Grading Autism Children Using Machine Learning Techniques

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Abstract
Clinical decision support systems are computer based automated systems developed with the aid of AI for supporting and improving the accuracy of clinical decision making processes. These systems are used by clinicians in making diagnostic decisions and treatment plans. It is able to simulate expertise and express logical reasoning for making assertions. Many inexperienced clinicians are not well confident in certain autistic cases because their observed diagnosis and the calculated grade may not be always similar. Availability of diagnostic experts to provide clinical expertise is also a problem in the diagnosis of autism children. Hence, there is a need of a computer assist system comprised of experience and skill of a clinician, which can advance the power of existing diagnostic method. The computer assisted system will help to confirm the assessment decisions of clinicians. Research works about the application of machine learning techniques for the development of autism assessment and grading in this area is very much required. This work proposes an approach which uses machine learning techniques for autism grading.

Keywords: Autism grading, Machine Learning, Naïve Bayesian, K-Nearest Neighbor, Support Vector Machine

INTRODUCTION
The accurate screening and assessment of childhood autism is a challenging decision making problem and is conventionally practiced by professional clinicians who are well experienced. Even though the understanding of childhood autism has changed in the past few years, still is a challenge in diagnosing and assessing the severity of the disorder in the medical world [1]. This is primarily due to many factors.

- The onset of the disorder before an age of three, making it hard to recognize.
- Lack of awareness about the disorder and its symptoms.
- Its similarity in nature with other neurological disorders.

A class of high functioning autism like Asperger’s syndrome goes unnoticed in society, because many developing states with respect to autism is even in a nascent stage [2][3]. In many cases, the parents may not indicate any willingness to get their minor to such diagnostic process. An early diagnosis and intervention helps an autistic child to improve and cope up with the social life in a fast and better direction [5]. This shows that early, accurate screening and assessment is critically significant for right remediation [11].

The conventional assessment method includes questionnaires or checklists containing the symptoms of childhood autism [9][7]. Many inexperienced clinicians are not well confident in certain autistic cases because their observed diagnosis (based on knowledge and expertise) and the calculated grade may not be always similar [4]. The possibility of autism is then indicated with a vague grade representation like ‘Mild-Moderate’ or ‘Moderate-Severe’ rather than giving a clear indication of grades like ‘Mild’, ‘Moderate’ or ‘Severe’. Therefore, clinical expertise in early screening and placing the disorder is a major component for getting about solutions for the affected children. But yet an expert clinician may experience uncertainty during an early diagnosis [1][6].

There was a research survey about autism diagnosis over 1200 patients in London, where parents expressed the practical difficulties happened like lengthy delays before receiving a correct diagnosis and assessment [10]. Only an early appropriate diagnosis results in early remediation which is essentially required for the child to alleviate his problem and succeed in life. Hence, explains that, the diagnostician himself finds a second opinion for an accurate diagnosis, the reason that makes the parents continue to experience lengthy and often frustrating delays before they finally receive a correct diagnosis [5].

Scarcity of diagnostic experts to offer clinical expertise is also a recognized problem. These suggested problems and the symptomatic nature of autism show the need of an assist system comprised of experience and knowledge of a clinician, which can improve the strength of existing diagnostic procedure [5]. It can confirm the assessment decisions of clinicians and can also utilize it for a diagnostic confirmation [8][9]. Research works about the application of soft computing techniques for the development of support systems in this area are little compared to the number of autistic children. Hence a research study is carried out in this subject.

LITERATURE REVIEW
Psychological disorders are usually assessed by observing the symptoms or features present in a human where quantitative tests are having less involvement during a diagnosis. Hence clinical expertise is much important for the differential diagnosis and grading of a disorder which is comparatively difficult than diagnosing a disease. There are classification techniques that have been applied related to the work and they are discussed as follows.

Anju Pratap, C.S. Kanimozhiselvi(2012), proposed a system for the application of Naive Bayes Dichotomizer Supported
with Expected Risk and Discriminant Functions in Clinical Decisions. This thesis investigated the performance of certain soft computing models and observed its applicability in assessment support systems, for a diagnostic confirmation to the clinicians. Frustrations due to misdiagnosis can be avoided to certain extend by the usage of clinical decision support systems, developed with the aid of soft computing techniques [1].

Bram van den Bekerom, University of Twente, Using Machine Learning proposed a system for Detection of Autism Spectrum Disorder. In this research machine learning is used to determine a set of conditions that together prove to be predictive of Autism Spectrum Disorder. This will be a great use to physicians, helping them detect Autism Spectrum Disorder at a much earlier stage. This will be done through literature review, data exploration and evaluation. Using the 1-away method it was also possible to predict the severity of Autism Spectrum Disorder quite reasonably. The 1-away method improved the accuracy from 54.1% to 90.2%, which is a significant increase [7].

Crippa, A., Salvatore, C., Perego, P., Forti, S., Nobile, M., Molteni, M., & Castiglioni, I. (2015), proposed a system using machine learning to identify children with autism and their motor abnormalities. They have undertaken a proof-of-concept study to determine whether a simple upper-limb movement could be useful to accurately classify low-functioning children with autism spectrum disorder (ASD) aged 2-4 [4].

**PROPOSED SYSTEM**

The proposed work is carried out in different stages and the scope is described as follows.

- Collecting CARS based case histories for preparing real world dataset
- Predicting the grade of childhood autism using some classification models in consistent with CARS diagnostic criteria
- Evaluating the performance of Machine Learning Algorithms

Real time CARS data containing 100 instances is collected from clinical pediatricians where 30 instances are severe, 20 instances are moderate, 29 instances are mild and 21 instances have no autism.

In machine learning and statistics, classification is a supervised learning approach in which the computer program learns from the data input given to it and then uses this learning to classify new observation. Here, the multiclass problem is implemented using the machine learning approaches like Naive Bayesian probabilistic approach, Decision Tree Classifier, K Nearest Neighbor Classifier and Support Vector Machine Classifier which are well suitable for classification problems. The reasons for applying these methods are their ability in simulating expertise as well as classifying an input even if the number of samples is small with appreciated accuracy.

**Figure 1** Proposed Flow Diagram

**Figure 2.** Accuracy measure

From this graph, it is inferred that Decision Tree Classifier Algorithm has the highest accuracy of 1.00 for training data and 0.96 for test data. All the other classifier algorithms classify the training data comparatively equal to that of Decision Tree Algorithm but they fail to classify the test data.

**Figure 3.** Precision Measure

Naive Bayes Algorithm has the highest precision for moderate instances, severe instances and instances with no autism and it has lower precision for mild instances. Decision tree Algorithm has the highest precision for mild instances, severe instances and instances with no autism and it has lower precision values for moderate instances. KNN and SVM Algorithms have equal precisions. They are higher for severe instances and instances with no autism. They are lower for mild and moderate instances.
Instances that are mild provide the highest recall value for all algorithms. Decision tree Algorithm provides highest recall value for mild instances, moderate instances and instances with no autism, but they provide slightly lower value of about 0.9 for severe instances. KNN and SVM algorithms provide equal recall values for all classes. In comparison with Moderate instances and instances with no autism, severe instances have higher values.

CONCLUSION

Autism is considered as one of the fastest growing developmental disorder in children, hence the study for its early diagnosis with the support of classification models will certainly contribute to a greater extent, in solving the problem of making a correct assessment. This work focused on the development of some classification models using machine learning algorithms such as Naive Bayes Algorithm, Decision Tree Algorithm, K Nearest Neighbours Algorithm, Support Vector Algorithm with real world clinical dataset CARS and its application in grading childhood autism helps the clinical paediatrician to diagnose the grades of autism in the earlier stages. This could serve as an additional mechanism to detect autism and treat children by the paediatricians. In this project decision tree algorithm provides the greatest accuracy of 1.00 for training set and 0.96 for test set.

One of the major difficulties in this work is the unavailability of a standard data set for comparing the performance of models with the existing works. The existing literatures also tested their proposed approaches in their own dataset collected locally. This proposed work has developed models by using a limited number of available real world clinical data. Hence problems in the training data like class imbalance may happen to the collected data. This work included only a limited number of classification models, though new approaches like Deep learning are available.

Hence, in the future work consideration will be given in collecting enough samples and standardizing the data set so that more machine learning models can be tested and compared easily. Mobile applications can also be developed will help the parents and paediatrician to perform preliminary diagnosis.

ACKNOWLEDGEMENT

This work is supported by Department of Science and Technology (DST) Government of India under the Technology Interventions for Disabled and Elderly Scheme.

REFERENCES


