EEG-BASED AUTOMATED MENTAL DISORDER DETECTION USING ARTIFICIAL INTELLIGENCE

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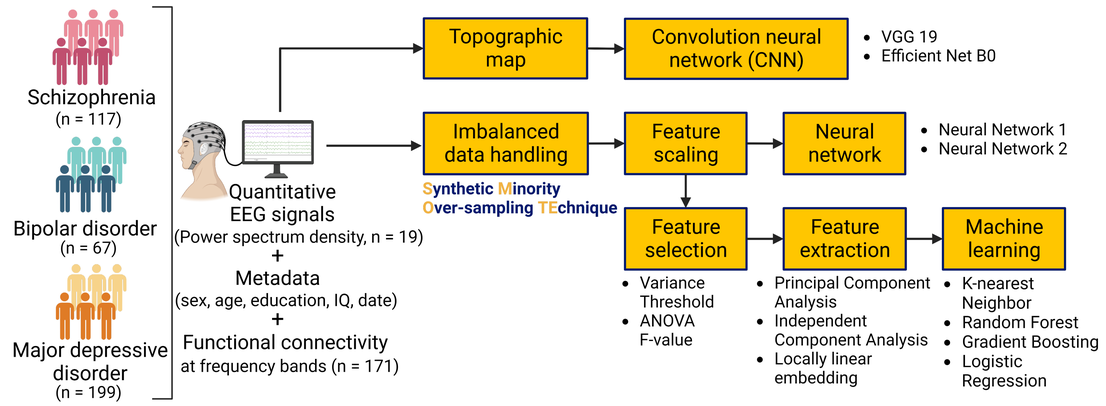
INTRODUCTION

In recent times, mental disorders have become a global concern, affecting millions worldwide. Improving the accuracy of diagnosing conditions like schizophrenia, bipolar disorder, and major depressive disorder is therefore important since overlapping symptoms can be overlooked by traditional diagnostic methods. This study aims to develop a novel diagnostic method by integrating electroencephalogram (EEG) signals and artificial intelligence to enable multi-class classification, thereby improving the well-beings of those with these complex conditions.

MATERIALS AND METHODS



RESULTS

1 Both VGG 19 and Efficient Net B0 are not sufficient for diagnosis

Table 1. *The classification accuracy of VGG19 and Efficient Net B0 in PSD topographical maps at each frequency band*

	Configures	Frequency Band	Accuracy
VGG 19	Epochs = 50 Learning rate = 0.001 Batch size = 32 Optimizer = Adam	Delta	0.55
		Theta	0.55
		Alpha	0.45
		Beta	0.55
		High beta	0.55
		Gamma	0.55
Efficient Net B0	Epochs = 5 Learning rate = 0.1 Batch size = 32 Optimizer = Adam	Delta	0.55
		Theta	0.45
		Alpha	0.50
		Beta	0.48
		High beta	0.56
		Gamma	0.44

2 Neural network 2 yielded better results than neural network 1

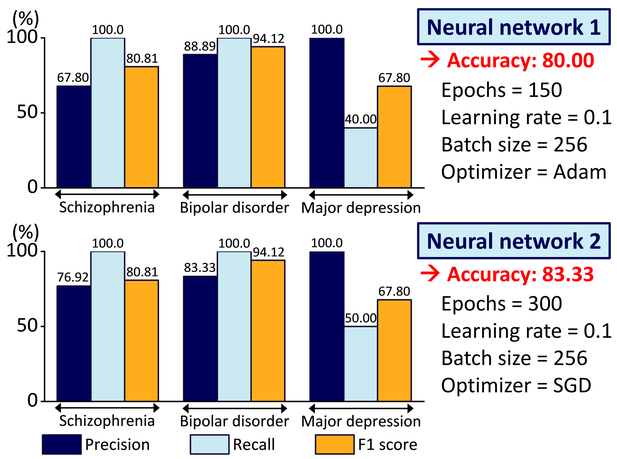


Figure 1. *Hyper-parameters and results of (a) neural network 1 and (b) neural network 2*

3 Combining dimensional reduction and fine-tuning improved classifier performance

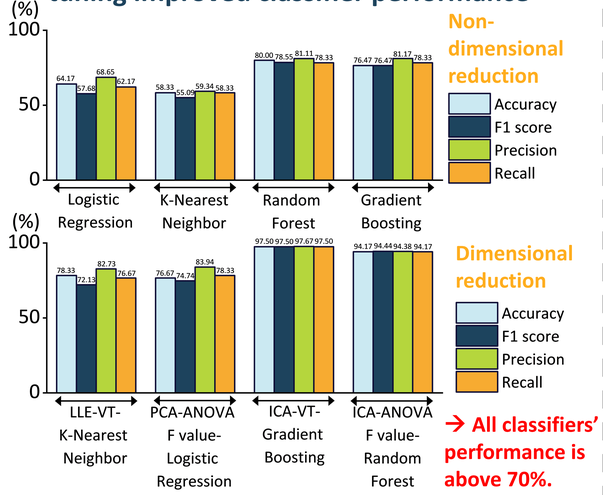


Figure 2. *Machine Learning models (a) without and (b) with dimensional reduction techniques*

4 Independent Component Analysis – Variance Threshold – Gradient Boosting showed the best overall performance

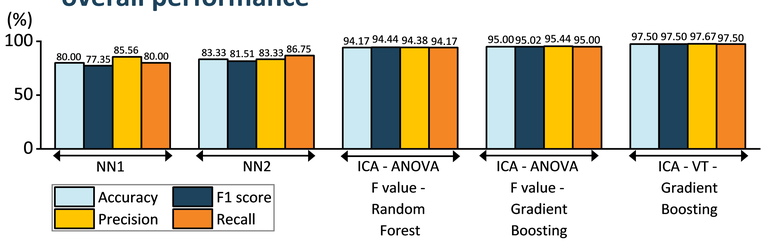


Figure 3. *The summary of the five high-performance pipeline of each proposed classifier*

Table 2. *The classification report of the ICA-VT -Gradient Boosting pipeline*

	Precision	Recall	F1 score
Schizophrenia	93.02	100.0	96.38
Bipolar disorder	100.0	92.50	96.10
Major depression	100.0	100.0	100.0
Macro average	97.67	97.50	97.50
Accuracy		**97.50**	

Machine learning demonstrates greater accuracy (up to 90%) compared to neural network models (only around 80%)

→ **The combination of ICA-VT-Gradient Boosting showed the highest performance, with bipolar disorder class having 100% of precision, recall, and F1 score**

The ICA-ANOVA-Gradient Boosting and ICA-ANOVA-Random Forest achieve the same examined metrics, yet the misdiagnosis rate reported in the confusion matrix slightly differs.

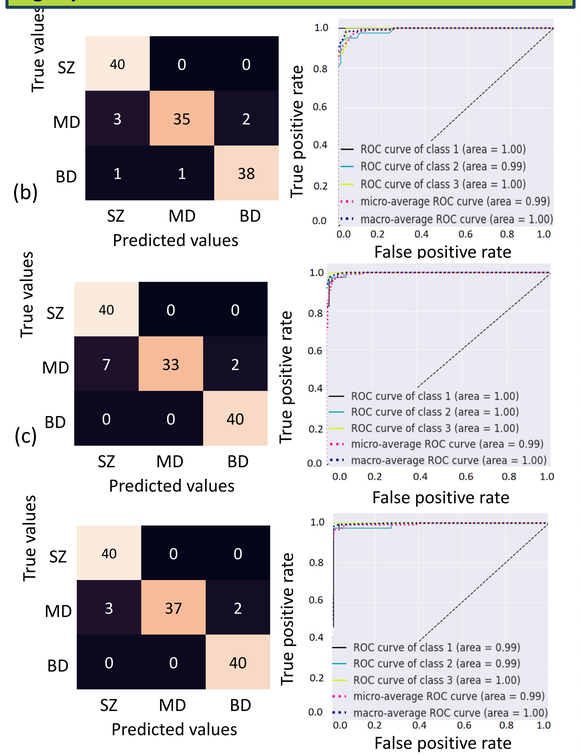


Figure 4. *Confusion matrix and receiver operating characteristic (ROC) curve of (a) the ICA-ANOVA-Random Forest pipeline, (b) ICA-ANOVA-Gradient Boosting pipeline, and (c) ICA-VT-Gradient Boosting pipeline*

→ **The ICA-VT-Gradient Boosting has the lowest mislabeling in the confusion matrix, with only four major depressive disorder patients misdiagnosed as schizophrenia**

FUTURE WORK

- Exploring alternative techniques for addressing data imbalance, optimizing feature selection, and further refining the integration of EEGs signals and AI for multi-class psychiatric classification
- Expanding the application of AI in diagnosing a wider range of psychiatric disorders in future research

CONCLUSIONS

- SMOTE effectively counteracts data imbalance through synthetic samples.
- The assessment of VGG 19 and Efficient Net B0 models highlights their limitations in accurate diagnosis.
- Neural network 2 surpasses neural network 1, except for the precision of bipolar disorder class, signifying progress in diagnostic potential.
- Integrating dimensional reduction and fine-tuning techniques yields improved classifier performance.
- Gradient Boosting and Random Forest are the two best classifiers across all criteria.
- ICA-VT-Gradient Boosting is found as the most effective combined approach, with lowest mislabeling and misdiagnosis rate.

References

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