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A STUDY OF MACHINE LEARNING TECHNIQUES ON BIPOLAR DISORDER

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ABSTRACT
Bipolar disorder is considered as one of the major mental health disorder by which people are suffered of this illness throughout the world. Various types of machine learning techniques are applied and implemented in order to detect bipolar disorder. Machine learning algorithms were applied not only for detection but also to diagnose, to predict and to provide remedies to many different type of diseases related to mental and physical illness. In this paper, the analysis of various articles where the machine learning algorithms are used in the detection of bipolar disorder. This study has been done with the needy of google search by analysing the terms such as “machine learning” and “bipolar disorder”. These words are highly utilzed to achieve this study.
Keywords: Bipolar disorder, Machine Learning, Detection and Prediction, Diseases.

INTRODUCTION
The detection of bipolar disorder using machine learning algorithms is a successful ongoing techniques used and applied for the benefit and welfare of the patients and to the society. This papers furnishes the data related to the articles such as algorithmic studies, comparative analysis, multimodal modalities, papers on wearable sensor devices such as watches, smartphones and so on. The primary concept of this paper is to analyze various machine learning techniques deals with bipolar disorder.

SURVEY ON VARIOUS MACHINE LEARNING TECHNIQUES
According to Benson Mwangi., Mon-Ju Shanghai dialect, et al., 2016[1] found that the structural neuroimaging scans paired with machine learning algorithms can able to differentiate individual bipolar disorder patients from Healthy individuals in a very massive cohort of 256 individuals. The bipolar disorder patients are of 128 whereas healthy controls are of 128 as classified from neuroimaging scan system. Thus the RVM rule varied the bipolar patients from healthy controls and additionally foretold accuracy of 70.3 percentage of accuracy by means of white matter density and 64.9 percentage of accuracy by means of grey matter density.
Karthick., 2019[2] proposed a Rank based Gene Biomarker Identification and Classification framework to rectify the overlapping and non-overlapping gene patterns of bipolar disorder and schizophrenia. As a result, 47 biomarkers were identified as duplicated genes. The performance of the proposed system is evaluated using a pre-built machine learning algorithm.

This proposed work uses the Deep Neural Community model to have accuracies of 97.01% and 95.65% on the bipolar disorder and schizophrenia datasets, outperforming other benchmarks his algorithm and its performance is shown.

The Author Ceccarelli, 2021[3] presents a framework for audio, video, and text modalities. Audio and video modalities are encoded with bidirectional LSTM models, and text modalities are encoded with paragraph vectors. Adaptive nonlinear Judge Classifier Neural Networks (NNs) for multimodal fusion are said to provide much better results compared to simple aggregation methods such as average voting or majority voting. With 0.858 accuracy, 0.883 recall, 0.867 accuracy, and 0.870 F1 score, this NN outperforms other fusion approaches on all metrics.

PJC Suen et al., 2021[4] designed two classification models, a logistic regression model using the elastic net method and an XGBoost machine learning model. A total of 155 patients with MDD or BD were included in the study, so both algorithms performed well with AUCs of 0.84 and 0.80, with balanced accuracy values of 72% and 76%, respectively.

Cooper et al., 2021[5] discussed about the evaluation of PLANN (Partial Logistic Artificial Neural Network). This is a useful step in investigating the use of neural networks as tools for diagnosing at-risk individuals and demonstrates the potential of neural networks in this area. PLANN performed better than traditional discrete-time survival models in predicting the development of severe mood disorders in high-risk individuals.

A study by M. B. Fonseca et al., 2018[6] found 92% accuracy when comparing BD patients with healthy individuals and 93% accuracy when comparing SZ with healthy individuals. These 18 findings distinguish patients with bipolar disorder from those with schizophrenia with her 92% accuracy.

The authors HO Sonkurt et al., 2020[7] presents a Prediction Algorithm for Highly Accurate Separation of Bipolar Disorder and Healthy Subjects of about 78% by using CANTAB (Cambridge Neuropsychological Test Automated Battery) neurocognitive battery and LASSO algorithm, also measures cognitive functions with high sensitivity, specificity and objectivity.

The Peerbasha's article "A Predictive Model to Identify possiblely built Bipolar Disorder Students Using Naive Baye's, Random Forest and SVM Machine Learning Techniques of Data Mining and Building a Sequential Deep Learning Model Using Keras" (2020) [8] shows this. I'm here. The support vector machine classifier achieves the highest classification accuracy compared to the naive bay and random forest classifiers. A sequential deep learning model was used to predict a student with bipolar disorder and was found to be 99% accurate.

A new neural network model based on radial basis functions uses a fuzzy averaging algorithm to classify patients with bipolar disorder. This method proves the highest accuracy of 97% and also has high recall, precision, and F1 scores, higher than those achieved by other traditional methods such as decision trees. [9] Therefore, the proposed function-based radial neural network could be a complementary tool to help healthcare workers diagnose brain injuries such as bipolar disorder.

The authors, 2019 [10], used a capsule neural network (CapsNet) to classify patients suffering from BD after a manic episode into three language-based classes: remission, hypomania, and mania. CapsNet Framework achieves competitive results with UAR of 46.2% and 45.5% in the development and test sections, respectively.

N. Abaeikopaei 2021[11].The purpose of this study was to use a dataset that uses the Young Mania Recall Scale to distinguish manic states in patients as mania, hypomania, and remission, and to evaluate bipolar It was to classify the condition of individuals with disabilities. The dataset contains audiovisual recordings of patients with bipolar disorder undergoing structured interviews. When developing semi-supervised models, manual annotation uses expensive and time-consuming training data. Informative audio, visual, and text features of recordings for implementation of multi-model mania classifiers. The proposed model achieved a UAR of 53.7% and a UAR of 60.0% on the test and trial sets, respectively.

The Author Jadhav. 2019 uses the machine learning algorithms in this article to search for bipolar disorder using the Mood Disorder Questionnaire (MDQ) and a decision tree algorithm. The dataset is fed to a 1-decision tree classifier that determines the significant features in the dataset and makes decisions at this level of the decision tree with 88.07% accuracy. [12].

M.-J. Wu et al. [13], a total of 21 normal his BD patients and his 21 demographically matched his HC patients were included in his study. Participants performed the computer-based Cambridge Neurocognitive Test Automated Battery (CANTAB) to assess cognitive performance. We implemented a machine learning algorithm using 19 least absolute contraction selection operators (LASSO) to identify neurocognitive signatures that distinguish individual BD patients from HC. Therefore, the receiver performance curve determined with 71% accuracy in <10 regions is 0.7143, significant at p=0.0053.

Liu et al., 2022[14], the multimodal classifier showed superior performance compared to all five individual modalities, 100% in major depression compared to healthy controls, and 100% in healthy controls. 100% compared with bipolar disorder. %, 98.5% for major depressive disorder vs. 100% for bipolar disorder. Therefore, a balanced accuracy of 73.65% is achieved, with a sensitivity of 74.32% for BD and a specificity of 72.97% for MDD.

B. Vai, L. Parenti, and I. Bollettini et al., 2019 [15] reported structural neuroimaging techniques used in multiple kernel learning methods (i.e., 26 tract-based spatial statistics, TBSS, and voxel based morphometrics) were integrated. To define predictive functions for BD and MDD diagnoses in a sample of 148 patients. Thus, a balanced accuracy of 73.65% was achieved with a sensitivity of 74.32% for BD and a specificity for MDD of 72.97%.

Li-Chung Chuang & Po-HsiuKuo., 2017[16] identified informative genetic markers to differentiate BPD from healthy controls with acceptable discrimination in a validation data set. In this study, used two genome-wide large-scale association data sets (GWAs) to generate a genetic risk model using a machine learning approach for bipolar disorder (BPD). The BPD's GWA data set from the Genetic Association Information Network was used as training data for model building, and the GWA data from STEP (Systematic Treatment Improvement Program) was used as a validation data set used. 0.289 candidate markers were well identified and random forests were selected. The area under the receiver operating curve is 0.944 (0.935–0.953) for the training data set and 0.702 (0.681–0.723) for the STEP data set. At the threshold of 184 His score, the sensitivity and specificity of BPD were 0.777 and 0, respectively.

Tomasik J et al., 2021. [17] presents a study developing a diagnostic algorithm based on online mental health questionnaire and blood biomarker data to identify BD patients among newly diagnosed MDD patients. The trained model achieved an average AUROC test of 0.92 with an average accuracy of 0.83.

Niloufar Abaei and Hussein Al Osman., 2020[18], The authors' aim was to classify the condition of BD patients into clinically significant stages (remission, hypomania, and mania). A convolutional neural network (CNN) model is applied to extract facial features from a video signal, and the feature set is passed into a long short-term memory model (LSTM) to resolve BD constraints.

R. Achalia, et al., 2020 [19] applied SVM, a supervised machine learning method, and concluded that it discriminated between patients and healthy subjects in 10 studies using k-fold cross-validation. The composite biomarker by imaging and neuropsychological measures had an accuracy of 87.60%, a sensitivity of 82.3%, and a specificity of 92.7%.

U. Cote-Allard., 2021[20] in this article, examines the detection of bipolar mania-normal state using data collected from wrist-worn sensors. Using actigraphy and her HRV data combined with the TSD-BCV, the LSVM classifier scored 81.54% ± were able to achieve an average accuracy of 32.39%. Moreover, a new ensemble method consisting of short and long networks was able to achieve an average accuracy of 91.59% ± 22.02% on the same data set using actigraphy and electrodermal activity data. . This clearly demonstrates the advantage of a multisensory approach for detecting bipolar conditions.

Yashashwini., 2022[21] developed a new neural network model to predict the accurate status of bipolar disorder in patients by determining appropriate characteristic descriptors based on subjective observations and clinical rating scales., Predict bipolar disorder in terms of episodic and temporal data and process both episodic and temporal data using a recurrent decision tree neural network. Therefore, the proposed neural decision tree system provides better performance than conventional decision trees.

LS ROTENBERG., 2021[22] studies about the ML algorithms (Support Vector Machines, Random Forest, Naive Bayes, and Multilayer Perceptron) showed reasonable performance on the prediction task, with F values ranging from 61 to 80%. The random forest algorithm yielded higher average performance. (68% relapsed vs. 74% non-relapsed). Their results suggest that applying machine learning-based precision medicine models to BD research could be a viable an approach to better support medical decision-making in treating bipolar disorder and preventing future relapses.

In this article, Huang et al., 2020[23] presented an approach to study mood disorders in relation to patterns present in the emotions of affected people. Thus introduced LASM (Latent Effective Model) to find out people's emotional connections, used six videos to show the disability. These videos were recorded emotional videos. The proposed class-specific LASM-based method achieved an accuracy of 73.33% in detecting mood disorders, outperforming SVM and LSTM-based classifiers.

Qiu Sun et al., 2019[24], the score of the proposed class-specific LASM-based method was 73.33% accuracy in detecting mood disorders, outperforming SVM and LSTM-based classifiers. The model can obtain the highest accuracy of 79%.

The author sujatha., 2021 [25] developed a model to detect more accurate, lower-cost bipolar disease shown to provide more accurate results using CNN's Multi-Modal Disease Risk Prediction (MDRP) algorithm and Random Forest Classification. The prediction accuracy of this CNN MDRP algorithm is up to 94% compared to other prediction algorithms such as decision tree, SVM and linear SVM. The methodology obtained here are voxel-based morphometry (VBM) for segmenting and preprocessing the obtained MRI information and

separately checking for gray matter (GM) and white matter (WM) changes in different data groups, the Principle Component Analysis (PCA) was applied.

G. Parker et al.,2021[26] aims to improve the accuracy of diagnosis of bipolar disorder by identifying symptoms to distinguish bipolar mania or hypomania from normal "healthy" unipolar disorder depressed patients. For a specific class, the proposed LASM-based method is 73.33% accuracy in detecting mood disorders, outperforming SVM and LSTM-based classifiers.

The proposed method of W Jiji., 2022 [27] is a supervised learning framework focused on detecting bipolar disorder (BD) using structural magnetic resonance imaging. The work is based on the newly developed 3D SIFT (scale-invariant feature transform) and 3D SURF (speeded up robust features) feature vectors with pattern recognition techniques to integrate neuroimaging biomarkers of BD. In this method, we combine or splice two newly developed feature vector and PCA kernels for projecting feature vectors. The diagnostic process is performed by Random Forest. Results show that this method has the potential to identify BDs with an average accuracy of 77.77%. This study demonstrates that neuroimaging studies can help differentiate BD from healthy controls.

Kour., 2022 [28] has proposed the model, it is a hybrid of two deep learning architectures: Convolutional Neural Networks (CNNs) and Bidirectional Long-Term Memory (biLSTMs) achieved 94.28% accuracy on a reference depression dataset using post-optimization tweet data. Increase. CNN-biLSTM models are compared to recurrent neural networks (RNNs) and CNN models. Experimental results based on various performance metrics show that the model can help improve prediction performance.

Z.li et al., 2021[29], A deep learning-based method for automatic detection of first-episode psychosis (FEP), bipolar disorder (BD), and healthy controls (HC). The convolutional neural network (CNN) structure development data set for sMRI (Structural Magnetic Functional Imaging)-based automatic diagnosis consists of 89 FEP patients, 40 BD patients, and 83 HC patients. Three-way classifier (FEP vs. BD vs. HC) and three binary classifiers (FEP vs BD, FEP vs HC, and BD vs HC) are trained on gray matter volume images. 17 Experimental results show that CNN-based methods outperform conventional classifiers on both two- and three-category classification problems. This study demonstrates that abnormal gray matter is one of the key features distinguishing her FEP, BD and HC.

Sotos et al., 2021 [30] proposes an extreme gradient gain (XGB) machine learning (ML) method using EEG signals. Four supervised learning algorithms, including KNN (K-Nearest Neighbor), DT (Decision Tree), GNB (Gaussian Naive Bayes), and SVM (Support Vector Machine), were compared with the proposed XGB method. 10x cross-validation process used for testing process. Results show that 15XGB has better prediction accuracy (94%), higher accuracy (>0.94>0.94) and higher recall (>0.94>0.94). These results indicate that an XGB system trained on clinical data could be a new tool to help diagnose patients with bipolar disorder.

Following table refers to the reviewed papers

S.NO.	AUTHOR DETAILS	TYPE OF DATA	YEAR and ID	PROPOSED MODEL	ACCURACY	PERFORMANCE METRICS
1.	Mwangi et al.	Neuroimaging data	2016[1]	RVM rule	61% - 87%.	Sensitivity, Specificity and Chi-Square
2.	M.-J. Wu et al	Neurocognitive Test data	2016[13]	The least absolute shrinkage selection operator (LASSO) machine learning algorithm	71%	Sensitivity, Specificity, AUC and threshold
3.	Li-ChungChuang & Po-HsiuKuo.	Genetic Association Information Network (GAIN) and Systematic treatment Enhancement Program (STEP),	2017[16]	The random forest (RF) ensemble-based machine learning method	0.852	Sensitivity, Specificity. AUROC
4.	M. B. Fonseca et al.	Neuropathology Data	2018[6]	Artificial Neural Network	92%	Sensitivity, Specificity And F1 score
5.	Karthick.	Gene Biomarker	2019[2]	Deep Neural Network	97.01%	Precision, Recall, F-Score
6.	Shahin et al.	Audio/Visual Emotional study-	2019 [10]	Capsule Neural Network (CapsNet)	-	UAR of 46.2% and 45.5% and Confusion matrix
7.	Jadhav	Mood Disorder Questionnaire (MDQ)	2019[12].	Decision Tree Classifier-CART Algorithm	88.07%	Confusion matrix
8.	Qiu Sun et al.	Genetic Data	2019[24]	Convolutional Neural Network	79%	Precision, Recall and F1-score
9.	B. Vai, L. Parenti and I. Bollettini et al.,	Structural Neuroimaging Data	2019 [15]	Multivariate Pattern Analyses Using Multiple Kernel Learning	73.65%	Specificity and Sensitivity
10.	HO Sonkurt et al.	Computational Neurocognitive Functional Data	2020[7]	CANTAB(Cambridge Neuropsychological Test Automated Battery)	78%	Specificity, Sensitivity, AUC and F1 score
11.	Peerbasha	Computerized Strategical Students Study	2020[8]	Sequential Deep Learning Model	99%.	Confusion Matrix
12.	Huang et al.	Audio Visual Modalities	2020[23]	LASM	73.33	recall, precision, and *F*1 score
13.	Niloufar Abaei and Hussein Al Osman.	Audio/Visual Emotion Challenges and Workshops (AVEC)	2020[18]	Convolutional Neural Network (CNN) model	63.32	UAR, Sensitivity and Specificity
14.	R. Achalia, et al.	Neuroimaging And Neuropsycholog -Gical Data	2020 [19]	Supervised Machine Learning Technique	87.60 %	Sensitivity and specificity
15.	Ceccarelli.	Multimodal data	2021[3]	The adaptive nonlinear judge classifier neural network (NN)	0.858	Recall, Precision, And *F*1 Score.
16.	P.J.C. Suen et al.	Transcranial Direct Current Stimulation (tDCS) clinical data	2021[4]	A Machine Learning Xgboost Model.	76%	Sensitivity, Specificity, PPV, NPV and AUC
17.	Tomasik J et al.	Online Mental Health Questionnaire	2021.[17]	The diagnostic algorithm(Extreme Gradient Boosting and nested cross-validation)	0.83	AUPRC. AUROC , PPV, PNV, Specificity, and Sensitivity
18.	U Cote-Allard	Leveraging Actigraphy And Electrodermal Activity Data.	2021[20]	Deep Learning-Based New Ensemble Method	91.59%	YMRS and MADRS used
19.	Sujatha.	MRI data	2021 [25]	CNN-MDRP algorithm	94%	Precision, Sensitivity and Specificity
20.	G. Parker et al.	Clinical data	2021[26]	Prediction Rule Ensembles (PREs)(Random Forest And Decision Tree)	98.2%	Sensitivity and Specificity

21	Rotenberg et al	Clinical data	2021[22]	Support Vector Machines, Random Forests, Naïve Bayes, and Multilayer Perceptron	-	F-Measure
22	Cooper et al.	High-Risk Offspring of Bipolar Parents study	2021[5]	PLANN(Partial Logistic Artificial Neural Network)	0.601-0.751	Specificity, Sensitivity, PPV and Average AUC is 0.74
23	N AbaeiKoupaei	Multimodal data	2021[11]	semi-supervised model	-	53.7% UAR and 60.0% UAR
24	Lujan et al.	EEG recordings	2022[9]	Radial Basis Function-Based Neural Network	97%	Recall, Precision, And F1 Score
25	Liu et al.	Neuroimaging And Demographic Data	2022[14]	SVM-RFE	92.1%	ROC curves and AUC curve
26	Yashashwini et al.	Clinical data	2022[21]	Novel Neural Network Model Based On Neural Decision Tree	-	MADRS score, R2 score, MSE score, RMSE score and MAE score
27	Kour et al.	Twitter dataset	2022 [28]	CNN-biLSTM model	94.28%	DT, Logistic Regression (LR), SVM, XGBoost, and RF
28	W Jiji et al.	Structural Magnetic Resonance Imaging Data	2022 [27]	Pattern Recognition Techniques	77.77%.	Equal Error Rate (EER)
29	Z.li et al.	Neurological data	2021[29]	CNN	Around 96%	Precision, Recall and F1-score
30	Sotos et al.	EEG records	2021[30]	XGB and ML method ((KNN), (DT), (GNB) and (SVM))	94%	Precision And Recall

Table. Review table

[Abbreviations : ML-Machine Learning, EEG - Electroencephalogram Records, AUPRC- Area Under Precision-Recall Curve, AUROC-Area Under Receiver Operating Characteristic Curve, NPV -Negative Predictive Value, PPV-Positive Predictive Value, SVM-Supervised Machine Learning Technique, SVM-RFE-Support Vector Machine Recursive Feature Elimination, CNN-MDRP-Multimodal Disease Risk Prediction , BCV-The Bipolar Complexity-Variability, TSD-Temporal-Spatial Descriptors, Act- Actigraphy, EDA-Electrodermal Activity, HR-Heart Rate, HRV-Heart Rate Variability, YMRS-Young Mania Rating Scale, MADRS -Montgomery Asberg Depression Rating Scale, KNN -K-nearest Neighbors, DT - Decision Tree, GNB - Gaussian Naïve Bayes, SVM -Support Vector Machine, XGB - Extreme Gradient Boosting, CNN- Convolutional Neural Network, biLSTM - bi-directional Long Short-Term Memory, UAR -Unweighted Average Recall, UPR- Unweighted Predicted Recall, LASM-Latent Effective model, R2 score- R Squared, MSE -Mean Squared Error, RMSE- Root Mean Squared Error, MAE- Mean Absolute Error, AUC-Area Under Curve]

CONCLUSION

Bipolar disorder is essentially a mental illness. This type of disability presents life-threatening difficulties. The importance of machine learning techniques in the medical field has been recognized, and steps are being taken to apply related techniques to disease prediction. Various research work done by different researchers and some effective techniques have been studied. This study provides an overview of different approaches 17 to detect and even predict failures. This paper provides an overview of various mining techniques proposed by researchers to improve the lives of those affected. Furthermore, this paper provides a marginal overview of existing research.

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