

Psychometric Assessment of Teacher Mindset using hybrid KNN-SVM Algorithm

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Abstract—With the rise of Information Technology, there has been a monumental rise in the number of jobs in the industry. To counter the huge number of applications and to ensure that candidates of proper attitudes are selected, a holistic evaluation from a psychology point of view is must. We propose a system to develop a similar platform for the evaluation of teachers, i.e., using Psychometric Games to measure and evaluate traits that are favourable for teachers to have. The statistics being captured are not shown to teachers which ensures unbiasedness to a large extent. We use hybrid of KNN and SVN algorithm and similarity index to predict the acceptance rating of the teacher on the basis of the previous results. The data set is generated by playing different games by different users and storing it in a one to many model mapping. Finally, a report is generated with summaries of all the actions and the approximate adherence to different traits being captured.

Index Terms—Psychometric Analysis, KNN, Machine Learning, Mindset, Clustering, Mean, Similarity Index, SVM

I. INTRODUCTION

A cogent qualitative analysis of psychology and people's rationality and thinking has always been a nebulous region. Analyzing the teachers' ability requires much more than studying their knowledge of the tech or domain in which they are experts. This behaviour cannot be just measured based on a questionnaire or a quantitative platform. A brain is like a muscle; it changes and adapts as you use it. Hence, an unbiased analysis that considers the ever-changing capability of the brain from situation to situation is needed. In teaching, world unbiasedness is very much needed and the knowledge to assess a teacher on their behavioural and qualitative features than only on their achievements and subject matter knowledge. Having a set of games that captures different information in the background without the person playing the games knowing is an efficient way to capture the same. We change the way we interact if some feature is shown or known to us while interacting hence having unbiased analysis is very much important.[1]

A. Mindset

The belief about human nature, abilities define the mindset of a person about others.[2] There can be two broad kinds of mindsets: fixed mindset, in which people believe that human traits, talents and behaviour are fixed, and nothing much can be done to change it, whereas growth mindset people believe

that characteristics of human beings can be developed and are not fixed. Research shows the kind of mindset is essential in shaping one's career, especially in teaching, where having a growth mindset amounts to the success of students.

B. Games in Mindset

By merging game-design thinking with trusted and proven psychometric principles, assessment games provide deep insight to inform better hiring decisions and give the candidate a rich, immersive experience. Instead of asking the candidates to complete a test that feels like a test, they get to play a series of games. Game-based assessments are ideally suited for measuring critical cognitive skills. Research has revealed that gamers typically use a high degree of mental resources whilst playing different digital games. Game-based assessments can accurately evaluate fluid intelligence, working memory, problem-solving, creativity etc.[3]

II. BACKGROUND

Growth mindset folks believe human traits and intelligence can be developed in contrast to fixed mindset people. A growth mindset person always believes in putting in effort and hard work to acquire a particular ability. They believe in challenging oneself to their maximum potential to overcome the hurdles.[4] Hence, it is found that growth mindset folks have more active brain as compared to the other group. In failure scenarios, the growth mindset group tend to look and learn from those who achieved success whereas fixed mindset people try to convince themselves, it was not in them to be able to achieve this and hence don't get the motivation to try and improve.

A. Growth Mindset of Teachers

A fixed mindset teacher is sometimes a threat to the developing minds of children and the concept of good teachers. In some scenarios, these teachers tend to blame the child, which hinders the child in taking challenges and learning from the situation. Whereas on the other side, a growth mindset teacher would encourage children to learn from their mistakes and try to improve them while also reflecting upon how they could improve their teaching techniques to maximize learning. The growth mindset teachers don't hesitate to share their own mistakes, provide adequate mentorship, find better strategies to help children learn better.[5]

B. Why Game based Assessments?

Game-based assessments offer a robust, friendly alternative to traditional testing—the game designed to analyze the candidates’ skills in a quick and engaging experience. These evaluations are very pliant, can be measured on a freestanding basis, and are ideally suited for measuring important analytical skills.[6] Games analyze your skills.Regular interaction with brain-based activities will keep your brain at its highest level and boost your analytical performance to its maximum.

C. Psychometric Tests

Psychometric assessments are a well defined and systematic method used to measure an individual’s cognitive and behavioural style. These tests analyze the candidates’ suitability for a particular post based on the required personality characteristics and aptitude (or cognitive abilities).[7] They spot how much the candidates’ personalities and mental abilities are similar to those required to perform the role. The statistics acquired from the test is used to determine the non visible aspects of candidates that are difficult to extract from a vis-a-vis interaction or a pen-paper test. Game-based assessments can accurately evaluate and identify the favourable traits for a teacher.

III. METHODOLOGY

A. System Design

The games have been developed using ReactJS and Redux are made with the motive that the user’s performance in these games can be used to quantify the traits that these games are used to measure. This requires extensive literature review to first find out what traits are favourable among teachers with the help of psychologists who are experts in the same domain.[8] The next step is to research and develop games for each trait or a game that measures multiple traits. The development is done as a web application, into which the user can log in and play the various games provided. The user first needs to authenticate via google auth API’s then the user is prompted to a dashboard. The user has to play multiple games, and once a game begins, it cannot be stopped. Each game stores different measures and statistics while the user is playing the game. These statistics are not shown to the user to maintain unbiasedness. Once data is collected, it is processed in the background and based on the Machine Learning model built, the score is predicted to the user in the form of a PDF report.

- The first constraint during the development of games is that the games developed should require the traits that are being measured by it. This has been achieved by consulting with psychologists to ensure that the games actually measure the characteristics they are designed to measure.
- The next stage, after the development of the games, is to get a critical mass of users to play the games. The machine learning models require data, and that is obtained by users playing the games.
- To evaluate the performance of the users, a hybrid of KNN and SVN algorithms is used to establish thresholds

in the data recorded, to quantify the performance on a scale.[10]

- The final report is generated with all traits and average results and sent to the required persons.

B. Data Collection

The games were hosted on AWS EC2 engine and S3 bucket. Over the course of few months, various teachers were asked to play the games in the colleges of Tricity and, result, segregated into different groups. To ensure valid data, unrealistic traits being shown by some players were discarded. For example, if a person finished a game in few seconds where the average finishing time is over 40 seconds, this shows us that the game was not played and random answers were marked. The training model doesn’t incorporate these values while making the aggregated groups. Each teacher played a total of four games. Each game captures different parameters from the game invisible to the player. The statistical data is stored in the database in a one to many model mapping.Over 200+ teachers participated in the games and around 180 data collections were deemed valid and model was built upon. The different types of data stored in each game are:

- Sharpness in Listening includes a person listening to audio and answering a few questions based on the audio. He can play/pause/rewind audio many times, and all the actions are stored and observed. Table 1 shows the different traits captured by the same.

TABLE I
SHARPNESS IN LISTENING.

Type of Data	Traits Measured
Number of times start/stop of audio	Critical Listening
Correct answer or not	
Number of times answer was changed	Understanding Capability
When was the question answered	

- In Blow the Balloon, a person has to blow a balloon. Every blow earns a potential amount. If a person collects the amount before the balloon bursts, it is added to his account. Every colour balloon follows a particular characteristic pattern. Table 2 shows the different traits captured by this game.

TABLE II
BLOW THE BALLOON

Type of Data	Traits Measured
Number of clicks a balloon is blown to	Risk
Balloon collected or burst	Pereceptiveness
Which kind of balloon is collected	Learning Capability

- In the Earn Maximum game, a person has to select a pile of cards, and a random numerical amount pops up. The random amount can be negative or positive, and the user’s objective is to maximize the amount. Every pile has some characteristics according to which the amount is generated. Table 3 shows the different traits captured by the same.

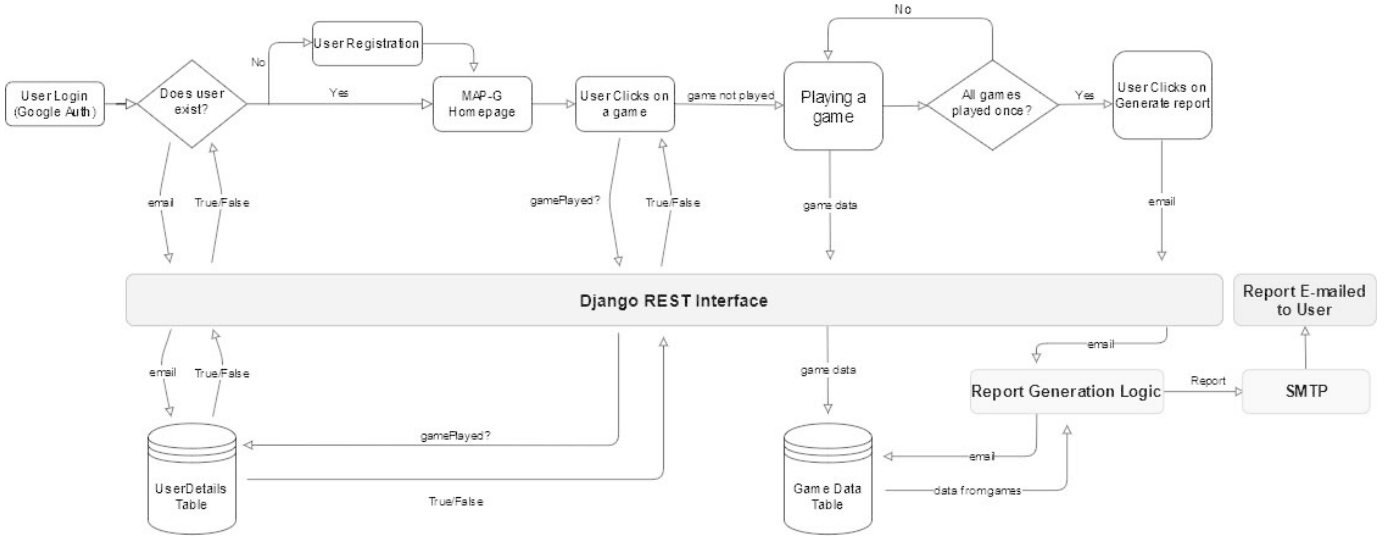


Fig. 1. An overview of the system.

TABLE III
EARN MAXIMUM

Type of Data	Traits Measured
Which Pile clicked	Risk
A positive change or negative	Behavioural analysis
Total money collected	Rationality

- In Emotion Predictor game a person has to decide the emotion of the person shown in the picture, either by reading the text as provided or by his intuition. Tab 4 shows the traits captured by this game.

TABLE IV
EMOTION PREDICTOR

Type of Data	Traits Measured
Which emotion selected	Personality reflection
Time taken to choose the emotion	Face study

C. Report Generation

The system uses a combination of K-Nearest Neighbour and Support Vector Machine hybrid classification. This has been used as the training complexity and run time complexity are practical and the final results of data set produced are reasonable. Considering the amount of data we have and the type of binary data with very less features using KNN as the first step made the task efficient and faster. It is a sturdy and straightforward technique. First, the initial test samples are checked to determine whether they satisfy a proximity condition using the KNN algorithm[9]. Each of the test patterns is separated, and the training set is sifted for a definite number of patterns to check for the approximate closeness of each pattern with the help of simple Euclidean distance formula :

$$d(x, y) = \sqrt{\sum_{i=1}^m (x_i - y_i)^2} \quad (1)$$

Furthermore, after this step, a Support Vector Machine is trained on the different training set patterns associated, and the classification is done on binary parameters. Numpy library in python has been used to create the SVM model.[10]The data generated by teachers is clustered and combined for matching traits before generating the statistical difference and assigning the binary value. SVM model ensures that even with a limited amount of data the approximation can be well measured[11] and also minimize the impact of anomalous results which may occur due to some sets of data having bias.

D. Results and Discussion

The data collected for different statistics were combined for similar features by quantitatively adding the same scalable values on the linear scale.[12] The cluster graphs were generated using the Matplotlib library for clustering with the extra knowledge of acceptance and rejections of the teachers. These have been generated to visualise how the data is spread and what is within the acceptable range. Different values of 'k' (n neighbours) were chosen separately for each kind of trait.[13] The best-fitting value can be varied and be chosen as per the choice of different traits. Below in Figures 2 and 3 is the graph for such two traits.

Similarly, the clustered scatter plots of all the traits are developed. Using the KNN-SVM hybrid algorithm, the scores of the new teacher are fetched and analyzed, and the analysis of whether the trait is imbibed for that player is produced.[14] Table 5 shows different players and their corresponding traits being followed after playing

TABLE V
ACCEPTANCE RATING AND TRAIT BOOLEAN TABLE FOR DIFFERENT NEW PLAYERS

Type of Data	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teacher 5
Critical Listening	1	1	1	1	1
Understanding Capability	1	1	1	1	1
Risk	1	0	0	1	0
Perceptiveness	1	1	1	1	0
Learning Capability	1	1	0	1	0
Behavioral Analysis	0	0	1	1	1
Rationality	1	1	1	1	1
Personality Reflection	1	1	0	1	0
Face Study	0	0	1	0	0
Acceptance Rating	78%	67%	67%	89%	44%

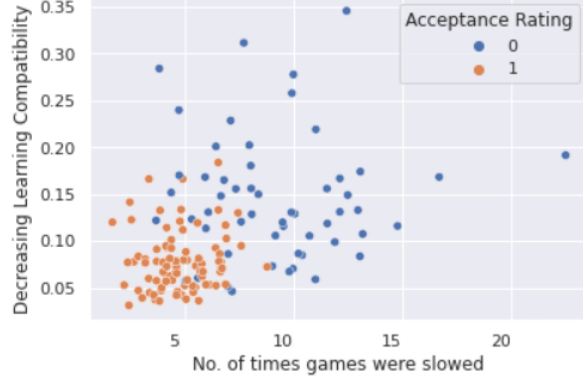


Fig. 2. No. of slow games



Fig. 3. Risk taking capacity

certain games. Our system takes these combined results and takes the mean effect of the same. Finally, using a simple similarity index, the final result is presented in the acceptance percentage on the basis of psychometric traits.[15] The formula finally used to assign the traits in boolean terms where a_i is the value of the same trait captured from different games :

$$X = \begin{cases} 1, & \text{if } \frac{1}{n} \sum_{i=1}^n a_i \geq 0.5 \\ 0, & \text{otherwise} \end{cases} \quad (2)$$

E. Conclusion

In this paper, a framework has been developed that adapts from psychometric tests and expands them to a sphere they are not currently being used in: to evaluate the mindset of teachers and candidates who aspire to be teachers someday. Since the final result is the mean of different parameters, the error resulting from a wrong bias of one or another parameter has very less impact on overall pass percentage. Apart from the mean percentage, it can be seen from the scattered plots the most of the responses are clustered around acceptance criteria; hence some anomalies occurring from some aspects can be easily measured without affecting the overall report. Hence this system works best when a sizeable amount of data for each trait is clustered into groups more clearly segregated into acceptance and non-acceptance criteria. The results can be improved if the data set collected by the playing of games is increased as the increase in the data set would further neutralize the effects of any anomalous results or biasedness being introduced by players, which could be due to earlier familiarity of the games being played. Another way to improve the result would be to check the attentiveness of user playing the game using Activity Monitoring Algorithm [17].

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