Webology (ISSN: 1735-188X)
Volume 18, Number 2, 2021

Machine Learning Based Application For Improving Learning Disabilities In Children

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Abstract

Learning disorders like dysgraphia, dyslexia, dyspraxia, and others hinder academic progress and have lasting implications beyond the academic realm. It is widely recognized that these disabilities affect approximately 5% to 10% of the population. Early in their lives, children must undergo a series of tests to be evaluated for such conditions. Human professionals score these assessments and determine whether specialized educational strategies are necessary based on the results. Unfortunately, this evaluation process can be time-consuming, expensive, and emotionally draining. Dyslexia, for example, is a learning disability characterized by difficulties in reading, writing, word identification, and spelling. Dyslexics struggle to comprehend words and letters, making reading a challenging task. Researchers use various methodologies, such as machine learning, image processing, brain science to study cerebrum behavior, and analyzing brain anatomy differences, to distinguish dyslexics from non-dyslexics. In recent years, e-learning technologies have gained significant importance in higher education, especially in enhancing learning experiences for individuals with learning disabilities. However, many professionals involved in creating and implementing e-learning tools often overlook the specific needs of dyslexic students. This research aims to conduct a comprehensive literature review focusing on machine learning algorithms for dyslexia prediction and e-learning solutions catering to learning and cognitive disorders.

Keywords: Deep learning, Learning disability, Machine learning.

1. INTRODUCTION

In recent times, there has been a growing emphasis on the potential of technology to enhance the teaching and learning experiences. The internet, in particular, has become a common tool in classrooms [1]. E-learning has emerged as a critical resource for enhancing students' knowledge, understanding, and skills. While these technological advancements have improved teachers' abilities to deliver educational content, students with disabilities, particularly those with dyslexia, are often neglected in the development and implementation of these tools. Consequently, they miss out on the same learning opportunities as their peers without disabilities. According to author, the majority of e-learning materials have been designed with the needs and abilities of non-dyslexic learners in mind, inadvertently leaving dyslexic students at a disadvantage [2]. This lack of consideration for their unique learning styles means that the current e-learning materials act as obstacles rather than aids to their learning, presenting additional challenges and disadvantages to students with dyslexia. These materials fail to offer

the necessary accessibility and support for all learners, as they are not tailored to accommodate the diverse needs of students with learning disabilities.

2. RELATED WORK BASED ON LEARNING DISABILITY

"Learning Disabilities" or learning disorders [3] encompass a range of different challenges, including dyslexia, dyspraxia, dysgraphia, and others. The American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [4] provides a comprehensive overview of these conditions. Learning disorders are believed to involve subtle and regionally distributed differences in mind-body systems, as indicated by various research studies. It is essential not to confuse them with learning difficulties resulting from visual, hearing, or motor impairments, or social challenges. In the past two decades, researchers have made significant efforts to understand the neural basis of learning disabilities, but the exact causes remain unknown. These learning impairments can also be examined from various additional perspectives, including family prevalence and alternative operational definitions of "learning impairments" and their impact. Despite the uncertainty about the origins of dyslexia and other learning problems, some believe that it is possible to identify dyslexia with high reliability. The same might hold true for other learning difficulties. Although the exact roots might be unclear, the effects are well-defined and categorized in the DSM-5 as Developmental Coordination Disorders. Dyslexia is a learning disability affecting reading ability. Motor dysgraphia is a learning disability affecting writing skills and could be linked to a developmental coordination disorder like dyspraxia [5]. These challenges may persist as individuals grow older, but with appropriate education, they can be managed. Learning disabilities affect approximately 10% of the population to some extent, as widely acknowledged. Academic failure can result from various combinations of the conditions listed in the DSM-5. However, with the right educational approaches, children with learning disabilities can acquire the same skills as their typically developing peers. Government assistance is often available to support these children through specific teaching lessons, extra educational resources, extended exam time, and additional classroom support from dedicated staff. For more information, one can refer to sources like Duke University or the DSM-5. To be eligible for such support, you need to submit a certificate from a recognized professional responsible for evaluating the child. However, the evaluation process can be time-consuming, costly, and emotionally taxing. Moreover, limited availability of accredited evaluators may result in significant delays. This situation poses difficulties for many individuals, especially those who are most in need of assistance, as they might be unable to undergo the examination. Hence, there is a pressing need for rapid, efficient, and widely accessible evaluations (or pre-assessments) to address this issue. In most instances, our methodology offers a viable solution to this challenge.

3. RELATED WORK BASED ON MACHINE LEARNING

Machine Learning is a powerful technique used to analyze vast amounts of data and identify new patterns and insights. It enables researchers and information professionals to develop strategies and plans more efficiently. Machine learning encompasses various approaches such as clustering, regression, and classification based on valuable data hidden within extensive datasets. There are two primary types of machine learning computations: supervised and

unsupervised learning. Supervised learning utilizes labelled examples to infer patterns and make predictions from known data class labels. On the other hand, unsupervised learning infers patterns from data with unknown class labels. In the healthcare field, machine learning has become a significant trend, assisting medical professionals in analyzing, predicting, and treating patients more effectively. There are numerous machine learning models available, each with its unique prediction methodologies. Selecting the right machine learning algorithm is crucial but can be a challenging and time-consuming task. Some commonly used machine learning algorithms include Support Vector Machines (SVM), Neural Networks, Decision Trees, Bayesian Classifiers, k-means clustering, and Logistic Regression. Support Vector Machines use kernels to analyze and classify raw data, making it useful for pattern analysis and classification. Neural Networks simulate the brain's information processing ability to make various predictions based on input data. Decision Trees use directed charts to represent decision-making in predictive modeling. Random Forest, a collection of numerous decision trees, finds application in various fields. K-means clustering is an unsupervised learning method that identifies distinct groups of data based on similarities when class labels are unknown. It has found utility in multiple business applications. Machine learning, with its versatility and potential, is transforming various industries, including healthcare, by revolutionizing data analysis and pattern recognition. Logistic regression [6] relies on measurements to make predictions. This straightforward machine learning algorithm is particularly effective when dealing with scenarios where there are only two possible outcomes, and these outcomes are highly dependent on explanatory variables. By considering a set of observable factors, logistic regression calculates the most probable outcome.

4. LITERATURE REVIEW

Machine learning is a subset of artificial intelligence that enables computers to learn from data and improve their performance without explicit programming. In the context of miRNomics, machine learning methods may be employed to analyze large-scale miRNA datasets, predict miRNA functions, identify potential miRNA targets, or discover miRNA-disease associations, among other applications. The research explained introduce readers to fundamental concepts in machine learning, such as supervised and unsupervised learning, feature engineering, model evaluation, and various algorithms used in the field. It likely highlights how these techniques can be leveraged to gain insights into microRNA biology and advance computational analyses related to miRNomics research [7].

The author conducted a descriptive study to assess various machine learning interventions in different teaching learning systems. They provided recommendations based on their findings, exploring the potential relevance of these systems in supporting individuals with disabilities. The study advocated the significant potential of machine learning algorithms in enriching educational systems, facilitating adaptive learning experiences, and enhancing learning effectiveness for people with special needs [8].

Khan et al. introduced a diagnosis and classification system based on machine learning. Their system included a diagnostic module, serving as a pre-screening tool to detect dyslexia's

negative effects. The classification module divided children into non-dyslexic and dyslexic groups with doubts, and a third module allowed researchers to analyze data.

Author focused on external appearance identification using convolutional neural networks for e-learning systems. Their approach comprised three main steps: preprocessing, feature extraction, and classification [9].

The author developed a semantically enhanced module-based e-learning system for computer science programs from a learner-centric perspective. Learners were categorized based on their proficiency, providing them with a customized learning environment. Additionally, they created a personalized evaluation theoretical model using learning objects to aid dyslexic youngsters in learning the alphabet [10].

The findings of a prototype mobile application designed to assist dyslexic users in dealing with their reading difficulties in real life while receiving appropriate treatment was stated. The application could recognize texts in the environment and read them aloud, offering customized features like chunking, looking over, and highlighting words based on the user's skill level. The study also explored the use of machine learning to improve the effectiveness of learning complex words for dyslexic individuals [11].

They aimed to provide assistance to students with dyslexia by adaptively sensing their engagement with learning content using a machine learning strategy. They used Bag of Features (BOF) image categorization, predicting student engagement based on the frontal face of 30 students. The authors utilized different classifiers, including Support Vector Machine (SVM), Naive Bayes, and K-Nearest Neighbor (k-NN), to achieve the best classification results [12].

The author suggested on early detection of dyslexia using machine learning models that analyzed how individuals engaged with an etymological task, aiming to improve dyslexia prediction and intervention. The computer game's pieces were designed through an empirical etymological analysis of errors made by individuals with dyslexia, while considering specific dyslexia-related cognitive functions such as Language Skills, Working Memory, Executive Functions, and Perceptual Processes. They developed an emotion recognition method based on outer appearance with change detection. The study involved an emotion elicitation experiment to collect facial-based landmark signals for creating emotion detection classifiers. They employed the sliding window technique and support vector machine (SVM) for distinguishing emotions, using Information Gain (IG) and Chi-square feature assessments to identify robust features for emotion identification [13].

A systematic literature review in four steps, involving a comprehensive search of scientific literature databases, study selection based on exclusion and consideration criteria, and literature analysis and synthesis. Additionally, [10] worked on distinguishing dyslexic from non-dyslexic individuals using various machine learning approaches, image processing techniques, design assessment, and assistive equipment to support dyslexia, examining several aspects of dyslexia research.

Intrusion detection systems are crucial for identifying and preventing unauthorized access and attacks on computer networks. However, they often deal with large volumes of data, making it essential to select relevant features to improve efficiency and accuracy. The author introduces the concept of multi-criteria decision-making to systematically evaluate and select the most informative features for the IDS. These decision-making methods allow researchers to consider multiple criteria simultaneously, leading to more robust and efficient feature selection. The study's findings and methodologies are likely to be of interest to researchers, network security professionals, and practitioners in the field of cybersecurity. By employing multi-criteria decision-making for feature selection, the paper contributes to the ongoing efforts to enhance the effectiveness and performance of intrusion detection systems [14].

Aimed to detect children's learning styles based on their interactions with the system, employing an Artificial Neural Network to predict the learning style of children with learning disabilities [5]. The author developed a personalized training device for dyslexic children, utilizing machine learning techniques to offer interactive graphics for words, facilitating better learning and recall. They further explored the use of speech recognition and phonetics for Hindi alphabets and words.

They presented a prediction model using statistical approaches to differentiate dyslexics from non-dyslexics based on eye movement. They employed an eye tracker to monitor eye movements and derived enhanced level characteristics using Principal Component Analysis. A Hybrid Kernel SVM-PSO based on Particle Swarm Optimization (PSO) was suggested for predicting dyslexia in people [15].

A survey is done to understand the work on learning impairments and machine learning. Machine learning is utilized to predict various future events, and one of its valuable applications is in predicting learning disabilities in children and detecting them early for suitable interventions [6].

Effective employee selection is crucial for the success and growth of any organization. Traditional decision-making methods may not adequately capture the complexities and uncertainties associated with personnel selection. Hence, the authors propose the use of Fuzzy MCDM, which allows for the consideration of fuzzy and imprecise data, providing a more comprehensive evaluation. By applying this approach, the paper aims to offer organizations a systematic and objective way to assess potential candidates, considering multiple criteria and their respective weights in a more nuanced manner. This Fuzzy MCDM approach can contribute to improved decision-making processes in employee selection, leading to better business outcomes and enhanced organizational performance. The paper's insights and methodologies are likely to be of interest to human resource professionals, management researchers, and organizations seeking to optimize their employee selection processes for increased business impact and success [16].

The author worked on personalized learning for students with disabilities, with the system divided into four sections: predicting the user's learning level, creating multimodal learning resources using web mining, linking results to the user's preferences, and providing user-

specific content through an intelligent interface. Advocated using frontal face detection as an alternative method for predicting student attention. They employed a machine learning approach using the Speed-Up Robust Features (SURF) descriptor to recognize major facial features in images.

Interest purposes were clustered using different codebook sizes, employing a Support Vector Machine (SVM) with two distinct kernels and Naive Bayes for the classification model.

They aimed to create a neurobiologically based classifier to effectively differentiate between two groups of children: one with dyslexia and the other without. They utilized the phase lag index (PLI) to generate weighted connection matrices from EEG resting-state data of dyslexic and regular readers. A SVM and K Nearest Neighbors (KNN) classifier were used to compute several nearby network measures, resulting in 37 selected features for classification.

The author examined recent contributions to dyslexia detection using machine learning approaches and highlighted future research prospects. Various methods, including game-based procedures, reading and composing assessments, facial image capture, eye tracking, MRI, and EEG examinations, have been proposed to detect developmental dyslexia.

It emphasized the importance of early detection and support for dyslexia in education to mitigate its harmful impacts. They stressed the need for a powerful and accurate screening approach for early dyslexia detection.

The author studied the learning process and outcomes in students with and without dyslexia to explore the redundancy effect described in the Cognitive Theory of Multimedia Learning. Adding sound appeared to impair the quality of knowledge and resulted in less effective learning across both groups.

They discussed learning disabilities and their varieties, along with techniques for determining the severity of learning disabilities, extracting patterns, and overcoming the challenges they present in life.

Author aimed to understand if disparities exist and how they relate to children's performance on linguistic and cognitive tasks commonly used to diagnose dyslexia. They trained a denoising autoencoder (DAE) to analyze the patterns in EEG data to classify dyslexia. learn a low-dimensional representation of the connectivity matrices, and temporal and spectra linter-channel EEG connectivity were computed for this purpose.

5. CONCLUSION

Language-based classification must be considered because the signs and symptoms of learning difficulties can vary depending on the language used. Several soft figure approaches currently in use have lower precision levels that can be enhanced [8]. Existing image databases of the brain used for dyslexia prediction often focus on only one part of the brain, which is insufficient as dyslexia can manifest in multiple brain regions. Dyslexics can benefit from various assistive devices to improve their reading and writing abilities. Early and accurate prediction of dyslexia remains challenging. This paper discusses the utilization of machine learning approaches,

image processing, and assistive equipment for dyslexia prediction and assistance. However, most machine learning algorithms used for dyslexia prediction focus on only a few dyslexia traits or symptoms, while language-based classification is crucial for better prediction, considering the variability of dyslexia characteristics across languages.

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