisco Javier Ramírez-Arias et. al. [7] presented various classification techniques for EEG signal classification. Artificial Neural Network (ANN), K-nearest Neighbor (KNN), Naïve Bays (N.B.) and Decision Tree (DT) are discussed.

3. OBJECTIVES:

EGG Signal Classification using machine learning based Support Vector Machine (SVM) and K-nearest Neighbor (KNN) classifier techniques. Measurement and comparison of performance parameters for each classifier.

4. RESEARCH METHODOLOGY:

- Collection of EEG Signal Subjects for the proposed implementation
- EEG Signal Denoising and Feature extraction
- Implementation of Support Vector Machine (SVM) Algorithm

- Implementation K-nearest Neighbor (KNN) algorithm
- Calculation of Performance parameters such as Spectral Roll off, Zero Crossing rate, Spectral Entropy and Accuracy for each classifier
- Comparing the performance parameters

5. RESULT:

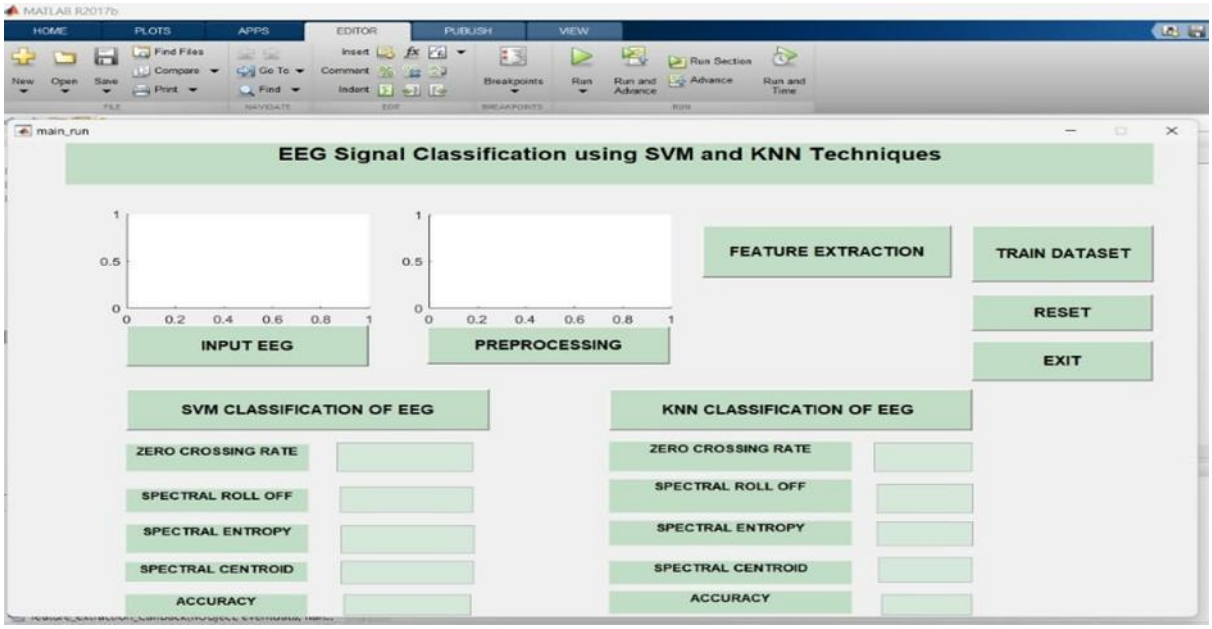

Figure 3. Project Implementation

Performance Parameters	Support Vector Machine (SVM)		K-nearest Neighbor (KNN)	
	Normal_0.1.txt	Normal_0.2.txt	Normal_0.1.txt	Normal_0.2.txt
Zero Crossing Rate	0.0125	0.125	0.0125	0.125
Spectral Entropy	0.46055	0	0.046055	0
Accuracy	70	80	55.78	55.175

Table 1. Performance Parameters for the Proposed Implementation considering Normal EEG

Performance Parameters	Support Vector Machine (SVM)		K-nearest Neighbor (KNN)	
	Subject_0.1.txt	Subject_0.2.txt	Subject_0.1.txt	Subject_0.2.txt
Zero Crossing Rate	0.155	0.1725	0.155	0.1725
Spectral Entropy	0.919	0.721	0.9199	0.2448
Accuracy	60	80	58.89	48.08

Table 1. Performance Parameters for the Proposed Implementation considering Abnormal EEG

6. DISCUSSION :

The proposed implementation results in obtaining the performance parameters of each classifier. The parameter zero crossing rate indicates the EEG signal retrieval. Higher the value of zero crossing rate indicates better signal retrieval after preprocessing. The zero-crossing rate of SVM classification shows better value than KNN classification.

The Spectral entropy indicates the amount of uniformity and signal power in the output signal. Higher the spectral entropy higher the randomness in the signal. The SVM classifier shows the lower spectral entropy. Accuracy for the EEG signal produced from SVM classifier shows better accuracy than KNN classifier.

7. CONCLUSION:

The machine learning based classifiers support vector machine and k-nearest neighbor are implemented to classify the EEG signals. The feature extraction and denoising is done for EEG signals prior input to classification process. Performance parameters are calculated for each classifier techniques. The Accuracy of each classifier technique is considered for comparison from the performance parameter. It is concluded that the Support vector machine (SVM) based EEG signal classification provide better classification for Normal and Abnormal EEG Signals.

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