2022 IEEE 4th PhD Colloquium on Emerging Domain Innovation and Technology for Society (PhD EDITS) | 978-1-6654-6143-6/22/$31.00 ©2022 IEEE | DOI: 10.1109/PhDEDITS56681.2022.9955308

DAAL: A Deep Aggregated Assemble Learning Model for detecting Epileptic patients from EEG

Sricheta Parui
IIT Kharagpur
India
srichetap.iitkgp@ieee.org

Uttam Ghosh
Meharry Sch. of Applied Computational Sc., USA
ghosh.uttam@ieee.org

Puspita Chatterjee
Tennessee State University, USA
pushpita.c@gmail.com

Deborsi Basu
IIT Kharagpur
India
d.basu@ieee.org

***Abstract*—In this study, we developed a Deep Aggregated Assemble Learning(DAAL) model to diagnose Epilepsy that uses two-step learning and generates the final prediction utilizing the output predictions of the level 0 classifier model. In level 0 CNN, RNN and ANN model has been used, and then a prediction algorithm has been used which predicts the final output from each of the probability vector coming from each model.**

***Index Terms*—Epilepsy, Neural Network, CNN, RNN, ANN, EEG**

I. Introduction

Epilepsy [1] is an abnormal brain activity that affects many different populations. The brain's electrical signals get jumbled with epilepsy, and electrical activity can occasionally burst out suddenly. The most crucial method for diagnosing epilepsy is the detection and identification of EEG signals [2].

II. Research Area

Choosing the appropriate feature extraction algorithms for seizure diagnosis in classical ML is a very challenging task that requires in-depth knowledge of signal processing and AI areas. Recently, DL-based methods for neurological illness diagnosis using EEG data have been developed to get around this problem. Till now various ML and DL technique has been introduced to detect seizure but there is still room for improvement due to the nonstationary characteristic of EEG signal.

III. Related Work and Objectives

To date, many machine learning model [3]–[6] has been proposed to understand the nature of the brain and predict the disorder from the EEG signal [7]. Encouraged by this, a distinct methodological approach from research in the literature [8] that is of a similar type was used in this work to build a very accurate model for automatically differentiating the two classes of EEG data. The primary goal of this research is to create a deep learning model with neural networks that are optimized for classifying epileptic patients and healthy controls.

IV. Dataset

We tested our approach using a collection of publicly accessible data on epileptic seizure detection [9].

V. Methodology

This article presents a proposal for a technique that uses explainable neural deep learning aggregated assembly to classify epileptic patients and healthy controls. Multiple basic neural network models that carry out the same classification job are combined in the aggregated assemble framework, which uses the transfer learning idea. Utilizing these predictions from all of the foundation models, a new model is known as a meta-learner creates its own prediction(Fig 2).

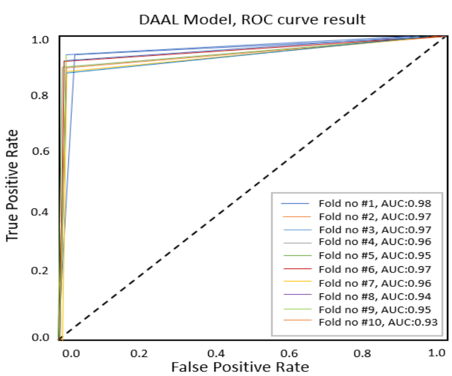

Fig. 1. ROC Curve of the DAAL model

VI. Experiment

The experiment was carried out by splitting the dataset into a 90:10 ratio. The first subset is used as a training dataset and the rest of the dataset is used as a validation set. To avoid the overfitting situation within the frame of k-fold cross validation 90% of the training dataset is used for training and 10 % of the training subset is picked as a validation set.

VII. Results and Analysis

The model results are depicted in Table 1 and Table 2 and a comparison has been done between the DNN model and our proposed DAAL model. The ROC curve results are shown in Fig. 2. Interictal and ictal signal classification produced positive results, with average accuracy, sensitivity, and specificity values of 92.4, 96.9, and 94.36 percent, respectively.

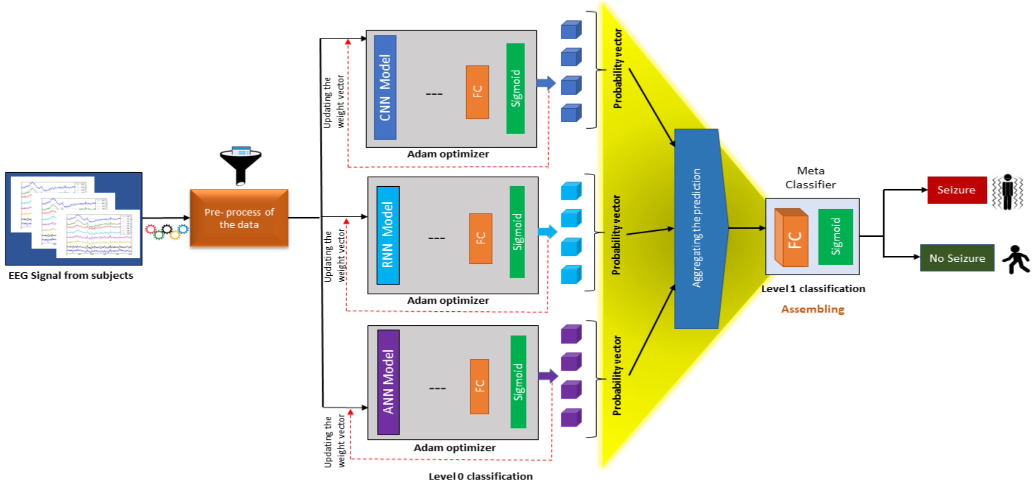

Fig. 2. Overview of the Aggregated Assemble Deep Learning method

TABLE I
CONFUSION MATRIX FOR THE DNN MODEL WITH 10 FOLD CROSS VALIDATION ALONG WITH MEAN VALUE

Confusion Matrix		**No of Fold**										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
Validation Dataset	Accuracy	95.26%	92.57%	92.95%	93.54%	86.14%	93.14%	92.45%	92.54%	94.68%	94.45%	91.26%
	Sensitivity	75.24%	71.59%	70.49%	81.75%	71.56%	76.42%	71.36%	77.63%	74.65%	76.56%	72.65%
	Specificity	99.15%	98.20%	99.32%	97.56%	94.63%	87.36%	98.88%	98.54%	98.56%	97.36%	96.65%
Test Dataset	Accuracy	96.36%	93.2%	91.56%	93.45%	84.23%	95.36%	94.21%	94.36%	94.66%	91.69%	91.44%
	Sensitivity	81.35%	72.36%	71.26%	79.36%	97.36%	85.23%	74.36%	70.69%	70.69%	74.60%	74.56%
	Specificity	99.05%	99.36%	99.21%	98.24%	99.58%	99.35%	99.41%	97.24%	97.25%	95.36%	98.23%

TABLE II
CONFUSION MATRIX FOR THE PROPOSED DAAL MODEL WITH 10 FOLD CROSS VALIDATION ALONG WITH MEAN VALUE

Confusion Matrix		**No of Fold**										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
Validation Dataset	Accuracy	97.6%	97.58%	97.28%	97.41%	96.84%	97.56%	97.53%	97.12%	97.44%	96.14%	97.21%
	Sensitivity	92.85%	91.25%	94.23%	96.5%	96.32%	95.3%	91.46%	91.85%	91.42%	94.63%	93.56%
	Specificity	94.36%	97.23%	98.52%	99.65%	98.63%	99.65%	96.58%	98.45%	99.64%	94.65%	96.45%
Test Dataset	Accuracy	95.65%	93.56%	96.65%	95.65%	93.56%	95.68%	96.64%	96.65%	96.64%	95.35%	96.45%
	Sensitivity	99.35%	98.56%	97.63%	98.36%	99.35%	98.36%	94.66%	99.65%	99.64%	99.42%	98.66%
	Specificity	92.36%	93.45%	94.36%	98.23%	95.36%	98.69%	99.36%	99.36%	98.65%	99.65%	98.64%

VIII. Conclusion

Moreover, the proposed Deep Aggregated Assemble Learning model(DAAL) provides better performance i.e. above 90 percent than 2D CNN or any combination of Deep learning models. By merging a DAAL model and other expert systems, further research on the categorization of multi-class epileptic seizures may be expanded.

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