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Research paper

A Study of dyslexia using different machine learning algorithm with data mining techniques

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Abstract

There are many children's were affected by dyslexia problem over the world. This paper is focusing on medical diagnostic problem – detecting and diagnosing children who were affected by dyslexia based on checklist containing the symptoms and signs of dyslexia using Artificial Neural Network techniques applied with WEKA. Many researchers research identifying or diagnosing dyslexia or non-dyslexia children in many ways. But the drawback in the existing system is they are research based on either Intellectual Intelligent (IQ) or Emotion-al Intelligent (EQ). They are not given accurate result for detecting the dyslexia children. The person's achievement in life is depends upon both knowledgeable and emotional intelligence. IQ is not only giving successful in life. We must need EQ also. The aim of the present research is to propose a quicker and more efficient technique of diagnosing the problem, leading to timely treatment of the children.

Keywords: *Artificial Neural Network; Dyslexia; J48 Decision Tree; Naive Bayes; Support Vector Machine.*

1. Introduction

In this paper, we discuss various algorithm approaches of data mining that have been utilized for dyslexia prediction. Data mining is a well-known technique used by health organizations for classification of diseases such as dengue, diabetes and cancer in bioinformatics research. In the proposed approach we have used WEKA with 10 cross validation to evaluate data and compare results. Weka has an extensive collection of different machine learning and data mining algorithms. In this paper, we have firstly classified the children data set and then compared the different data mining techniques in weka through Explorer, knowledge flow and Experimenter interfaces.

Over the globe 25% of children were affected by dyslexia. A person is severely affected by dyslexia because of increasing emotional problems. Oswald Berkhan was first identified dyslexia in 1881. Dyslexia (dys - abnormal and lexis - language or words) comes from Greek word is one of the types of learning disability such as difficult for reading and writing. [1] Parents and teachers can help with right support however they can succeed not only in school life also succeed in their life by encouraging their powers, knowing their weaknesses, understanding the different learning methods. Dyslexia does not improve without proper treatment.

The main objective of this paper is analysis of data from a dataset classification technique to predict class accurately in each case in data. The major contributions of this paper are:

- To extract useful classified accuracy for prediction of children problems
- Comparison of different data mining algorithms on dataset
- Identify the best performance algorithm for prediction of problems.

In this paper, we have used dataset for classification method. The steps followed include collection of the dataset for determining the accuracy, classification and then comparison of results. Several classification algorithms have been used in this paper in order to analyze the performance of applied algorithm on the given dataset but the thrust in this paper is on accuracy measure. Accuracy measures analyze the errors through measures like root mean square error, relative absolute error and correctly classified instances. Though data mining has several different algorithms to analyze data but analysis using all the methods is not feasible therefore in this paper we have performed the analysis using SMO, Naïve Bayes, J48 Tree, Neural Network algorithms by using Explorer, Experimenter and knowledge flow interface of weka tool.

2. Related work

Athanasios S. Drigas and Rodi-Eleni Ioannidou in 2013 suggested Artificial Intelligence methods to use different diagnosis of SEN (Special Education Needs) learners from dyslexia and autism, also to develop the excellence of life of SEN learners [2]. Julie M. David, Kannan Balakrishnan in 2013 to improve a new procedure for assigning and defining the importance of the missing value complaint method and dimensionality decrease method in the performance of fuzzy and neuro fuzzy classifiers with specific emphasis on prediction of learning disabilities in school age children[3].

Manghirmalani et al. presented a soft computing method called Learning Vector Quantization to classify a child as learning ability or disability. Once examined with learning disability, rule based approach is used to classify them into types of learning disability [4]. Kohli et al. presented a systematic method for identifying dyslexia at an early stage by using ANN. This study paper is the first dyslexia identification problems using ANN. Also, it cans covering the assessment results of dyslexia children between 2003 and 2007 based on test data. Using an error back-propagation

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algorithm the test data covers the input data of the system and the output result contains two categories such as dyslexic and non-dyslexic [5].

Anuradha et al. presented a paper for analysis of Attention Deficit Hyperactivity Disorder (ADHD). This research paper is more perfect and less time consuming. SVM algorithms are mainly suitable for classification and regression. A data-set and the results of a questionnaire conducted by doctors are used to analyze the disorder and implement with SVM module. The result of this supervised learning technique referred as percentage of 88,674% success in identifying between the ages six to eleven years old children [6].

Hernadez et al. introduced SEDA ('Sistema Experto de Dificulta desparael prendizaje' or 'Expert System for Learning Difficulties' in English) is a diagnostic tool for Learning Difficulties in elementary education. Using the Expert Systems design methodology is developed which include an information base containing of a series of strategies for Psycopedagogy assessment. It was assessed by the scale of Poor, Moderately Efficient and Efficient where 80% of the assessors rated the system as Well-organized [7].

Jain et al. introduced Perceptron based Learning Disability Detector (PLEDDOR) model is used for identifying dyslexia, dyscalculia, and dysgraphia using syllabus based test conducted by special educators using an ANN technique. Totally 240 children were subjected to this test and results gathered from various schools and hospitals in India. It was evaluated as simple and easy to replicate in huge volumes [8].

Arthi and Tamilarasi proposed a model is used to diagnosis the children with autism using ANN techniques. The original autistic data is changed into fuzzy value and given as an input to the neural network architecture with back propagation algorithm using pseudo algorithm. In future k-nearest neighbor algorithm for a comparative could be used in expecting research the autistic disorder [9].

Fonseca et al showed electroencephalograms (EEG) to notice abnormalities related to electrical activity of the brain by studying different brainwaves. He produced a result that there is a significant difference between brainwaves of normal and learning Disability children [10]. Macas et al proposed a system for extracting the features of eye movements from frequency and time domain. They decided that back propagation method based classification gave better outcomes than that offered by Bayes and Kohonen network [11].

Rahman urged that Increasing Intelligibility within the Speech of the Autistic Children by an Interactive Computer Game. There is no definite treatment for autism. Serving to autistic children by providing games and teaching facilities to improve their skills [12].

In the year 2013 Santos examines the first detection of Autism means that taking the symptoms of patient during childhood supported by preverbal vocalization by using the classification technique supervised learning SVM (support vector machine)[13].

Chaminade started a shot to use MRI study of young adults with autism interacting with a humanoid robot [14]. Prud'hommeaux et al. examines the difficulties for classification of non-standardized text of machine learning techniques [15]. Kathleen T Quach suggested that problem through the classification problem is that ASD may be a terribly heterogeneous disorder which will have subgroups with totally different genetic expression signatures. To boost classification, it should be helpful to stratify the ASD class into subgroups and enrich the input set with clinical measures [16].

Alexander Genkin et al. have given an easy Bayesian logistic regression approach that uses a Laplace prior to avoid over fitting and produces sparse predictive models for text data. They applied this approach to a spread of document classification issues and show that it produces compact predictive models a minimum of as effective as those created by support vector machine classifiers or ridge logistic regression combined with feature selection [17].

Morris [18] has reviewed the conceptual and operational limitations of classic approaches in classification of learning disability. He found that through the new development of more reliable and valid classification method will remove many of the present problems in clinical and research endeavors with learning disabled children. Suresh and Raja [19] have applied Functional Magnetic Resonance Imaging (firm) through image processing techniques to classify SLD (specific learning disability), to determine depth of severity, degree of recovery and therapy.

Cohen and Sedater [20] have used ANN technology in classification of autism among children. They compare ANN method with simultaneous and stepwise linear discriminate analysis. They found neural network methodology is superior to discriminate function analysis both in its ability to classify groups (92% vs. 85%) and to generalize to new cases that were not part of the training sample. It has been observed that several researchers have applied ANN for classification of disability in children with encouraging results.

3. Methodology

In order to carry out experimentations and implementations weka was used as the data mining tool [21]. Weka is a data mining tool written in java developed at Waikato. Weka is a very good data mining tool for the user to classify the accuracy on the basis of datasets by applying different algorithmic approaches and compared in the field of bioinformatics. Explorer, Experimenter and Knowledge flow are the interface available in Weka that has been used by us. In this paper we have used these data mining techniques to predict the survivability of dyslexia problems through classification of different algorithms accuracy. Figure 1 visualizes the interface of WEKA Data mining tool. It has four applications:

1) Explorer: The explorer interface has several panels like preprocess, classify, cluster, associate, select attribute and visualize. However, in this interface our main focus is on the classification panel.
2) Experimenter: this interface provides facility for systematic comparison of different algorithms on basis of given datasets. Each algorithm run s 10 times and then the accuracy reported.
3) Knowledge Flow: It is an alternative to the explorer interface. The only difference between this and others is that here user selects Weka component from toolbar and connects them to make a layout for running the algorithms.
4) Simple CLI: Simple CLI means command line interface. User performs operations through a command line interface by giving instructions to the operating system. This interface is less popular as compared to other three.



Fig. 1: Screenshot View of WEKA.

In data mining tools classification deals with identifying the problem by observing characteristics of problems amongst children and diagnoses which algorithm shows best performance on the basis of WEKA's statistical output [22]. Table 1 shows the WEKA data mining techniques that have been used in this paper along with other prerequisites like data set format etc. by using different algorithms.

Table 1: Weka Data Mining Technique by Using Different Algorithms

Software	WEKA
Datasets	Dyslexia
Weka Data Mining Technique	Explorer

Classification Algorithms	SOM Naive Bayes J48 Tree Neural Network
Operating System	Windows 7
Dataset File Format	ARFF
Purpose	Classifications

All the algorithms used by us were applied to a data set explained in detail in section 4. In order to obtain better accuracy 10 fold cross validation was performed. For each classification we selected training and testing sample randomly from the base set to train the model and then test it in order to estimate the classification and accuracy measure for each classifier.

4. Dataset descriptions

Dataset is a collection of data or a single statistical data where every attribute of data represents variable and each instance has its own description. In this present work, the method of informal assessment is adopted for designing the tool for predicting the dyslexia children. Even though different types of checklists are generally available for assessing dyslexia characteristics, a check list containing the 16 most frequent and important characteristics (signs & symptoms) of dyslexia collected from the above assessment list, after eliminating the unwanted and redundant ones, is prepared suiting to the dyslexia conditions generally prevailing in Tamil Nadu. The file format of datasets used is ARFF. Figure 2 shows screenshot view of dyslexia dataset.

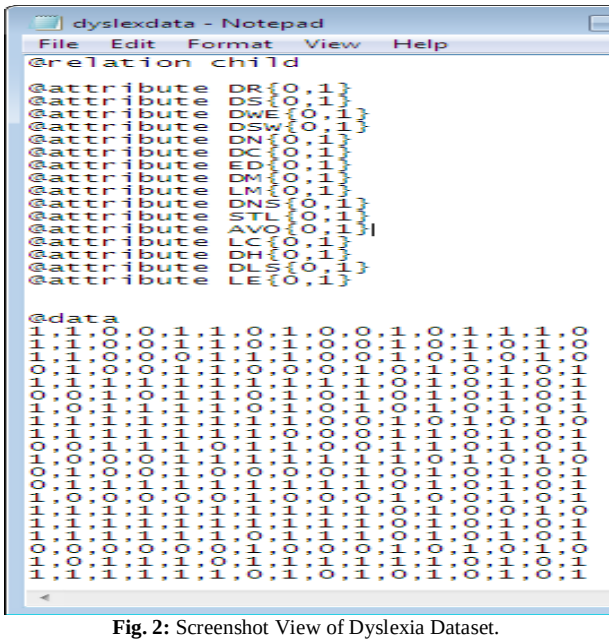


Fig. 2: Screenshot View of Dyslexia Dataset.

This general check list adopted in this research work is shown in given table 2 below. Each attribute show the present and absent of dyslexia symptoms among children in different cities.

Table 2: Description of Dataset Attributes

S. No	Attributes	Signs & symptoms of dyslexia
1	DR	Difficulty with reading
2	DS	Difficulty with spelling
3	DWE	Difficulty with written expression
4	DSW	Difficulty with speeds in writing
5	DN	Difficulty with numbers
6	DC	Difficulty with concentration
7	ED	Easily distracted
8	DM	Difficulty with memory
9	LM	Lack of motivation
10	DNS	Does not like school
11	STL	Slow to learn
12	AVO	Avoidance
13	LC	Lost confidence
14	DH	Difficulty with handwriting
15	DLS	Difficulty in learning a subject
16	LE	Low effort

5. Data mining techniques

Data mining is the process of mining information from bulky amount of data. The data mining technique have been used by us to predict dyslexia problems. Predictions have been done by using weka data mining tool for classification and accuracy by applying different algorithms approaches. It has very important to our real life data. Many tools are available for the purpose of prediction algorithm but they have some errors. Many of them cannot handle big data. There are many hospitals and health care institutions which collect huge amounts of patient data which becomes difficult to handle with currently existing systems. ML algorithms helps to examine and deriving hidden knowledge and information from the data sets. It improves accuracy and speed and also used in diagnosing several diseases. Nowadays various efficient algorithms in data mining become popular such as SVM, ANN, Decision trees etc.

WEKA is developed by the University of Waikato in New Zealand, an open source data mining tool can be used new machine learning algorithms and also extended existing algorithms. Machine learning algorithms are applied directly to a dataset for data preprocessing, feature reduction, classification, regression, clustering, and association rules and visualization tools to develop machine learning (ML) techniques and their application are used to solve the real-world data mining problems. The interfaces of weka used in this paper are the following:

5.1. Explorer interface

It first preprocesses the data and then filters the data. Users can then load the data file in ARFF format and then analyze the classification accuracy result by selecting the following algorithms using 10 cross validation: SOM, Naïve Bayes, J48 Decision Tree, Neural Network. Figure 3 shows the interface of explorer when using dataset is opened ARFF file along with its graphical view.

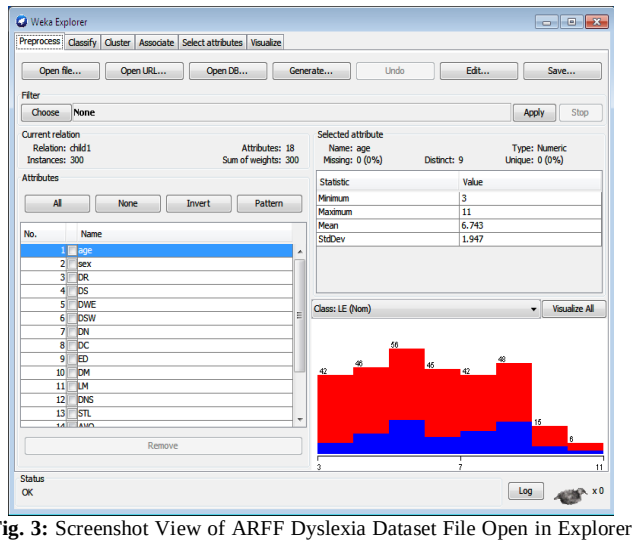


Fig. 3: Screenshot View of ARFF Dyslexia Dataset File Open in Explorer Interface.

5.2. Support vector machine (SVM)

In machine learning, SVM are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. An SVM training algorithm constructs a model that assigns new examples to one category or the other making it a non-probabilistic binary linear classifier [23]. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided

by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall. In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature.
The SOM algorithm gives the following correctness results for the given dataset.

Table 3: Performance Results from SOM Classification Algorithm- Cross Validation

S. No	Particulars	Value
1	Correctly Classified Instances	206
2	Incorrectly Classified Instances	94
3	Kappa statistic	0.3177
4	Mean absolute error	0.3133
5	Root mean squared error	0.5598
6	Relative absolute error	66.0262
7	Root relative squared error	114.9289
8	Total number of instances	300
9	Time taken to build model	0.14 sec

Table 4: Detailed Accuracy by Class

TP Rate	Precision	Recall	F-Measure	ROC Area	Class
0.58	0.754	0.582	0.657	0.757	0
0.93	0.862	0.932	0.563	0.757	1

Table 5: Confusion Matrix

a	b	Classified as
59	57	0
37	147	1

5.3. Naive bayes

In machine learning, Naive Bayes classifiers are a family of simple probabilistic classifiers based on applying Bayes' theorem with strong (naive) independence assumptions between the features. Naive Bayes has been studied extensively since the 1950s. It was introduced under a different name into the text retrieval community in the early 1960s, and remains a popular (baseline) method for text categorization, the problem of judging documents as belonging to one category or the other (such as spam or legitimate, sports or politics, etc.) with word frequencies as the features. With appropriate pre-processing, it is competitive in this domain with more advanced methods including support vector machines. It also finds application in automatic medical diagnosis. [25] Naive Bayes classifiers are highly scalable, requiring a number of parameters linear in the number of variables (features/predictors) in a learning problem. Maximum-likelihood training can be done by evaluating a closed-form expression, which takes linear time, rather than by expensive iterative approximation as used for many other types of classifiers. The Naïve Bayes algorithm gives the following correctness results for the given dataset.

Table 6: Performance Results from Naïve Bayes Classification Algorithm- Cross Validation

S. No	Particulars	Value
1	Correctly Classified Instances	252
2	Incorrectly Classified Instances	48
3	Kappa statistic	0.5942
4	Mean absolute error	0.2306
5	Root mean squared error	0.3659
6	Relative absolute error	59.3074
7	Root relative squared error	83.0646
8	Total number of instances	300
9	Time taken to build model	0.01 sec

Table 7: Detailed Accuracy by Class

TP Rate	Precision	Recall	F-Measure	ROC Area	Class
0.72	0.687	0.722	0.595	0.851	0
0.88	0.899	0.882	0.595	0.851	1

Table 8: Confusion Matrix

a	b	Classified as
57	22	0
26	195	1

5.4. J48 decision tree

It's an algorithm used to generate a decision tree developed by Ross Quinlan. It is an extension of Quinlan's earlier ID3 algorithm. It has been used in this paper to decide the target value based on various attributes of dataset to predict machine-learning model and classify their accuracy. We have also used J48 Tree on our dyslexia dataset. After running this algorithm we analyzed the outputs obtained from the classifier, the output gave several statistics based on 10 cross validation to make a prediction of each instances of dataset. The decision trees can be used for classification and also referred as a statistical classifier [26]. The J48 Decision Tree algorithm gives the following correctness results for the given dataset.

Table 9: Performance Results from J48 Decision Tree Classification Algorithm- Cross Validation

S. No	Particulars	Value
1	Correctly Classified Instances	255
2	Incorrectly Classified Instances	45
3	Kappa statistic	0.6356
4	Mean absolute error	0.246
5	Root mean squared error	0.3173
6	Relative absolute error	63.2637
7	Root relative squared error	72.0373
8	Total number of instances	300
9	Time taken to build model	0.11 sec

Table 10: Detailed Accuracy by Class

TP Rate	Precision	Recall	F-Measure	ROC Area	Class
0.81	0.681	0.810	0.740	0.640	0
0.86	0.927	0.864	0.895	0.640	1

Table 11: Confusion Matrix

a	b	Classified as
64	15	0
30	191	1

5.5. Neural network

ANN is the most powerful and information processing model and mainly used for biological nervous systems such as the processing of the brain information. Also in the medical field it deals with large amount of useful information for diagnosis and various types of therapy. In this article proposed ANN techniques using Multilayer Perceptron and Back propagation algorithm and implement with WEKA software for detecting dyslexia children [27] [28]. The most general form of neural network architecture is the multilayer perceptron (MLP). MLP contains an input, an output and a hidden layer. ANN is referred as a set of nodes called neurons and forms a network (connections between them). The connections have weights associated with them, representing the strength of those connections [29]. The Neural Network algorithm gives the following correctness results for the given dataset.

Table 12: Performance Results from Neural Network Classification Algorithm- Cross Validation

S. No	Particulars	Value
1	Correctly Classified Instances	290
2	Incorrectly Classified Instances	10
3	Kappa statistic	0.9134
4	Mean absolute error	0.036
5	Root mean squared error	0.157
6	Relative absolute error	9.2609
7	Root relative squared error	35.6351
8	Total number of instances	300
9	Time taken to build model	1.45 sec

Table 13: Detailed Accuracy by Class

TP Rate	Precision	Recall	F-Measure	ROC Area	Class
0.92	0.948	0.924	0.936	0.964	0.

0.98	0.973	0.982	0.977	0.964	1

Table 14: Confusion Matrix

a	b	Classified as
57	22	0
26	195	1

6. Result and discussion

The aim of this paper is to find the best machine learning algorithms for dyslexia detection. Using these algorithms we select four different classifiers using with WEKA tool. It is well-suited for developing new machine learning schemes. We have applied 10-fold cross validation in order to check the results of every classifier for unknown instances. This result of whole experimentation is shown in Table 2. While the above figures shows the pictorial representation of efficiency of these algorithms.

Table 15: Comparison of Different Machine Learning Algorithms

Algorithm classification	Correct Classification Rate	Incorrect Classification Rate
Support Vector Machine	84 %	16 %
Naive Bayes	8 %	16 %
J48 Decision Tree	93 %	7 %
Neural Network	96.6667 %	3.3333 %

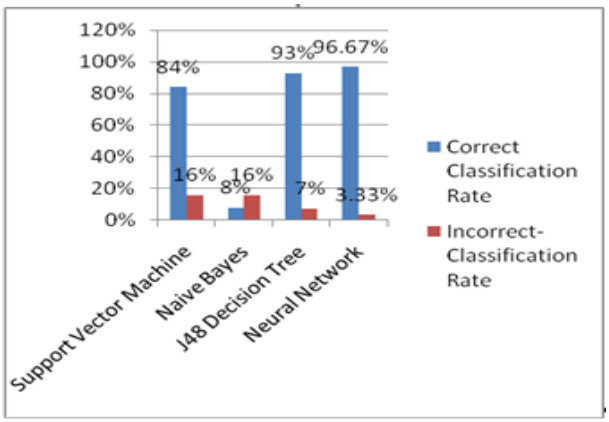


Fig. 4: Graph for Correct Classification VS. Misclassification Rate.

7. Conclusion and future work

The main aim of this paper is to predict dyslexia problems using WEKA data mining tool. In this research paper, select four important common machines learning algorithms for classification and implemented using with WEKA data mining technique to analyze algorithm accuracy which was obtained after running these algorithms in the output window are compared on the basis of correct classification and incorrect classification rate according to results. It can be concluded that Neural Network classifier is the best as compared to Support Vector Machine, Decision Tree and Naive Bayes. After examining the quantitative data generated from the computer models, Moreover their performance is closely competitive showing slight difference. So, many experiments on several other datasets need to be measured to draw a more general conclusion on the comparative performance of the classifiers.

In future it is planned to gather the information from different locales over the world and make a more precise and general prescient model for dyslexia conclusion. Future study will likewise focus on gathering information from a later time period and discover new potential prognostic elements to be incorporated. The work can be extended and improved for the automation of dyslexia analysis.

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