

# A Research on Machine Learning Techniques to Analyze EEG Signals of Human Beings

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## ABSTRACT

In this paper it is important to understand the significance of the work so done. The current research work will be based on how to do calculation which is mainly a implementation of the EEG signal classification and thus allows the user for the learning of EEG signal classification. It is a general fact that EEG signal classification is mainly on the basis of either some disease on or some metabolic activities. This research work is pre dominantly about the epilepsy which creates a section of work which is not bound in the hands of any medical person. Machines these days are made digitised and intelligence is added to help doctors diagnose a person with epilepsy disorders, so the research paper mainly adds to the work of classification

**Keywords:** machine learning; supervised learning; unsupervised learning; semi-supervised learning; reinforcement learning.

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## INTRODUCTION

Machine learning is multidisplinary subject in synthetic intelligence, possibility, statistics, information concept, philosophy, psychology, and neurobiology. Machine mastering solves the actual world issues via building a model that is right and useful approximation to the records. The study of Machine studying has grown from the efforts of exploring whether or not computer systems may want to discover ways to mimic the human brain, and a discipline of data to a vast area that has produced fundamental statistical computational theories of mastering techniques. In 1946 the primary computer gadget ENIAC becomes developed. The idea at that point was that human thinking and getting to know might be rendered logically in such a device. In 1950 Alan Turing proposed a check to degree its overall performance. The Turing test is based totally on the idea that we will handiest determine if a device can absolutely examine if we talk with it and cannot distinguish it from another human. Around 1952 Arthur Samuel (IBM) wrote the first game-gaming program, for checkers, to acquire sufficient talent to venture a world champion. In 1957 Frank Rosenblatt invented the perceptron which connects an internet of factors where easy selections are made that come together in the larger program to solve more complex troubles. In 1967, sample popularity is evolved while first program capable of apprehend styles have been designed primarily based on the form of algorithm called the closest neighbor. In 1981, Gerold Dejong brought rationalization based totally learning wherein earlier expertise of the world is furnished with the aid of training examples which makes the use of supervised getting to know. In the early 90's machine getting to know became very famous again due to the intersection of Computer Science and Statistics [1].

Advances continued in system getting to know algorithm in the trendy regions of supervised and unsupervised getting to know. In the existing era, adaptive programming is in explored which makes use of device learning wherein programs are capable of recognizing patterns, getting to know from enjoy, abstracting new information from information and optimizing the efficiency and accuracy of its processing and output. In the invention of expertise from the multidimensional facts available in a numerous quantity of software areas, machine getting to know strategies are used.

Because of recent computing technologies, gadget studying these days is not like machine mastering of the past. Though many device getting to know algorithms were advanced from long term, latest development in system mastering is the potential to mechanically practice complex mathematical calculations to large statistics – over and over, quicker and faster. More interest is advanced in system getting to know nowadays is because of developing volumes and types of to be had statistics, computational processing that is cheaper and more effective, and low-cost facts garage. All of this stuff means it's

viable to quickly and mechanically produce models that can analyze larger, greater complicated information and deliver faster, more accurate outcomes even on a totally large scale. Machine getting to know model produces excessive-cost predictions that could guide higher choices and smart moves in actual time with out human intervention [2].

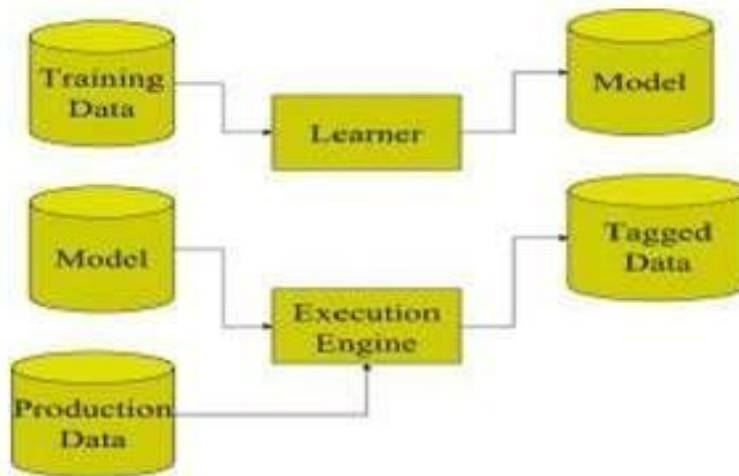
Machine learning do no longer just reply to contemporary demand, however so that you can expect demand in actual time. As computation gets less expensive, device studying makes the impossible things possible and those generally tend to start doing them and turn out to be with making shrewd infrastructure. It is the need to develop newer algorithms to boost the technology of device learning and big amount of work that desires to be accomplished to update existing algorithms from new algorithms. To make the existing algorithms extra sturdy and consumable it isn't always crucial to expand an ideal model set of rules, due to the fact an ideal model will no longer be the final products data often has only a temporal fee.

### MACHINE LEARNING MODEL

Learning technique in device getting to know version is split into two steps as

- Training
- Testing

In schooling manner, samples in schooling facts are taken as input wherein functions are learned by studying algorithm or learner and build the getting to know version. In the checking out procedure, getting to know version makes use of the execution engine to make the prediction for the test or manufacturing statistics [3]. Tagged facts are the output of mastering model which offers the final prediction or categorised facts.



**Figure 1: Operational model of machine learning**

### MACHINE LEARNING TECHNIQUES

Machine classification methods are divided into three important categories on the basis of the studying sign or remarks provide to gaining knowledge of scenario as follows:

#### Supervised learning

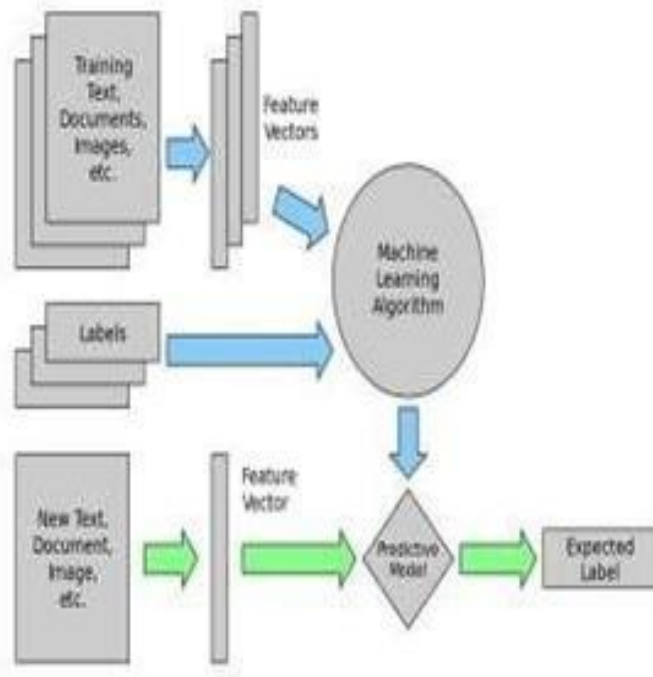
Supervised gaining knowledge of is skilled using classified examples, consisting of enter where the desired output is thought. Supervised gaining knowledge of offers dataset inclusive of both capabilities and labels. For example, a piece of gadget may want to have training records points classified both as F (failed) and as R (runs). The mission of supervised mastering is to construct an estimator which is capable of predict the label of an item given the set of functions. The mastering set of rules receives a hard and fast of capabilities as inputs along side the corresponding accurate outputs, and the set of rules learns by way of evaluating its actual output with accurate outputs to find mistakes. It then modifies the version as a result.

Supervised learning is normally used in applications wherein an ancient fact predicts in all likelihood future occasions. For instance, it can count on when credit card transactions are likely to be fraudulent or which coverage client is probable to document declare. Another application is predicting the species of iris given a set of measurements of its flower. Other greater complex examples consists of popularity gadget as given a multicolor picture of an item via a telescope, decide whether or not that item is a star, a quasar, or a galaxy, or given a list of films someone has watched and their non-public score of the movie, advise a listing of movies they would love.

Supervised learning duties are divided into two categories as classification and regression. In classification, the label is discrete, while in regression, the label is non-stop. For instance, in astronomy, the challenge of figuring out whether an object is a celeb, a galaxy, or a quasar is a class trouble where the label is from 3 distinct categories. On the alternative hand, in regression trouble, the label (age) is a non-stop quantity, for example, finding the age of an item primarily based on observations [4].

Supervised mastering version is given in determine 2 which shows that algorithm makes the distinction between the raw determined facts X that is schooling facts which can be textual content, document or photograph and some label given to the version for the duration of schooling. In the process of education, supervised mastering set of rules builds the predictive version. After education, the equipped model will attempt to are expecting the most probable labels for brand spanking new a fixed of samples X in test data. Depending on the nature of the goal y, supervised gaining knowledge of may be categorized as follows:

- If y has values in a fixed set of categorical consequences (represented through integers) the project to expect y is known as type.
- If y has floating point values (eg. To symbolize a charge, a temperature, a size...), the undertakings are expecting y is referred to as regression.



**Figure 2 Supervised learning model**

**B. Unsupervised Learning**

Unsupervised gaining knowledge of used statistics that has no historical labels and the intention is to discover the statistics and locate similarities among the gadgets. It is the method of coming across labels from the records itself [5]. Unsupervised studying works nicely on transactional information together with perceive segments of clients with similar attributes who can then be dealt with further in marketing campaigns. Or it can discover the principle attributes that separate purchaser segments from every other.

Other unsupervised studying issues are:

- Given targeted observations of distant galaxies, decide which capabilities or combos of features are maximum vital in distinguishing between galaxies.
- Given a combination of sound sources as an instance, someone talking over a few song, separate the two which is referred to as the blind supply separation hassle.
- Given a video, isolate a shifting object and categorize on the subject of other shifting objects that have been seen.

Typical unsupervised task is clustering wherein a set of inputs is split into organizations, not like in type, the organizations are not recognized before. Popular unsupervised techniques consist of self-organizing maps, k nearest neighbors, okay approach and singular value disintegration are also used to section textual content topics, suggest gadgets and discover information outliers. The unsupervised mastering model is given in parent 3 which suggests that unsupervised studying algorithm simplest uses a single set of observations  $X$  with  $n$  samples and  $n$  capabilities and does now not use any type of labels [6]. In the schooling manner, unsupervised getting to know algorithm builds the predictive version which will attempt to suit its parameters so one cans high-quality summarizes regularities located in the information.

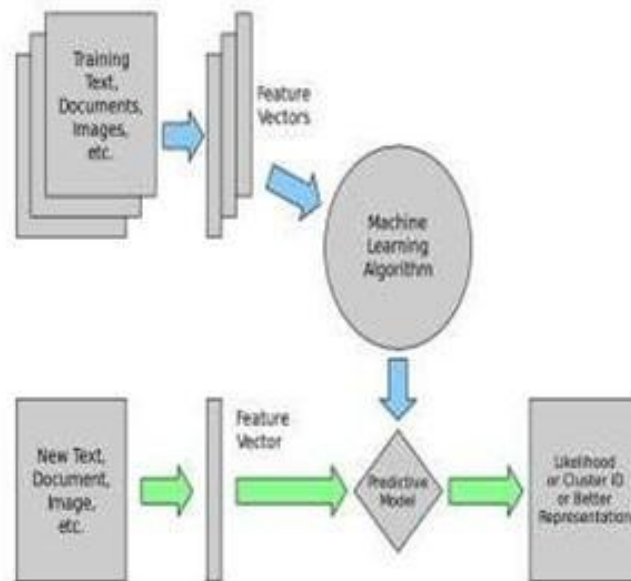


Figure 3 Unsupervised learning model

### C. Semi-supervised Learning

In many sensible learning domain including textual content processing, video indexing, bioinformatics, there may be big supply of unlabeled data however confined classified records which can be high priced to generate .So semi supervised getting to know is used for the same packages as supervised gaining knowledge of but it uses each categorized and unlabeled information for training [7]. There is a desired prediction trouble but the version ought to analyze the systems to organize the data in addition to make predictions. Semi-supervised learning is beneficial whilst the fee related to labelling is too excessive to allow for a fully categorized schooling technique. This sort of gaining knowledge of can be used with strategies along with classification, regression and prediction. Early examples of this consist of identifying someone's face on an internet cam. Example algorithms are extensions to other flexible techniques that make assumptions about the way to version the unlabelled information.

### D. Reinforcement Learning

It is regularly used for robotics, gaming and navigation. It is the mastering technique which interacts with a dynamic surroundings wherein it have to carry out a sure intention without a instructor explicitly telling it whether it has come near its goal. With reinforcement gaining knowledge of, the set of rules discovers through trial and blunders which movements yield the best rewards. So inside the chess playing, reinforcement getting to know learns to play a recreation by playing towards an opponent which plays trial and errors moves to win [8].

This type of getting to know has 3 primary additives: the learner, the surroundings and moves. The goal is for the learner to pick moves that maximize the anticipated praise over a given quantity of time. The learner will reach the intention a whole lot faster by way of following an excellent policy. So the goal in reinforcement learning is to analyze the nice coverage [9].

## MACHINE LEARNING ALGORITHM

A massive set of device learning algorithms are developed to build machine studying models and put in force an iterative machine gaining knowledge of process. These algorithms can be categorized on the basis of mastering fashion as follows:

### Regression Algorithm

Regression is all about modelling the relationship between variables that is used again and again . Regression is the venture of predicting the value of a continuously various variable along with a rate, a temperature if given some input variables like functions and regressor. The maximum regression algorithms are defined as follows:

- **Simple Least Square Regression**
- **Linear Prediction**
- **Analytical Regression**
- **Stair Regression**
- **Multivariate Changing Regression**
- **Locally Estimation based Regression**

### B. Example based Primary Algorithm

Example based totally mastering simple models are a type of trouble with examples of schooling information that are commonly increased in a database using a correlation measure of a effort to discover the quality health and make a estimation. Instance-primarily based strategies are also called lazy learner. Lazy gaining knowledge of without a doubt stores education information and waits until its miles given a check statistics then plays the mastering. So lazy learner takes less time in education however more time in predicting. The most famous example-based totally algorithms are knn

- **LVQ**
- **SOM**
- **LWL**

### C. Decision Tree Classification Algorithm

Decision tree is used to predict about data using mapping methods. Tree technique in which the target variable can take finite set of values are referred to class variables. In those tree systems, leaves constitute class labels and branches represent conjunctions of capabilities that lead to those elegance labels. Decision trees in which the target variable assumes running values (generally real numbers) are called regression bushes.

Decision tools are educated on records for class and regression situation. Decision tools are very often frequent and correct and a large preferred in machining study. The famous decision tree algorithms are:

- **Classification and Regression Tree**
- **Iterative Dichotomiser (ID3)**
- **C4 Five and C5 Zero (one of a kind version of a effective approach)**
- **Chi Squared Automatic Interaction Detection**
- **Decision Stump**
- **Conditional Decision Tree**

### D. Bayesian Classification Algorithm

Machine Learning is a hybrid of Statistics and algorithmic Computer Science. Statistics is about managing and quantifying uncertainty. To represent all forms of uncertainty, bayesian algorithms are used which are based on opportunity theory [10]. In the following bays' theorem which include category and regression. The famous algorithms are:

- **Naive Bayes**
- **Gaussian Naive Bayes**

- **Multinomial Naive Bayes**
- **Averaged One-Dependence Estimators**
- **BNNs**
- **Bayesian Network**

#### **E. Clustering Algorithm**

Clusters are the basic approach of category of objects into special companies. It walls the statistics set into subsets or clusters, so that the statistics in each subset proportion some common trait frequently in line with some defined distance degree. Clustering is the kind of unsupervised gaining knowledge of. Clusters are like regression described by the magnificence of the situation and the type of method. Clustering techniques are categorized as hierarchical clustering and partitional clustering. K-manner is partional clustering algorithms which uses centroid-based method. The most famous clustering algorithms are:

- **okay-Means**
- **ok-Medians**
- **Maximum likelihood**
- **Hierarchical Assemblage**

#### **F. Association Rule Learning Algorithm**

Association based rule is strategies that gives policies that first-class provide an explanation for found relationships between variables in records. These policies can find out vital and commercially beneficial institutions in big multidimensional datasets that may be victimized by way of the business enterprise [11]. The most famous affiliation rule getting to know algorithms are:

- **Apriori algorithm**
- **Eclat set of rules**

#### **G. Artificial Neural Network Algorithm**

Artificial neural networks are fashions which makes use of supervised gaining knowledge of which are constructed primarily based at the shape of biological neural networks. It has synthetic neurons which has exceptionally weighted interconnections amongst devices and learns by means of tuning the connection weights to perform parallel distributed processing. Hence synthetic neural networks also are called parallel distributed processing networks. The popular artificial neural network algorithms are:

- **Perceptron learning**
- **Error Back Propagation**
- **Hopfield Network**

#### **H. Deep Learning Algorithm**

Learning algorithms based on deep learning approach are a current update to existing neural networks systems that gives clear plentiful cheap computation. They are concerned with building a great deal larger and more difficult neural system as many strategies are worried using supervised studying issues in which huge datasets include very little labelled facts. The most popular deep getting to know algorithms are:

- **Restricted Boltzmann Machine**
- **DBN**
- **Conv Nets**
- **Stacked Auto-Encoders**

#### **I. Dimensionality Reduction Algorithm**

Dimension is reduced in an manner to solve problem of coarse dimension way. As the volume of the space increases the available data become sparse. This is a problem for any method that needs methods of statistics. Study of methods for dimension reduction describing the data.

Most of the time objectives are to increase search speed and decrease complexity. To improve upon quality of data for data organisation. Like methods of clustering, dimension reduction and exploit the structure inherent in the data in an unsupervised manner. The dimensionality reduction algorithms are:

- **Principal Component Analysis**
- **Principal Component Regression**
- **Partial Least Squares Regression**
- **Sammon Aligning**
- **Multidimensional Scaling**
- **Projection Pursuit**
- **Linear Discriminant Analysis**
- **Mixture Discriminant Analysis**
- **Quadratic Discriminant Analysis**
- **Flexible Discriminant Analysis**

#### **J. Ensemble Algorithms**

Ensemble methods are models based on unsupervised learning which is collection of several weak learner models that are singly trained and whose vaticination are sumed up in any way to give overall prediction. It divides the training data into number of subsets of data for which independent learning models are constructed[12]..All learning models are combined to make correct hypothesis.The popular ensemble algorithms are

- **Encourage**
- **Bagging**
- **Bootstrapped Accumulation**
- **Blending**
- **Gradient Boosting Machines**
- **Gradient Tree Boosting**
- **Random Decision Forests**

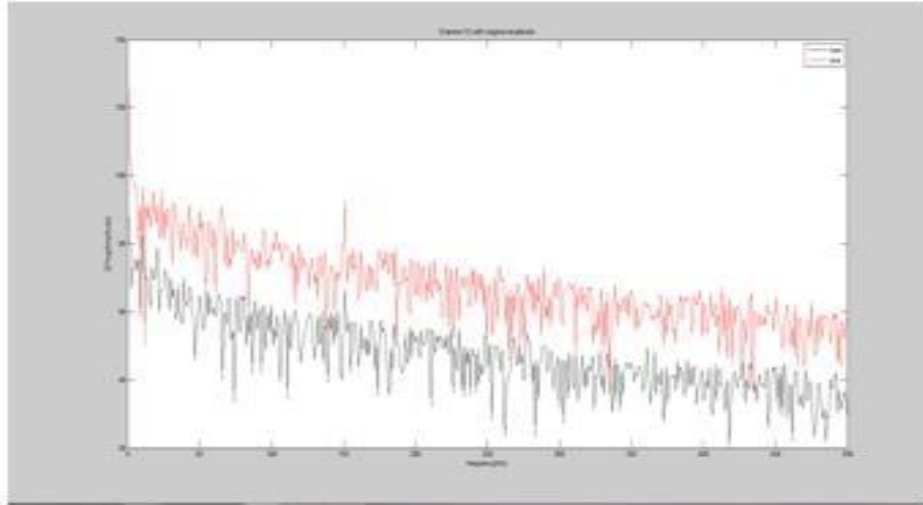
### **APPLICATION AND TOOLS**

Machine learning applications are broadly classified based on learning techniques: supervised and unsupervised learning. Classification applications make use of supervised learning that are pattern recognition, face recognizance, character recognition, medical interpretation, web announcement. Unsupervised learning applications are clustering, explanation, association analysis, customer segmentation in CRM, image compression, bio computing. Robot control and game playing are the example application of reinforcement learning.

Tools are the articulation of the machine learning and it is needed to select an appropriate tool which is as essential as working with the best procedure. Intelligence retrieval tools makes intelligence learning faster, easier and more fun. Machine learning tools provide capabilities to deliver results in a machine learning project. Also it is used as a filter to decide whether or not to learn a new tool or new feature. Machine learning tools provide an intuitive interface onto the sub-tasks of the applied machine learning process. There's a good mapping and suitability in the interface for the task. Great machine learning tools embody best practices for process, configuration and implementation. Examples include automatic configuration of machine learning algorithms and good process built into the structure of the tool. Machine learning tools are separated into platforms and libraries.

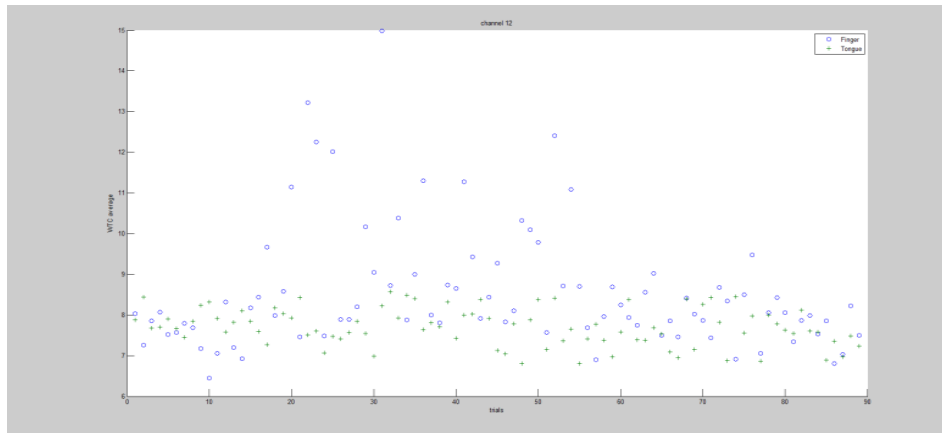
### **RESULT**

This paper looks for comparison in the existing techniques of EEG signal processing and adds new dimensions in the work. The complete work is based on the sub banding of the work and dividing the scope of work in literature applications and results. The results section in this paper gives an idea on how to use the graphics and develops the results for the same. Figure 4. is a example to epileptic waveforms that are mainly recorded with a typical recorder and with several probes. For the current analysis it is necessary to consider two typical epileptic waveforms.

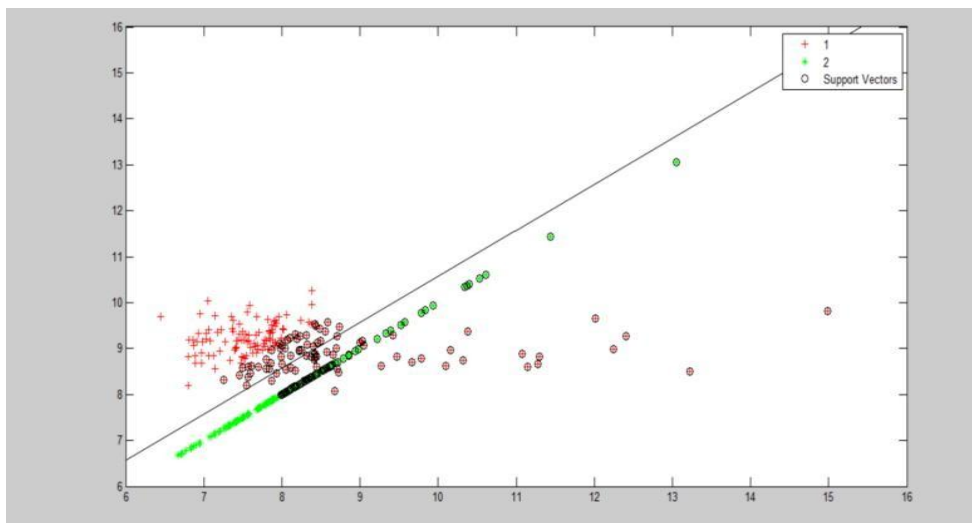


**Fig 4. Epileptic waveforms measured for 1000 samples**

Figure 5: is all about the understanding of the data that has been recorded and implied in the complete report with respect to the normalization of the images recorded.

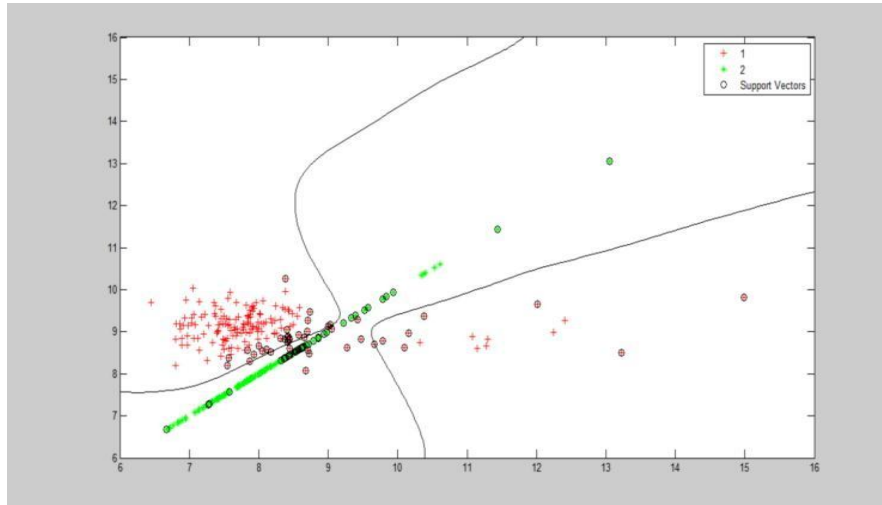


**Fig 5: EEG epileptic signal for frequency domain visualization**



**Fig 6: Introduction to classification planes**





**Fig 7: Introduction to polynomial classification plane**

Figure 6 and 7 are the images to classifiers that are mainly responsible for the work of classification of signals are not important the most imperative work is the classification based on the different classifiers

## CONCLUSION

As the research is not new the existing work has extended two new things in this field that will lead to a better level of recognition, this has been done by firstly increasing the number of patients above 30 and then the number of features found per subject. In this work the number of features that could be used is time domain features, wavelet features and frequency features, by introducing all three features the probability of increasing the chances of recognition of heart rate variability has increased drastically.

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