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Survey on different Machine Learning Techniques for Student Improvement using Psychometric Data

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Abstract: ***Student improvement aims in identifying student behavior traits and patterns using multiple psychometric tests followed by suggesting ways to improve areas of the subject's interest along with overall psychological balance by continuous testing at constant intervals of time and suggesting the same. To identify the subject's strengths, weaknesses, and behavioral interests, assessments are carried out on the principle of psychological assessments which aims to assess the students by making them imagine their reactions in various psychological situations. Each response to the question is evaluated with pre-decided scores. Psychometric tests are aimed at measuring a person's traits, behavior, guidance, and placements/employment to match the person's capabilities and features like cognitive ability, EQ, IQ, and the tendency to react to predefined situations. Psychometric tests have a huge role to play in the fields of career guidance and employability. These tests suggest your strengths, weaknesses, and imaginative abilities and hint if they suit the particular role. This paper provides a survey on different machine learning algorithms used over the years to recognize personality traits and learning styles which would further contribute to students' overall improvement.***

Keywords: Machine Learning, Big Five Personality, BTSA, KOLB, Student Performance Improvement

I. INTRODUCTION

Every individual is different in terms of their psychological structure (thinking, behavior, and personal preferences). Psychometric assessments are tests that measure a person's traits, behavior, intelligence, abilities, and aptitude. The tests are widely used in the process of career guidance and placements/employment to match the person's capabilities and check if he/she is suitable for the defined role.

Psychometric tests have proven their accuracy in improving one's performance and impact on human life over a long tenure of observation through which one can possess various aspects of development such as learning speed and accuracy, student performance, and career growth. Multiple personality tests can also help organizations determine the right candidate for a given position.

They are meticulously designed in a way to measure a person's personality and factors like cognitive ability, IQ, EQ, and tendency to react to particular pre-defined situations. Psychometric tests solve real-life problems of students' psychological behavior by suggesting them various methods to improve in all dimensions.

We have used three major psychometric tests for the project research. They are:

Benziger developed a model which says that our brain has 4 specialized areas and each is responsible for various functions which differ from each other and imply their strengths, behavior, and thinking styles individually. It is used to measure the individuals' preferences in their way of thinking.

The KOLB learning styles model describes different learning styles a student may prefer while approaching a task (watch/do) and emotional approach to experience(think/feel). Learning styles show how an individual processes information to learn and apply it.[10]

Big five-factor assessment measures your result based on 5 different parameters: Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism (OCEAN). Multiple personality tests can help organizations determine the right candidate for a given position.

In this survey paper, the objective is to study different machine learning techniques used in evaluating a student's performance using different psychometric tests.

II. RELATED WORK

Every individual can be differentiated in terms of their personality. Throughout the years' numerous amounts of research have been conducted on psychometric factors affecting a student's educational performance.

In 2011, university students' data was collected from their third-semester course. A questionnaire was used to collect data to describe the relationship between the behavior of students and their final academic performance. Students' final grade was predicted using the SSVM algorithm and students were clustered into groups using kernel k-means clustering. The average testing accuracy of the lowest at 61% was achieved for the prediction of "good" performance and the highest at 93.7% for the prediction of "poor" performance [5].

In 2014, 6 classification algorithms were used to predict the student's academic performance. The models were trained on the 2010 and 2011 cohorts and tested models on the 2012 cohort. Younger students were observed to have good predictive accuracy and older students' results were less accurate. The resulting accuracy gained for SVM was 73.3% and 60% accuracy was obtained for logistic regression [2].

Tripti Mishra, Dr. Dharminder Kumar, and Dr. Sangeeta Gupta have considered students' third-semester results and applied the Random tree and J48 algorithm to identify factors affecting students' performance. The academic performance of the students was predicted based on their social economic condition and previous academic performances. For classification purposes, an open-source data mining tool Waikato Environment for Knowledge Analysis (WEKA) was used. The overall accuracy (94.418%) achieved by the random tree was better as compared to J48 with 88.372% [3].

In 2015 a thinking style assessment was conducted amongst 552 third-year undergraduate engineering students to identify the relationship between brain dominance and academic results. A survey was conducted with a questionnaire using the open-source software MOODLE. It was observed that students achieved better results if their thinking style matched their learning styles and increased brain dominance leads to better academic grades [10].

In the 2021 IEEE paper Twitter data from user's Twitter profiles and myPersonality data set from Facebook were collected for the assessment by Noureen Aslam, Khalid Masood Khan, Afrozad Nadeem, Sundus Munir, and Javairya Nadeem. The big five-factor model is used for prediction and the efficiency was measured using Precision, Recall, and F1-Score. The prediction model was created using multi-target regression with TF-IDF vectorizer and deep sequential neural network model. They have achieved 94% accuracy from their training data and 78% for the testing data in predicting the connection between a person's personality and their tweets [1].

In 2015, Amirah Shahiri proposed a review of all the existing factors used for students' performance improvements like CGPA, Psychometric factors, and Internal assessment. Different algorithms are used, 65% accuracy was achieved for psychometric factors using the decision tree method and 83% accuracy using the Support Vector Machine [4].

An automatic personality classification system was proposed by V.Mamatha which uses different data mining techniques to classify the personality of different users. The personality of the user was predicted using the questionnaire of the Big Five personality model. The different models used obtained an accuracy of 96% for the decision tree, 91% for SVM, and 78% for logistic regression. Scores were analyzed and calculated based on precision, recall, and F1 score [6].

Social media platforms allow people to share their thoughts, emotions, and experiences and connect with people all around the world. In 2021, Thahira M and Mubeena A K proposed an approach to predict a person's personality using social media networks by using the OCEAN model. My personality dataset was used which consists of status updates, social network features, and comments and articles. The highest accuracy of 58% was obtained for openness-to-experience using the SVM classifier. The deep learning model was observed to have the highest accuracy amongst other machine learning classifiers [7].

A famous stream-of-consciousness essays data set collected by James Pennbaker and Lauren King was used for personality detection. Features extraction was performed using Google's word2vec embedding and Mairese features and a binary classifier was used to classify the personality traits. The proposed model was created using deep CNN and the holdout method was used for the evaluation of the model. The model achieved better results as compared to the k-fold cross-validation technique [8].

A. Summary Paper

Name, Year, and Reference	Data set	Summary
Analysis of Personality Assessment Based On the Five-Factor Model Through Machine Learning. 2021, Noureen Aslam, Khalid Masood Khan, Afrozah Nadeem, Sundas Munir, Javairya Nadeem [1]	Twitter data and myPersonality data set	Different techniques are used to predict the personality traits of Twitter users using Big Five personality assessment.

A review on predicting students' performance using data mining Techniques 2015, Amirah Mohamed Shahiri, Wahidah Husain, Nuraini Abdul Rashid [4]	CGPA, Psychometric fac- tors, Extra-curricular activities, Academic grades	Multiple factors and techniques used to predict students' performance. 65% accuracy was achieved for psychometric factors using the decision tree method and 83% accuracy using the Support Vector Machine.
Exploring the Relationship between Academic Performances and Brain Dominance. 2015, Lakshmi Dhandabani and Rajeev Sukumaran [10]	Thinking style assessment carried out among 552 third year undergrad engineering students in the form of a questionnaire	Shows the relation between TSA and its impact on academic performance. Students have good academic performance if their thinking styles match their learning preferences.
Mining Students Data for Performance Prediction. 2014, Tripti Mishra, Dr. Dharminder Kumar, Dr. Sangeeta Gupta [3]	Third-semester grades of university students	Model based on students' emotional skills, social integration, and academic integration. Applied the Random tree and J48 algorithm to identify factors affecting students' performance.

B. Observation on Survey

From the above survey, we can observe that psychometric tests could be of great value in improving a student's performance in academics and also in personal aspects of life. These papers gave us an idea of how psychometric tests have been used to date to predict the subject's thorough assessment on taking the test. Using different machine learning algorithms and techniques accurate predictions are made which could help in increasing the quality of education. Deep learning models for automatic personality classification have been found to have the best performance.

III. TECHNIQUES

For the prediction of students' performance, different techniques and methods are used to achieve the best accurate results. From the above survey, it is observed that different classification techniques like Decision trees, Random Forest, SVM, K-means, etc. are used for the classification of an individual based on their personality factors. In a few cases, deep learning techniques have been used which have given better results as compared to other models. These techniques help in increasing the accuracy of our model and enhancing its performance and predictability.

A. Decision Tree

It is a type of supervised machine learning used to create a training model to predict the class or value of the target variable by learning different rules extracted from the training data. It is widely used for predicting classes in a particular data set. The data set is split into different features using the cost function and forms a hierarchical tree-like structure.

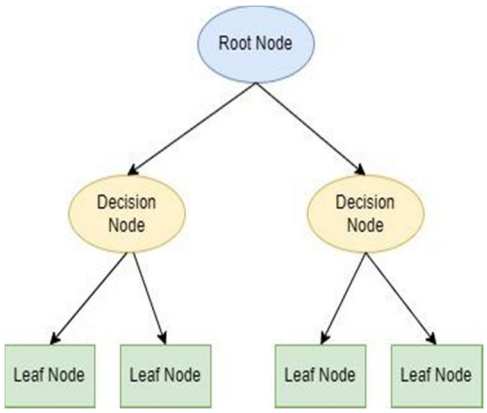

Figure 1: Decision Tree

B. Support Vector Machine

SVM is a linear model used for both classification and regression problems. It divides the data set into two different groups based on their features. SVM works by mapping data to a high dimensional feature space so that data points can be categorized, even when the data are not otherwise linearly separable [13]. Sembriring et al. (2011) proposed a model of student performance using SSVM and stated that the performance was better than other methods [5].

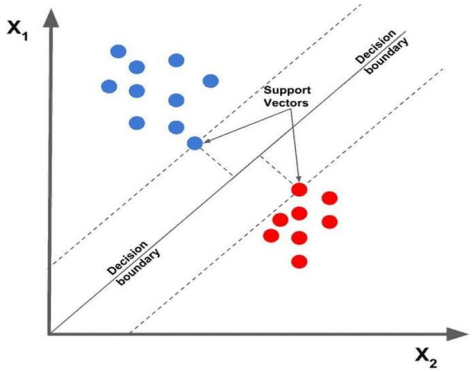

Figure 2: Support Vector Machine

C. Naive Bayes

It is one of the easiest and most effective classification algorithms based on the Bayes Theorem that can make quick real-time predictions. Predictions are made based on the probability of a variable and are also known as probability classifiers. Since it takes linear time rather than the costly iterative approximation used by many other types of algorithms, it can easily scale to larger data sets [7].

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

Posterior, Likelihood, Prior, Normalizing constant

$$P(B) = \sum_{Y} P(B|A)P(A)$$

Figure 3: Naive Bayes

D. Neural Network

Neural networks are a type of machine learning algorithm that mimics the way the human brain processes different things from its surroundings and makes decisions based on that information. It is a system of artificial neurons that can detect all possible interactions even in a complex nonlinear relationship between dependent and independent variables. It is a technique that is widely used for complex predictions giving the best accurate results.

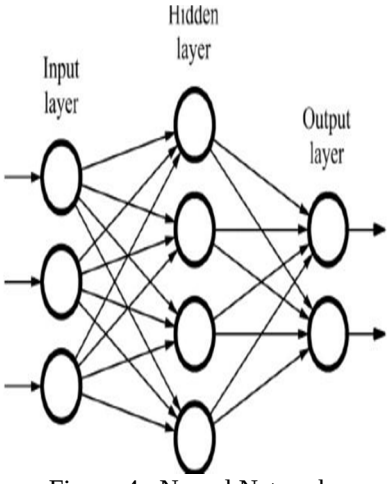

Figure 4: Neural Networks

IV. CONCLUSION

We discovered a connection between psychometric parameters such as learning style, thinking style, ability, and self-behavior which can be analyzed using machine learning, and suggestions to improve traits that can be automated, thus one can continuously self-analyze using the designed tests and work on self-psychological improvement using the suggestions given by different machine learning techniques. It is possible to enhance the self-awareness of a student in academic and behavioral terms using automated systems fed with data and results and by following the recommendations the chances of success in the chosen path can increase. This paper has reviewed different techniques used in predicting student performance and finding the correlation between an individual's academic performance and psychological factors. Among all the techniques Decision trees and neural networks were highly used giving the best accurate results thereby helping students to improve in different fields and leading to career growth. This analysis has motivated us to carry out further research which we can apply in our environment. It can benefit various educational institutes to monitor and improve one's performance systematically.

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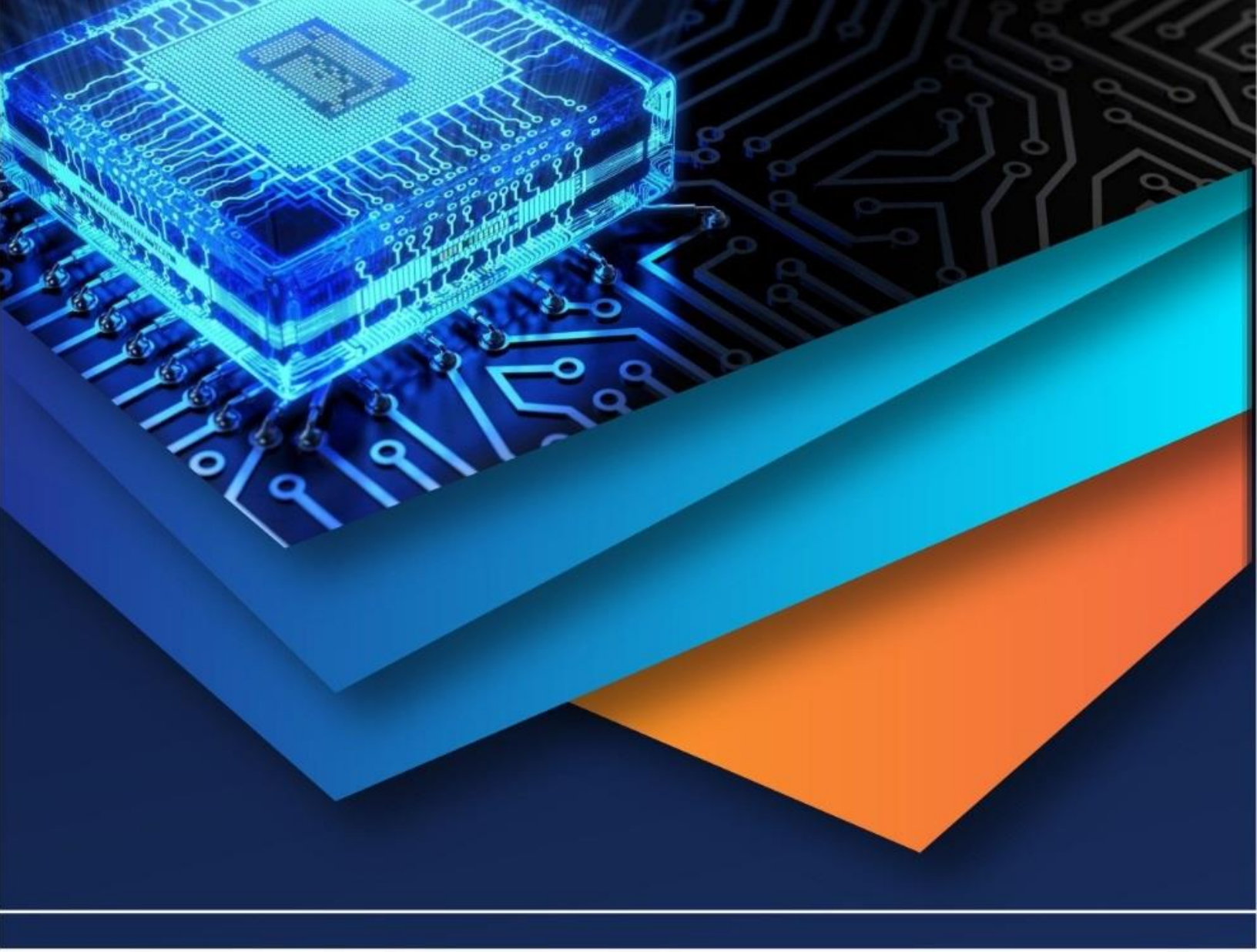

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