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Performance Analysis of Machine Learning Techniques to Predict Mental Health Disorders in Children

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Abstract: Mental disorders are quite common in children. The commonly found childhood mental disorders are anxiety disorders; depression and attention deficit disorder. Diagnosis of these problems at early stage helps the professionals in treating it at beginning stage and to improve the patient's health. Therefore the need to treat common mental health disorders that are found in children which lead to complicated problems, if ignored at early stage. Machine learning Techniques can be applied for analyzing patient's history to diagnose the problem. In this research three machine learning techniques have been identified and compared based on their performances on several scales of accuracy on selected attributes to diagnose five basic mental health disorders. The basic aim is to find the technique which is most accurate. The data set is containing sixty attributes for analyzing and measuring the performance of techniques. Ignoring the irrelevant attributes that do not have much effect, twenty-five attributes were found as important to diagnose the disorder. Applying Feature Selection algorithms on the attribute set, thirteen attributes were found. Accuracy of the selected attribute set on three machine learning techniques were compared viz., Multilayer Perception, LAD Tree and Multiclass Classifier. It is clear by the results that the Multiclass classifier produces much accurate results on set of selected attributes.

Keywords: Mental health disorders, Machine learning techniques, Selected attributes, Feature selection methods, Early diagnosis.

I. INTRODUCTION

Mental disorders are increasing at high pace in the world. As per WHO, one among four people in the world will be affected by mental or neurological disorders at some point of time in their life. Mental disorders are going to be second leading cause of global disease burden by year 2020, lagging behind ischemic heart illness but leading all the other diseases [1]. The increase in the number of professionals who treat the mental illness is very less as compared to the growth in number of people who are suffering from mental problems. Mental health diagnoses involve steps like specially designed interviews about symptoms and medical data and sometimes physical examination of the patient. Several psychological tests may also be conducted to make sure the symptoms are due of mental health problems and not because of any other disease.

Similarity in the symptoms of several mental health disorders has made diagnosis complicated task. Diagnoses of mental health problems in children are far more difficult than diagnosing them in adults. Therefore one needs to be careful to diagnose the mental health disorders with accuracy.

Artificial Intelligence uses lot of machine learning techniques that help in copying the human reasoning or in making logical decisions. Some methods can even work upon uncertain or partial information, using concepts of probability, pattern matching and other fields. Ms. Sumathi MR and Dr. B Poorna [2-6] compared eight machine learning techniques; RBF Network, IB1, KStar, AODEsr, Multi-Layer Perceptron, Multi-Class Classifier, FT, LAD Tree. Out of them they found Multiclass Classifier, Multilayer Perception and LAD Tree are better in accuracy than other Techniques.

In this research one machine learning technique was identified that diagnosed mental health problems correctly over a sample data set of three cases. Three machine-learning techniques have been compared and identified the one which can be used to help mental health professionals to diagnose mental health disorders. The five main mental health

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disorders in children are Anxiety Problem, Attention Deficit Hyperactivity Disorder, and Attention problem, Academic Problem and Pervasive Developmental Disorder (PDD) have been taken in consideration. The symptoms, factors involved and test results observed by the professionals are fed as input to techniques and the psychological disorder diagnosed received as the output.

II. LITERATURE SURVEY

The Research in developing machine learning for mental health diagnosis has started back in 1980s. DTREE [2], an expert system, helps in diagnosing DSM-IV Axis I disorders by the use of Decision Tree. Yap RH and Clarke DM [4] have developed an expert system 'Monash Interview for Liaison Psychiatry' using constraint-based reasoning for systematic diagnoses of mental disorders based on DSM-III-R, DSM-IV and ICD-10. Constraint Logic Programming (CLP) language was applied for the development of the system. Kipli et al. [3] introduced latest approaches for the classification and Data-mining of mental problems by using Brain Imaging data.

Masri RY and Jani HM [5] offered the mental health Diagnostic Expert System for the assistance of psychologists to diagnose and treat their mental patients. Three artificial techniques viz., Fuzzy Logic, Rule-Based Reasoning and Fuzzy Genetic Algorithm were applied in diagnosing and suggesting the treatment plans. Luxton et al. [7] analyzed the use of artificial intelligence for psychological task.

Razzouk D et al. [8] developed the decision supporting system for diagnosis of schizophrenia having accuracy up to 66-82%. Chattopadhyay S et al. [9] developed a neuro-fuzzy approach for categorizing of adult depression. The supervised Adaptive Network Based Fuzzy Inference System and Back Propagation Neural Network and unsupervised Self Organizing Map neural network learning techniques were utilized and compared. It was observed that Adaptive Network Based Fuzzy Inference System, a hybrid system performed far better than Back Propagation Neural Network.

Basavappa SR et al. [10] applied depth first search algorithm with the backward search approach for diagnosing dementia. An expert system was developed by them taking in consideration patient's behavior, cognition, emotions and the results of neuropsychological tests. Rahman et al. [11] compared several classification techniques; Multilayer Perceptron, Bayesian Network, Single Conjunctive Rule Learning, Decision Trees, Neuro-Fuzzy Inference System and Fuzzy Inference Systems using various data mining softwares like TANAGRA ,WEKA and MATLAB for diagnosing diabetes. They observed that accuracy levels are different for different techniques on different accuracy measures such as Kappa Statistic and Error rates.

Gomuła, Jerzy et al. tried finding efficient techniques for the classification of MMPI profiles of patients having mental problem. They found that Attribute Extension methodology improves classification accuracy in case of discreatised data[12]. Anchana Khemphila,Veera Boonjing applied Multi-Layer Perceptron with Back Propagation Learning for diagnosing Parkinson's disease efficiently with selected attributes. Information Gain from all attributes is taken as a measure for the reduction of attributes [13]. Pirooznia Mehdi et al. [14] used data mining techniques to find Genome wide Association in Mood Disorders. Six classifiers Support Vector Machine, Bayesian Network, Logistic Regression, Radial-Basis Function, Random Forest and Polygenic Scoring method were being compared. It was found that a simple polygenic score classifier performed much better than others and they also found that all classifiers performed worse with small number of Single Nucleotide Polymorphisms in brain expressed set compared to whole genome set.

Kipli et al. [3] detected depression in structural MRI scans for diagnosing mental health of the patients. They compared performances of four Feature Selection Techniques; Information Gain, OneR, SVM and Relief. They found that the SVM Evaluator along with the combination of Expectation Maximization classifier and the Information Gain evaluator along with the combination of Random Tree Classifier give highest accuracy.

Dabek et al. [15] build a Neural Network Model with accuracy of 82.35% to predict the likeness of developing psychological conditions like anxiety, behavioral disorders, post-traumatic stress, and depression disorders.

The literature review on one side shows that numbers of research works are going on for automating diagnosis of mental health problems. On the other hand, efforts are made with utmost accuracy for diagnosing the mental health disorders with different machine learning techniques. Combinations of different machine learning techniques (Hybrid techniques) are also used to improve accuracy of diagnosis with selected set of attributes from patient's profile. This research is for analyzing selected machine learning techniques to the predict the possibility of primary mental health problems like ADHD, Attention Problems, PDD, Academic Problems and Anxiety Problems. Diagnosis of these problems at early age in children can lead to effective treatment and will improve their quality of life.

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III. ANALYSIS OF THE MACHINE LEARNING TECHNIQUES

Various machine learning techniques are accessible and still lot of research is going on to find new techniques that can produce accurate results. According to Ms. Sumathi MR et al. [6], three techniques Multilayer Classifier, Multilayer Perceptron and LAD Tree show more accuracy than the other classifiers on selected attributes.
Removal of irrelevant and redundant attributes is important, from your dataset before analyzing algorithms. Feature Selection is the process of automatically searching the best subset of attributes from the whole dataset. The notion of "best" is the set of best attributes which lead to highest accuracy.
In this research, one technique Multiclass classifier is selected which produces most accurate results on selected dataset in all the three important accuracy measuring methods; Accuracy Kappa Statistic and ROC Area.

3.1 Multilayer Perceptron

Multilayer Perceptron is a network of simple neurons called perceptron's. It is a feed forward neural network model which maps set of input data with a set of appropriate outputs. It contains multiple layers of nodes in directed graph, where every layer is fully connected with the next one. In the computational neuroscience and parallel distributed processing, it is the subject of research currently. They are helpful in research in terms of the ability for solving problems stochastically, in turn allows one to acquire approximate solutions for the very complex problems.

3.2 Multiclass Classifier

In this technique, the problem of classifying the instances into one or more than two classes (binary classification). Each training point from one of N separate classes. The goal is to construct a function which, given a new data point, will correctly predict the class to which the new point belongs.

3.3 LAD Tree Technique

LAD (Logical Analysis of Data) tree is that classifier which generates multiclass alternating decision tree applying logistics strategy. It leads to combining the concepts and ideas from combinatory, optimization and Boolean functions. One of the main goals of the LAD is to classify new observations in such a way so that it is consistent with the past classifications. The accessible information contains archive or previous observations. Every observation consists of vector of attribute values and its outcome. It has proved successful for data analysis problems in several domains like biology and medicine.

IV. APPROACH

Firstly the problem, the diagnosis of basic mental health was identified followed by knowing the mental health disorders that are often found in children. A list of machine learning techniques for diagnosis of five most common mental health disorders effectively if the symptoms of the patient are provided as input.
The data sets of 25 attributes containing the class type labels that are found. The set includes these attributes: Age, Family, History, Pregnancy Complication, Delayed Speech, Under Medication, Academic Performance, Relationship Formation, Behavioural Problem, Concentration, Restless, Seizures, Learning Difficulty, Attention Aroused, Attention Sustained, CBCL Score, IQ Test Score, ADHD Positive, ODD Positive, Manic Episode Test Score, Major Depressive Episode, General Anxiety Disorder, CDI Score, PDD Score, Autism Score and Problem Since only few attributes are relevant to classify and predict the problem, Best First Search technique is used to eliminate redundant and irrelevant attributes. This will also help in achieving more accuracy. The data set are mentioned in Table 1.

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S. No	Attribute	Brief Explanation	Value Set
1	Academic Performance	If the performance of the child is adequate/inadequate in academics	{A,I}
2	Age	Age group of the child, infant/Early childhood/Adolescent	{I,E,M,A}
3	Attention Aroused	If the child is physiologically alert, awake and attentive	{Y,N}
4	Attention Sustained	If the child ids able to direct and focus cognitive activity on specific stimuli	{Y,N}
5	Behavioural Problem	If the child has adequate ability to Socialize with Peers, relative and teachers	{Y,N}
6	CBCL Score	A checklist filled by teacher/parents/Self-reported to identify problem in children	{BC,EC,AC}
7	Concentration	If the child has adequate ability to focus his attention on particular object or activity	{A,I}
8	Delayed Speech	Presence/ Absence of delay in of speech	{Y,N}
9	Family History	Presence/ Absence of physiological disorder in the family	{Y,N}
10	IQ Test Sore	A standardized test to access the intelligence level of the child. The level may be below average, average, Above average.	{BA,A,AA}
11	Pregnancy Complication	Presence or absence of complication during pregnancy	{Y,N}
12	Problem	The class attributes Specifying the mental health problem of the child	{ATT_ACA,ANX_SYM, ANX_DEP_SYMP,PDD, DEV_DELAY,AUT_SYMP, ACA,ATT_EMO}
13	Relationship Formation	Weather the child has adequate ability to socialize with Peers , relative and teache0072	{A,I}

Table 1: Selected attributes with feature selection method.

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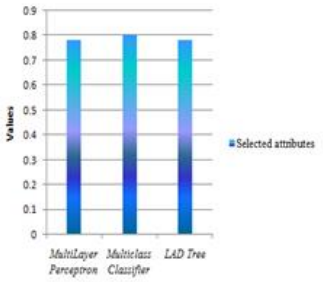
V. ANALYSIS RESULTS

The performance analysis of the three classification algorithms has been carried out with common dataset applying WEKA tool. The classifiers were executed by including selected attributes (13) only using feature selection method. WEKA tool bestows with the various measures for understanding the classification. Among the number of measures, the three measures which are very important for the comparison of the accuracy level of different classifiers are Kappa Statistics, ROC Area and Accuracy.



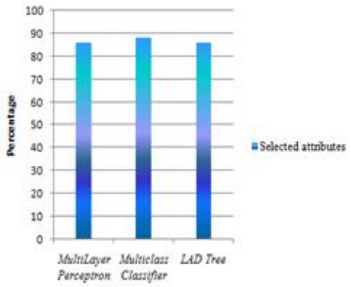


Figure 1: Kappa statistics. **Figure 2:** Accuracy measure.

The Kappa Statistic measures agreement of prediction with true class. A measure 0 means complete disagreement and the 1 means complete agreement between the prediction and true class. Figure 1 shows the kappa statistics measure of the Multilayer Classifier is greater than other two classifiers on selected attributes.
Accuracy of a classifier on any given test set is the percentage of the test set instances which are classified correctly by classifier Figure 2. Shows the Multilayer Classifier is more accurate than the other classifiers on selected attributes.
Accuracy of classifier depends basically on how well the classifier classifies data set being tested. It is measured by the area under the Receiver Operating Curve (ROC). The area of 1 means a perfect test whereas the area of 0.5 means a worthless test. The Figure 3 depicts the graph of ROC Area values of three classifiers. The ROC Area of Multiclass Classifier is 0.9 and is accurate than the other classifiers to predict basic mental health problems in children on the set of selected attributes.

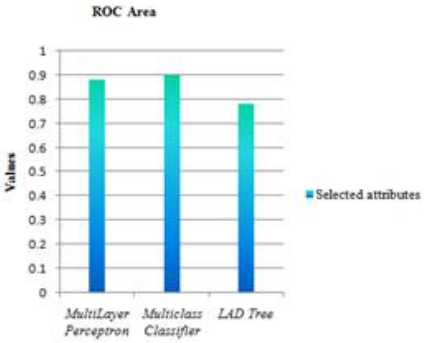


Figure 3: ROC area values.

VI. CONCLUSION

In medical domain, numbers of expert systems are available to predict diseases at very early stage to make the treatment effective and efficient. In the similar manner, expert systems have been developed in mental health sector for predicting the mental health problems at early stage. Since number of machine techniques are present for building expert systems, analysis of the techniques and their comparison for identifying the best technique which suits domain

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of the interest. This research has identified and compared three machine learning techniques, based on dataset for different mental health problems. The results have made it evident that Multiclass Classifier produces much accurate results than other techniques on selected attributes.

VII. FUTURE SCOPE

Since the data set is very minimal and in future, the research may be applied for a large data set to achieve more accuracy of classifier. The classifiers also need to be trained before the implementation of any prediction technique.

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