International Journal of Research Publication and Reviews, Vol (5), Issue (4), April (2024), Page – 4834-4841

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

PERFORMANCE ANALYSIS OF ML AND ANN ON EPILEPTIC SEIZURE DETECTION

[1]Sri D V L N Sastry,[2] V Sneha,[3] P Rajesh Kumar, [4]Sai Jayanth Patnaik, [5]Ch Harsha vardan

[1] Sr. Assistant professor, [2,3,4,5,]Student, Dept of Electronic and Communication Engineering,
Aditya Institute of Technology and Management, Tekkali.

ABSTRACT:

Epilepsy is a life-threatening neurological brain disorder that gives rise to occurring often repeatedly uncontrolled burst of electrical activity in the brain. It occurs due to abnormal chemical changes in our brains. For many years, studies have been conducted to support the automatic diagnosis of epileptic seizures for clinicians' ease. For that, several studies entail machine learning methods for early predicting epileptic seizures. Mainly, feature extraction methods have been used to extract the right features from the EEG data generated by the EEG machine. Then various machine learning classifiers are used for the classification process, And various performance metrics for each classifier is measured and compared among different classification. algorithms which helps to attain classification performance.

1. INTRODUCTION :

Machine learning-based epileptic seizure detection is a novel method in medical diagnosis. Timely detection and successful care of epilepsy, a neurological condition characterized by unpredictable seizures resulting from aberrant brain activity, pose significant problems. A potential solution to these problems is to use machine learning techniques, which use the analysis of electroencephalogram (EEG) data to identify minute patterns suggestive of seizure events.There are multiple complex steps in this creative process. Patients first provide raw EEG data, which frequently includes artifacts and unrelated noise. Then, using preprocessing procedures, this data is filtered and cleaned so that only pertinent information is used in the analysis that follows. The next step is featuring extraction, which is the process of identifying important properties like frequency, amplitude, or statistical metrics that are present in EEG signals.with QR code integration offers a comprehensive solution for streamlined medication management and patient care,leveraging both software and hardware components for efficient operation.The aforementioned properties are essential inputs for a range of machine learning algorithms, such as decision trees, neural networks, support vector machines, and ensemble techniques.The training of these machine learning models is the key step in the process. These models are trained to distinguish between patterns in brain activity that indicate an imminent seizure and those that indicate continuous epileptic activity. Large and varied datasets are needed for training in order to guarantee that the models appropriately represent the intricacy and diversity of seizure patterns. After that, these models undergo thorough testing and validation. Their accuracy, sensitivity, specificity, and precision are measured using different datasets.Following a successful training and validation process, real-time monitoring systems can utilize these models. By continuously analysing incoming EEG signals, these devices are able to quickly identify possible seizure episodes. Subsequently, prompt alerts or notification can be produced for medical professionals or epileptic patients, enabling prompt interventions or activities to lessen the effects of seizures.Even while machine learning has great potential for detecting epileptic seizures, there are still obstacles to overcome. There are constant challenges, such as individual variations in seizure patterns, the need for large and diverse datasets for reliable model training, processing limitations in real-time, and the need to reduce false alarms. To improve these methods' accuracy, dependability, and usefulness in clinical settings, more research and developmentare required.

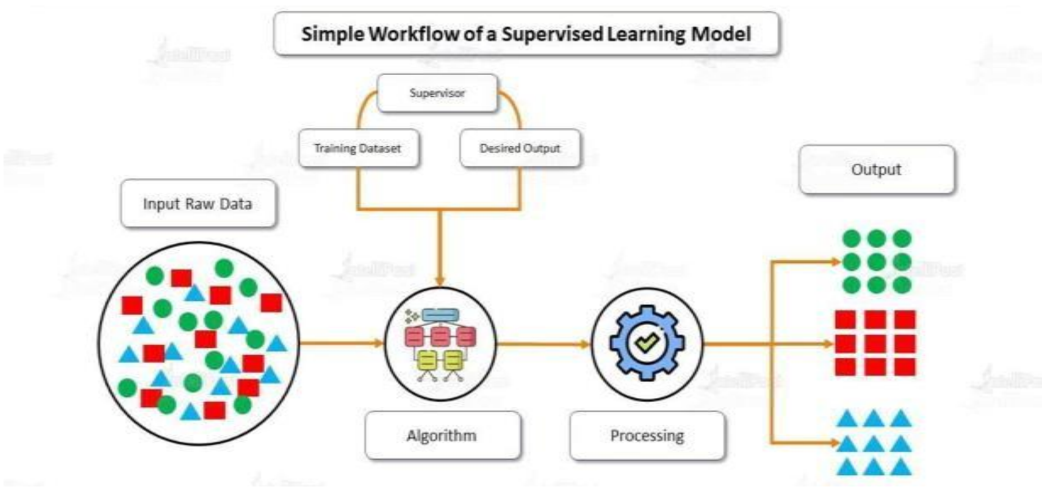

figure.1 workflow of supervised learning

All things considered, the application of machine learning to the field of epileptic seizure detection has enormous potential to completely transform the way seizuresare tracked and treated.

Overview machine learning:

Supervised Learning:

Supervised learning refers to the kind of machine learning wherein machines are trained using properly "labelled" training data, and then they make output predictions based on that data. Some input data has already been tagged with the appropriate output, as indicated by the labelled data. In supervised learning, the machines' training data serve as the supervisor, teaching them to accurately predict the output. It uses the same idea that a student would learn under a teacher's guidance The process of giving the machine learning model accurate input and output data is known as supervised learning. The objective of an algorithm for supervised learning is to identify a mapping function that associates the input variable (x) with the output variable (y). In the actual world,

How supervised learning works :

Supervised learning required training labelled data. In order to do classification, we need to first label the data and then use it to train in model to classify them in groups. In supervised learning, we train your model on a labelled dataset that means we both raw input data as well as its results. We split our data into a training dataset and test dataset where the training dataset is used to train our model whereas the test dataset acts as new data for predicting results or to see the accuracy of our model.

- The shape is designated as a square if it has four sides and each side is equal.
- The shape will be designated as a triangleif it has three sides.
- The shape will be called a hexagon if it has six equal sides. After training, we usethe Est set to put our model to the test. The model's job is to recognize the shape. The computer has already been educated on a wide variety of shapes. When it encounters a new shape, it categorizes it based on several sides and forecasts the result.

2.2. Unsupervised Learning:

Unsupervised learning does not require labelled or classified data explicitly. In unsupervised learning, the information used to train is neither classified nor labelled in the dataset. Unsupervised learning studies on how systems can infer a function to describe a hidden structure from unlabelled data. The maintask of unsupervised learning is to find patterns in the data.

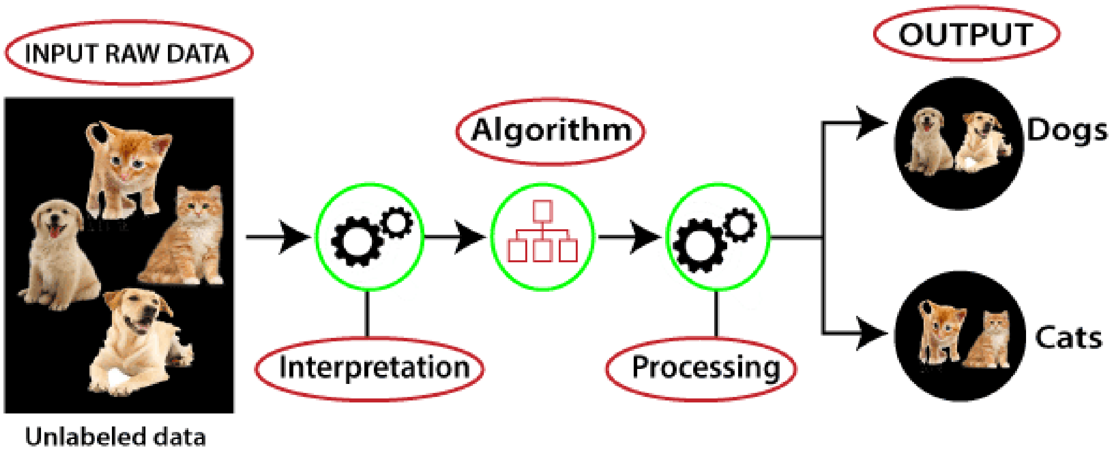

Fig.2 unsupervised learning workflow

In this case, the input data is unlabelled, meaning it is not categorized and no corresponding outputs are provided. The machine learning model is now fed this unlabelled input data in order to train it. It will first analyse the raw data to identify any hidden patterns before applying the appropriate techniques, including decision trees and k-means clustering, to the data. After applying the appropriate algorithm, the algorithm groups the data objects based on the similarities and differences among them.

Classifiers

2.3.Linear regression
2.4.Decision Tree Classifier
2.5.Random Forest Classifier

2.6.ANN

2.3 Linear regression :

The link between independent factors (such latitude, longitude, depth, and the number of seismic stations) and a dependent variable (shock magnitude) is modeled by the supervised machine learning process known as linear regression. To anticipate the relationship between earthquake magnitude, latitude, longitude, depth, and the number of seismic stations that recorded it, we used multiple linear regression.

Latitude, longitude, depth, and the number of seismic stations are the independent variables, and the dependent variable, magnitude, is assumed to have a linear relationship with them in the multiple linear regression model. Each independent variable has an independent effect on the dependent variable in this additive relationship.

2.4.Decision Tree Classifier:

Applied to classification applications, such as epileptic seizure recognition, the Decision Tree Classifier is a straightforward yet effective machine learning technique. Based on the values of the input features, it divides the feature space into smaller parts and then determines the class label for each region.

- **Choosing Features:** Features taken from EEG signals are essential for epileptic seizure classification using a decision tree classifier, much like in logistic regression. These features might include different EEG signal properties including frequency bands, spectral power, statistical measurements, and more.
- **model Training:** A dataset including labeled samples of EEG signals connected to seizure and non-seizure events is used to teach the decision tree algorithm. In order to distinguish seizure from non- seizure instances, it repeatedly divides the feature space into smaller subsets based on the values of input characteristics. This process results in the construction of a tree structure.
- **Making Choices:** After training, the decision tree can identify new EEG signals by tracing a path through the tree according to the feature values. The signal eventually reaches a leaf node, which determines whether or not it is indicative of a seizure.
- **Model Evaluation:** Metrics including accuracy, sensitivity, specificity, and area under the curve are used to evaluate the decision tree classifier's performance.comparable to a logistic regression's ROC curve (AUC). These metrics assess the model's ability to discriminate between seizure and non-seizure cases.

Random Forest Classifier:

In order to identify EEG signals as either suggesting a seizure or not, Random Forest is a machine learning technique that creates numerous decision trees and aggregates their predictions. Random Forest generates a "forest" of decision trees, each trained on a distinct subset of the data and employing a variety of attributes, as opposed to depending simply on one decision tree. It then creates a final prediction by combining their outputs.

- **Feature Selection:** The Random Forest model is trained using features that are derived from EEG data, such as frequencies, patterns, or statistical measurements. These characteristics aid the algorithm's learning process in differentiating between seizure and non- seizure situations.
- **Training the Model**: A random selection of features and data samples provides the basis for each decision tree that the algorithm builds during training. Every tree gains the ability to decide for itself.
- **Making Predictions:** Each decision tree in the Random Forest casts a vote to determine whether or not fresh EEG signals suggest a seizure when they are incorporated into the model. The average of all tree projections or the majority votedetermines the final prediction.

ANN(artificial neural network):

Now, let's explore how we can use a special kind of computer system called Artificial Neural Networks (ANN) to help someone with epilepsy. This system is designed to detect when a seizure might happen and alert others to keep the person safe. Here's how it works: First, we need to know that a seizure is when the brain has unusual activity that can cause a person to shake or lose control of their body. ANN is like a smart system inspired by our brains that can learn patterns from data. Our project wants to make a system that can sense when a seizure is about to happen. When it notices these early signs, it will send a message to caregivers or family members so they can help quickly.

Different layers of ANN:An Artificial Neural Network (ANN) is made up of several layers, each with its own unique role in processing information. Let's break down these layers in a simple way:

- **Input Layer**: This is the first layer where the network "sees" and takes in the data. It's like the eyes and ears of the network, collecting raw information. Each node(or neuron) in this layer represents a different piece of information about the input data**.**
- **Hidden Layers**: These are in-between layers that process the input data and learn from it. They're called "hidden" because we don't interact with them directly; they're doing the thinking behind the scenes.Each hidden layer consists of multiple neurons that perform calculations on the input data. The more hidden layers a network has, the more complex patterns it can learn.
- **Output Layer:** This is the final layer that gives us the network's prediction or output.It interprets the processed data from the hidden layers and produces the result.The number of nodes in the output layer depends on the type of problem we're solving. For example, if we're predicting whether an email is spam or not, we might have two nodes: one for "spam" and one for "not spam."

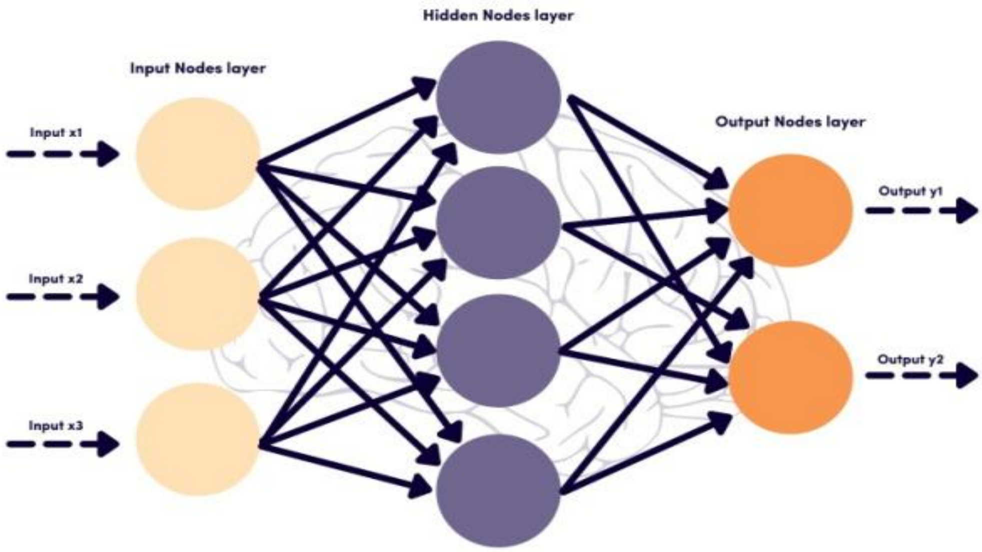

Figure.3:layers of ANN

3.Problem statement:

Developing an efficient epileptic seizure detection system using machine learning classifiers to accurately identify seizure events from EEG signals, aiming to improve patient monitoring and provide timely intervention. This project addresses the challenge of distinguishing between seizure and non-seizure EEG patterns with high accuracy, sensitivity, and specificity, while minimizing false alarms. The systemshould handle the variability in seizure manifestations and EEG patterns across patients, as well as address the need for real-time processing to enable promptmedical response. Additionally, it should berobust to noise and artifacts commonly present in EEG recordings, ensuring reliable performance in clinical settings. The ultimate goal is to create a reliable and practical tool that aids healthcare professionals in epilepsy diagnosis and management, contributing to improved patient outcomes and quality of life.

Methodology:

3.1.General methodology for detecting seizure

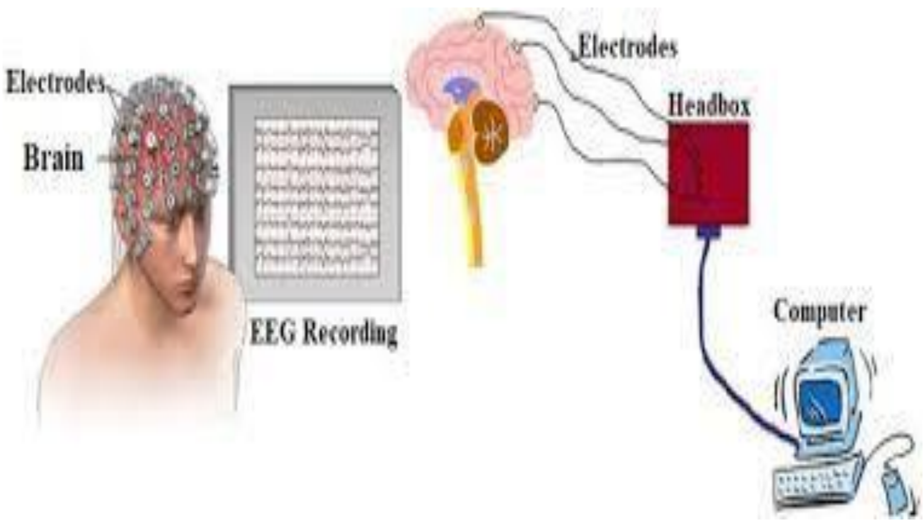

Figure.4 general methodology

As recordings are frequently used to detect epileptic seizures using the electroencephalography (EEG) technique. Analysis of EEG waves is crucial for identifying neurological conditions likeepilepsy.

Electric signals from EEG monitor are used to capture the neural activity of the human brain.The brain's electrical activity is analyzed by EEG, which creates patternsto categorize it as normal or abnormal. EEG typically captures the patterns of brain waves

and a piece of equipment that is implanted, such as electrodes positioned on the head, collects the signals.

4.Detecting seizure by using machinelearning classifiers:

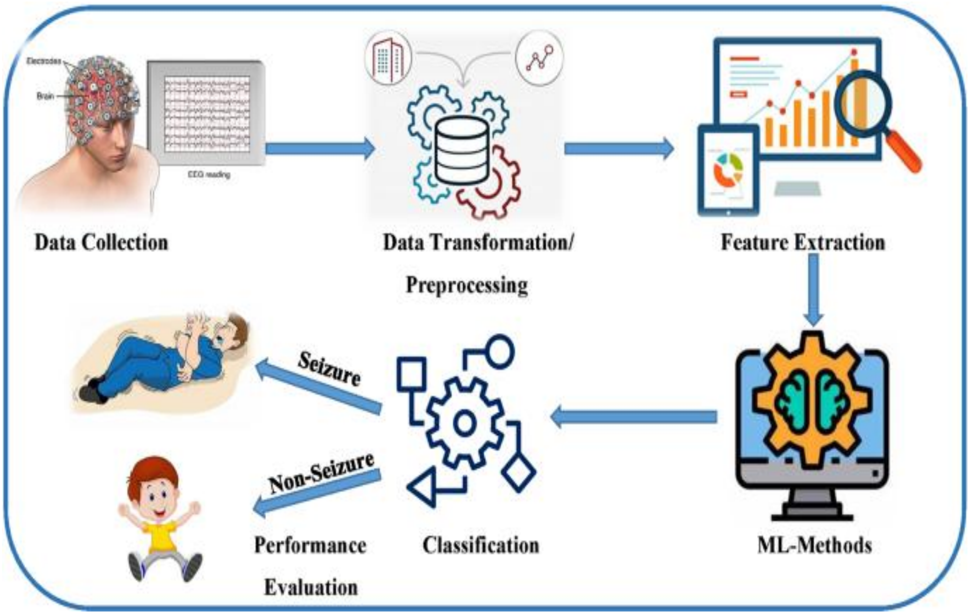

Figure.5 detection using ML classifiers

Gathering the brain signal dataset is the first prerequisite. Various monitoring tools are used for this. The most commonly utilized devices are usually EEG and ECoG, as their electrodes or channels are glued to the scalp's surfacein accordance with the 10–20 International system, at various lobes. The EEG channels are positioned on thesubject's scalp, and the electrical signalsare read by the EEG monitoring tool, which then displays these raw signals onthe screen. Each of them has a wireconnection to the EEG device, giving timely information about the variations in voltage along with temporal and spatial information. Additionally, the analyst has closely observed these raw signals and divided them into "seizure" and "non-seizure" phases.

5.Results:

Logistic Regression:

Accuracy: 62 %
51.2 Confusion Matrix

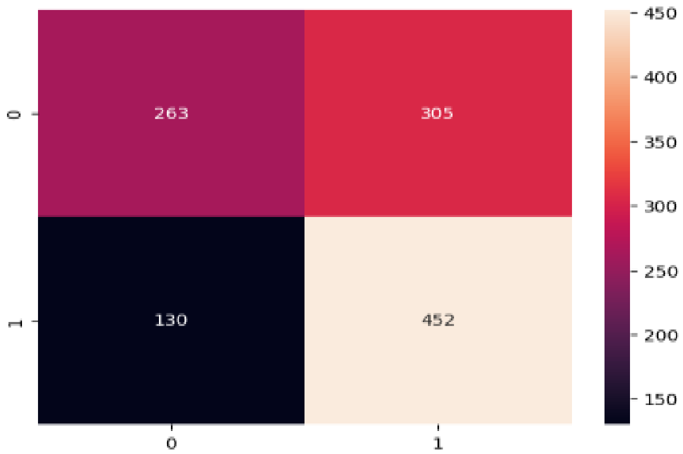

Figure.6.Logistic regression confusion matrix

5.1.3 Classification Report

precision	recall	f1-score	support 1	0.67	0.46	0.55	568
2	0.60	0.78	0.68	582			

accuracy 0.62 1150

Decision tree classifier:

Accuracy: 88 %
Confusion Matrix

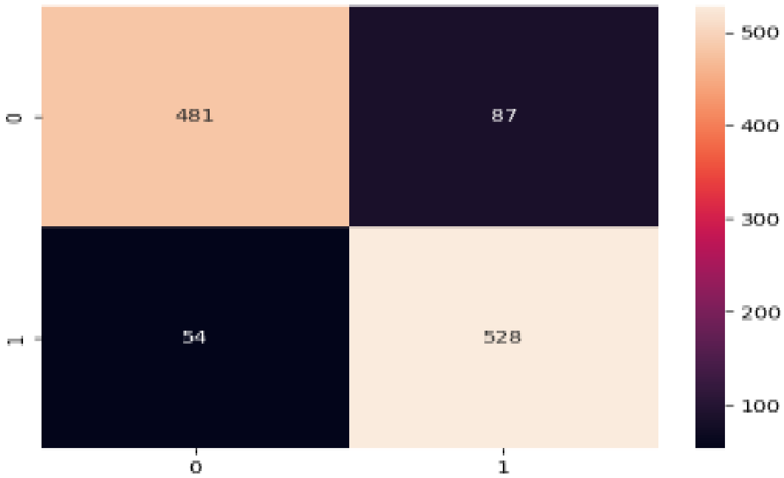

Figure.7.Decision tree confusion matrix

Classification Report

	precision	recall	f1-score	support
1	0.90	0.85	0.87	568
2	0.86	0.91	0.88	582
	accuracy		0.88	1150

Random Forest Classifier:

Accuracy: 96 %
Confusion Matrix

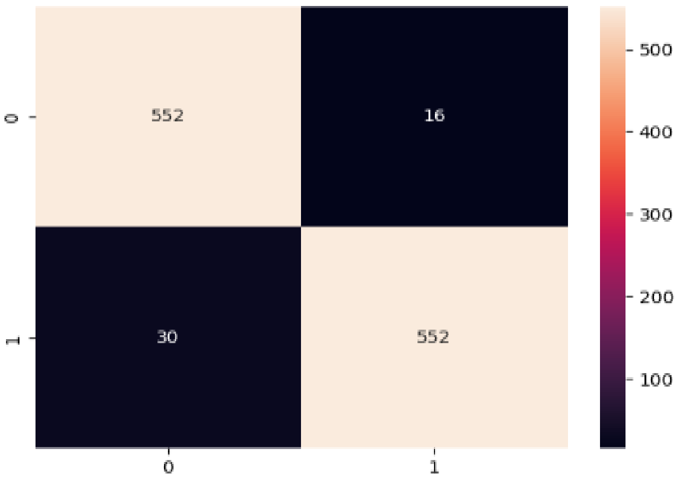

Figure.8.Random forest confusion matrix

Classification Report

	precision	recall	f1-scc
1	0.95	0.97	0.!

2	0.97	0.95	0.96	582
accuracy			0.96	1150

Artificial Neural Networks (ANNs)

Mean Square Error (MSE) :

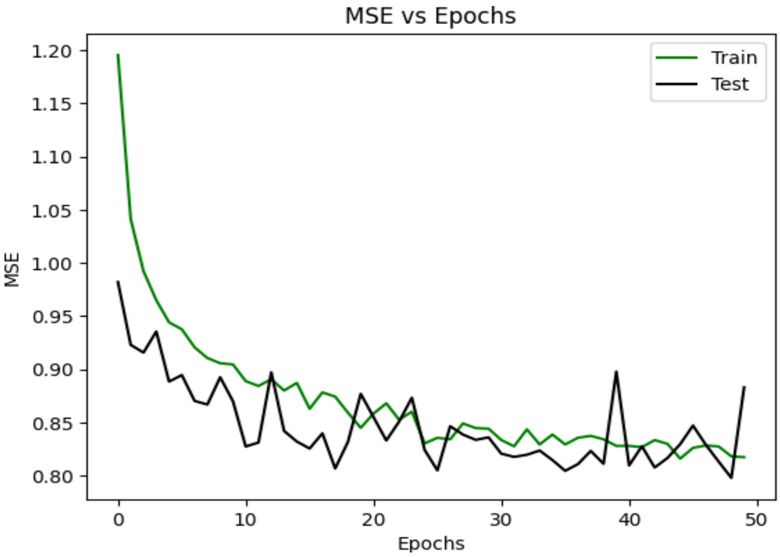

Figure.9.MSE

Accuracy :

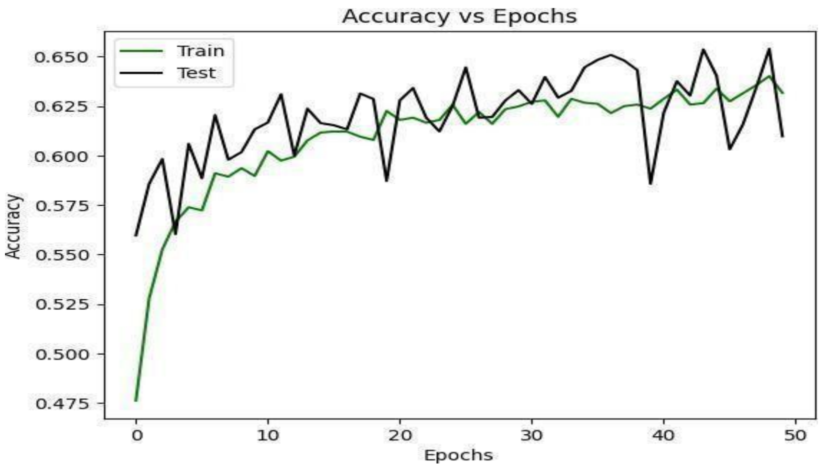

Figure.10.Accuracy

6. Conclusion and Reference

6.1. Conclusion

- When it comes to spotting epileptic seizures in brain signals, we have three main tools: Logistic Regression, Decision Tree Classifier, and Random Forest Classifier, Artificial Neural Network.
- Logistic Regression is like making straightforward guesses based on simple patterns. It's easy to understand but might miss more complex signs of seizures.
- Decision Tree Classifier is a bit like following a map, trying to navigate through different possibilities. It's good at spotting twists and turns in the data but might get too detailed and makemistakes.
- Random Forest Classifier is like asking a bunch of friends for their opinions and then combining them. It's usually the most accurate because it listens to manydifferent voices, but it's a bit harder to understand why it makes its decisions.
- Our project shows that ANN can be a powerful tool for predicting epileptic seizures. As technology advances, using models like these in hospitals could change the way we care for people withepilepsy, making their lives safer and better.
- In the end, choosing the right tool depends on the situation. If things are pretty straightforward, Logistic Regression might do the trick. If it's more complicated, Decision Tree or Random Forest might be better. ANNs is far better and power full tool for predicting epileptic seizure. Each has itsstrengths and weaknesses, but all aim tohelp us detect seizures early and improve people's lives.

REFERENCES:

1. Amin, H.U.; Yusoff, M.Z.; Ahmad,
2. R.F. A novel approach based on wavelet analysis and arithmetic coding for automated detection and diagnosis of epileptic seizure in EEG signals using machine learning techniques. Biomed. Signal Process. Control 2020,56, 101707. [CrossRef]
3. Sharmila, A.; Geethanjali, P. A review on the pattern detection methods for epilepsy seizure detection from EEG signals. Biomed. Eng. Biomed. Tech. 2019, 64, 507–517.
4. Harpal, V.; Bairagi, V. An adaptive method for feature selection and extraction for classification of epileptic EEG signal in significant states. J. King Saud Univ.-Compute. Inf. Sci.2021, 33, 668–676
5. Acharya, U.R.; Hagiwara, Y.; Adeli, H.Automated seizure prediction. Epilepsy Behav. 2018, 88, 251–261. [CrossRef]
6. Orhan, U.; Hekim, M.; Ozer, M. EEG signals classification using the K-means clustering and a multilayer perceptron neural network model. Expert Syst. Appl. 2011, 38, 13475– 13481
7. Naderi, M.A.; Mahdavi - Nasab, H. Analysis and classification of EEG signals using spectral analysis and recurrent neural networks. In Proceedings of the 2010 17th Iranian Conference of BiomedicalEngineering (ICBME),Isfahan, Iran, 3–4 November 2010; pp. 3–4
8. Kumar, Y.; Dewal, M.; Anand, R. Epileptic seizure detection using DWT based fuzzy approximate entropy and support vector machine. Neurocomputing 2014, 133, 271–279.