

COGNITIVE SCIENCE APPROACH TO ENHANCE STUDENT PERFORMANCE

The main goal of this case study is to utilize cognitive science principles to analyze and enhance student performance by understanding their behaviors, strengths, weaknesses, and factors of neurological, psychological, philosophical perceptive.

To achieve this,

OBJECTIVE: To Analyze the performance of a student including intelligence, memory, behaviour, classifying normal and abnormal and providing a Recommender system.

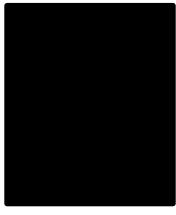
Constraints: <Time bounded (MID), <No timelines (Survey)>

Parameters: < Marks in exam, score-card for modelling, students intelligence, memory>

Input: <Survey Pre-exam, Mid Exam, Post survey form after mid exam>



Survey (assignment) Mid Exam



Google form

By conducting a thorough survey and analyzing the gathered data, our objective is to predict student exam preferences, identify outliers, and propose customized interventions based on insights from cognitive science.

METHODOLOGY:

1. Survey and Persona Analysis:

- We will gather data from three sources: surveys (assignment test) (before mid-exam), students' mid-exam answersheets, and a Google Form (Feedback form after Mid exam).
- Initially, conduct a detailed survey from students to gather information on their behaviors, study habits, and psychological traits, problem solving skills, diagrammatically skills, conceptual skills. There is no time constraint, survey (assignment test) was conducted in classrooms.
- Eliminate unreliable survey data through manual analysis of exam papers to ensure data accuracy. This could be done by checking if they had given the survey genuinely or not.
- Utilize the survey data to create personas for each student, including a SWOT(Strengths, Weaknesses, Opportunities, Threats) analysis, their psychological traits.
- The survey includes different types of questions. Some are logical, and others are creative, like making up a story using pictures or drawing complicated diagrams. There are also questions about yourself.

OUTPUT: DATA COLLECTION, UNDERSTANDING PERSONAS

2. Prediction Hypothesis: using DATA ANALYSIS AND STATISTICS

Data analytics is the science of integrating heterogeneous data from diverse sources, drawing inferences, and making predictions to enable innovation, gain competitive business advantage, and help strategic decision-making. The data analytics domain has evolved under various names including online analytical processing (OLAP), data mining, visual analytics, big data analytics, and cognitive analytics. Also the term analytics is used to refer to any data-driven decision-making.

- Based on the survey data, formulate hypotheses, predicting the type of questions each student is likely to attempt in the mid-exam.
- Compare predictions with actual exam data to identify matches and mis-matches.
- To understand the analysis statistics and probability mechanisms are to be performed.

Statistics has a two-way meaning. First, Statistics is concerned with scientific methods for collecting, organizing, summarizing, presenting, and analyzing data, as well as drawing valid conclusions and making relevant decisions on the basis of such analysis.

OUTPUT: STATISTICAL INFERENCES TO ANALYZE PROBABILITY

3. Mismatch Analysis:

- Convert the data to probabilities to know if our prediction was good. If it is good i.e if there are less mismatches, the data is said to be reliable and we could proceed.
- Investigate mismatches to determine reasons, such as time constraints or inadequate preparation.

OUTPUT: PROBABILISTIC ANALYSIS

EXAMPLE: If hobbies == problem solving , then student might attempt questions relating to problems and vice versa

4. Mid-Mark Prediction:

(ML) is a subset of artificial intelligence that develops dynamic algorithms capable of data-driven decisions, in contrast to models that follow static programming instructions. ML is concerned with enabling computer programs automatically to improve their performance at some tasks through experience.

- Convert the survey responses to scores on a scale of 10.
- Use survey responses to predict mid-term exam scores.
- Input numerical data into an Excel sheet for further analysis.

Perform Text analysis :Text mining is the data mining technique or process which discovers earlier unfamiliar and valuable information from a huge quantity of unstructured text data. This knowledge is then analyzed and processed for operators, so they can receive valid knowledge. Text mining contains various types of text data such as documents, plain text files, messages, HTML files, and e-mails. So, a huge amount of data is mined using text mining. Text mining can be categorized into different categories including—text clustering, text categorization, and document summarization.

OUTPUT: APPLYING ML MODEL TO PREDICT

5. Rule-Based Classifier:

To implement we can apply the concept of Knowledge discovery

Knowledge discovery in databases (KDD) was initially defined as the “non-trivial extraction of implicit, previously unknown, and potentially useful information from data” (Frawley et al., 1991). A revised version of this definition states that “KDD is the non-trivial process of identifying valid, novel, potentially useful, and ultimately understandable patterns in data” (Fayyad et al., 1996).

According to this definition, data mining (DM) is a step in the KDD process concerned with applying computational techniques (i.e., DM algorithms implemented as computer programs) to actually find patterns in the data. In a sense, DM is the central step in the KDD process. The other steps in the KDD process are concerned with preparing data for DM, as well as evaluating the discovered patterns (the results of DM)

- Develop a rule-based classifier to transform survey marks and actual mid-termmarks into a unified scale.
- Example: If (Survey Marks > 7 && Mid Marks > 20) → Score: 4.5/5.

OUTPUT: INPUT TO DATA MINING APPROACHES

NOTE: IN CASE OF LARGE DATASET WE IMPLEMENT BIG DATA

The term big data was first used by John Mashey [18] to refer to handling and analysing massive datasets. The concept of big data gained strength in the early 2000s when Doug Laney defined big data by the "3V's": volume, velocity, and variety. By this definition, "big data" refers to a large amount of data that increases fast and is difficult or even impossible to handle by traditional methods. The most common way of defining big data nowadays is by the "4V's" which adds veracity to the "3V's". The list below details each of the "4V's" based on : (a) Volume: refers to the amount, size, and scale of the data. The amount of data reaches such a level that it cannot be managed without dedicated analytic tools. The size can be defined either vertically by the number of samples in a dataset or horizontally by the number of features. (b) Velocity: refers to the speed by which the data is generated and how fast the data should be processed. (c) Variety: refers to the heterogeneity of the data. Big data often comes from different sources, which can be diverse in type, format, semantics, and volume. (d) Veracity: refers to the quality of the collected data. It is related to biases, noise, and abnormality in data. The accuracy of any analytic process applied to the data depends greatly on the veracity of the source data.

6. Association Rule Mining:

- Utilize Association Rule Mining algorithms (e.g., Apriori Algorithm, FP-Growth) to generate a scorecard for each student.
- The data now has Roll Number, Survey Marks, Mid Marks, Predicted MidMarks, Google Form Data, and Score from the classifier.

OUTPUT: CONFIDENCE, SUPPORT, CONFIDENCE, THRESHOLD FREQUENCY values

7. Data Analytics and EDA:

- Perform Exploratory Data Analysis (EDA) on the collected data.
- Utilize data visualization tools like Tableau to gain insights into individual and group performance.

OUTPUT: DATA SUMMARIZATION

8. Use Google form:

- You can use a Google form to find out student's interest in the subject and gather feedback about the faculty. This feedback can help determine if students are having difficulty understanding the lectures.

9. Identifying Outliers:

- From the numerical data, we could categorize students into 3 classes being Good, Average, Bad. Average Students can be given special attention
- The bad students or the outliers, such as students who excel in surveys and their predicted mid marks is also high but underperform in mid-term exams.
- Examples of outliers might include a student writing an answer which is not asked in exam, attempting 1a 2b questions where in you are suppose to answer 1a 1b or 2a 2b from question paper.
- These outliers become the focus of our further study.

OUTPUT: DATA CLEANING, FILLING NULL VALUES & HANDLING INCONSISTENT DATA

10. Reasons for Underperformance:

- Investigate reasons for underperformance, including lack of memory, conceptual understanding, and time management.
- Categorize causes into genetic, accidental, or incidental factors.
- To identify the root cause of these factors, we can examine whether there are any issues in the motor nervous system, peripheral nervous system, or central nervous system. This examination will help us pinpoint the underlying cause.
- In executing above we need to apply interdisciplinary concepts of DL AND AI
 - Deep learning refers to a class of algorithms which are based on artificial neural networks optimized to work with unstructured data such as images, voice, videos and text. Deep Learning (DL) provides powerful tools for a wide range of robotics-related tasks, ranging from solving complex perception problems to performing end-to-end control and planning.
 - ⊕ Artificial intelligence (AI) is the intelligence exhibited by machines, which mimic humans. The major goals of AI are analytical, human-inspired, and humanized AI. Analytical AI is to incorporate cognitive intelligence to machines, which means understanding the previous experiences and applying that knowledge in future decisions. Human-inspired AI is conglomeration of two ideas, which are cognitive and emotional intelligence; besides cognitive intelligence, interpretation of human emotions and contemplating them in

their decisions.

11. Intervention Measures:

- To execute we need to implement Cognitive computing concepts

Cognitive computing is an emerging field ushered in by the synergistic confluence of cognitive science, data science, and an array of computing technologies. Cognitive science theories provide frameworks to describe various models of human cognition including how information is represented and processed by the brain. Cognitive neuroscience investigates the emergence of cognitive function from the physical and chemical activity of neurons in the brain. Active representations in the brain consist of patterns of neural activity, processing takes place through the propagation of activity via excitatory and inhibitory connections, and learning and memory arise primarily through the modification of connections.

Cognitive psychology is that specialty area of psychology concerned with the examination of how knowledge is acquired, how it is internally represented, how it interacts and modifies or is modified by previous experience and existing information, and how acquired knowledge affects feelings and behavior. The subject matter encompasses not only the process of thinking (attention, concentration, consciousness, memory), but also an examination of emotions and motivation in relation to cognition. There has been a dramatic shift in the theoretical base of clinical psychology since the 1940s from psychoanalytic and behavioral models to cognitive models as the task of clinical psychology has changed to encompass more than simply disturbed behavior and maladaptive habits.

- Propose tailored intervention measures based on the identified causes.
- If the causes are incidental, meaning changes in behavior due to specific events, it could lead to feelings of depression. In such cases, it is recommended to consider behavioral therapies or stress management to address and manage these issues.
- For genetic factors or accidental factors that involve mutations or changes to brain, we need to go for neurological solutions within the realm of cognitiveneuroscience.

Computer simulation is the process of mathematical modelling, performed on a computer, which is designed to predict the behaviour of, or the outcome of, a real-world or physical system. The reliability of some mathematical models can be determined by comparing their results to the real-world outcomes they aim to predict.

RECOMMENDATIONS:

- ⊕ COGNITIVE BEHAVIOURAL THERAPY
- ⊕ GAMING APPROACHES
- ⊕ NEUROLOGICAL APPROACH

NOTE:

Text mining also referred to as text analytics is a similar approach to AI method that utilizes natural language processing. Here, the data or information in an unorganized manner is

made into an organized or structured format using different datasets. The output given by this method is embodied in various databases and helps to facilitate the predictive analysis of compounds. Evidence from medical and pharmaceutical fields may contain a vast range of data regarding drugs, diseases, and others