Optimizing HealthCare Interventions for Cognitive Enhancement and Quality of Life

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Abstract: *To improve quality of life and cognitive function, this initiative optimizes healthcare interventions through utilizing an encompassing system for mental health evaluation and mentor-led assistance. The initiative aims to tackle the intricacies associated to mental health by adopting a comprehensive approach, given its vital role in modern society's total well-being. The mentees, or individuals, are able to contribute valuable insights into their mental well-being using standardized surveys that are used by the system to gather mental health data. Additionally, it creates a platform that mentors can use to evaluate the cognitive of their individual mentees. This mentor-led assessment enhances the evaluation process by incorporating the unique dynamics of mentor-mentee interactions, providing a more personalized approach. Furthermore, the system utilizes machine learning models to analyze the collected information and generate tailored recommendations based on the assessment outcomes. These suggestions aim to increase cognitive well-being by offering doable ideas and methods for development.*

KEYWORDS: *HealthCare, Quality of Life, Mental Health, Machine Learning.*

I. INTRODUCTION:

The value of mental health and well-being is becoming more widely acknowledged in modern culture as a critical aspects of general health. Mental health includes a state of well-being that allows people to manage life's obstacles, work effectively and give back to their communities. It extends beyond mere absence of mental illness. Assure that to improve cognitive performance and quality of life, this project explores the study of mental health optimization by putting forth a comprehensive system that combines data collecting, mentor-led examinations, and individualized recommendations.

A considerable section of the world's population struggles with mental health concerns, and finding creative solutions that go beyond conventional methods is necessary to treat these problems. The approach under consideration recognizes the interdependence of mental health and other aspects of an individual's life, The elements includes surroundings, interpersonal connections and individual experiences. The system uses structured questionnaires to gather data on mental health to be able to present a more comprehensive picture of each person's mental health.

In Impoverished or developed nations as well, one of the largest problems is facing mankind in access to healthcare. Improved quality of life is the primary main incentive in the background of the creation of intelligent, productive, secure healthcare system worldwide. Working in these topics has attracted researchers from a variety of backgrounds such as neuroscience and psychology because of the early studies of human behaviour. In the expanding fields of computer science and machine learning research, this is also the case. Things like that don't happen very often, especially with adolescents and young adults.

II. LITERATURE REVIEW:

Healthcare is among the major problems faced by the entire world regardless of the situation whether the country is developing or developed. As a leading interest worldwide, smart, efficient, and secure healthcare systems are developed to Improve the quality of life. The early studies of human behaviour have attracted the researchers of different fields to work in the discipline of psychology and

Neuroscience The same is the case with the growing field of research in computer science and machine learning. Identifying the mental health issues of a patient is an enduring challenge to doctors and healthcare organizations and especially among younger people, is not a new phenomenon [1].

Through the application of deep learning methodologies, machine learning algorithms can analyze this dataset to detect patterns and signals of mental disorders. Leveraging machine learning algorithms to forecast mental health conditions can result in interventions that are more individualized and precisely tailored [2].

[3] A novel feature selection method has been developed to effectively choose relevant features even when the feature set vastly exceeds the sample size. This method facilitates the creation of models capable of identifying depression at distinct time intervals, taking into account an extensive array of features calculated over preceding weeks.

The results illustrates that Support Vector Machine, with an astounding F1-score of 89.7%, is the top classifier for sentiment analysis. This implies that SVM excels at correctly categorizing diary entries as good or negative, offering a useful tool for deciphering readers' emotional states. Moreover, a variety of positive and negative variables linked to resilience are shown by the theme analysis. Positive themes like self-efficacy, thankfulness, and socializing show sources of strength and resilience, while negative themes like stress, loneliness, and depression reflect the difficulties people confront[4].

This paper appears to offer a state-of-the-art framework and method for using predictive analytics with digital health devices. An environment that is powerful for evaluating mental health records is created through the integration of different components, including machine learning models, connectors for electronic health record sources, and natural language processing services[5].

With the progress in medical imaging and computational capabilities, novel techniques emerge for promptly identifying neurocognitive disorders, aimed at staving off or mitigating cognitive deterioration. Employing computer-assisted image analysis for early recognition of cognitive alterations represents a hopeful strategy, particularly for individuals experiencing mild cognitive impairment, which can serve as an initial phase leading to disease [6].

The suggested method, which focuses on the stressors faced by nurses, uses a variance-based feature selection methodology called QLESMO (Q-learning embedded Starling Murmuration Optimiser) to find pertinent characteristics from a dataset gathered during the Covid-19 outbreak. This method seeks to accurately distinguish between stressed and non-stressed individuals by choosing the most informative traits.[7]The potential impact of digital technologies on enhancing mental health outcomes has garnered attention the application of artificial intelligence to the evaluation, diagnosis, and treatment of mental health conditions[8].

Depression and quality of life (QOL) in hemodialysis patients may be influenced by changes in lifestyle brought on by end-stage renal illness. In this cross-sectional study, 124 hemodialysis patients' nutritional status, quality of life, and depression were investigated. According to these findings, people requiring longer dialysis sessions and lower health literacy levels need special care regimens. Future research focus on comprehending the connections between non-modifiable patient features and psychosocial consequences.[9]

The automatic social media depression detection has gained significant attention as a field of study. We developed an automated model to fill out the Becks Depression Inventory (BDI) questionnaire using the eRisk 2021. this model for inference on a population dataset of Canadians and contrasted its predictions with researches of Statistics Canada mental health survey.[10]

III. METHODOLOGY:

1 System Architecture: The System architecture involves the components as depicted in the Diagram. Data is gathered concerning factors indicative of an individual's mental health status. Then data undergoes through preprocessing i.e Crucial for converting unprocessed data into a refined form, organized format suitable for training predictive models. The required data is trained to classifying model and testing it with the validation

data. The results provides the interface to the users to indicate their mental health based on their responses. It signifies the extent of their mental stress, spanning from mild to moderate to severe. Subsequently, users receive tailored suggestions aimed at enhancing their overall mental well-being and quality of life.

Architecture diagrams show the interactions between software components. It offers a means of visualizing the parts, associations and interactions inside the system. It displays the various system components. It might be used for specific services, databases, libraries, or user interfaces. An architecture diagram encompasses key elements such as modules or their interconnections, as well as the flow of data or control among them. It helps to comprehend how the software is organized, how different components are assigned duties, and the underlying design philosophy.

2 Data Input: The user input's the data using interactive questionnaire form, A structured form is provided for users to input their responses.. The interactive questionnaire form is the primary interface for users to input their data, It plays an essential role in the initial phase of gathering valuable information. about their cognitive functionality and various activities affecting overall mental wellbeing. The form might ask about emotional states, daily mental activities, lifestyle factors affecting mood and cognition, and any symptoms or concerns related to mental health.

3 Data Preprocessing: Preprocessing within machine learning involves converting unprocessed data into a structured and refined format suitable for training predictive models. Preprocessing aims to enhance the quality of the data and potentially improve the model's performance to make it more receptive to the algorithms. Handling of data can be either eliminating the data entries containing missing values, predict the missing values using more sophisticated algorithms. The preprocessing layer splits the data into training and validation data. It uses the labelled data stored in the dataset. Then machine learning model is trained using ML Algorithm that builds the ML Classification model to classify the individuals into different levels of mental stress and decline in cognitive performance. Machine learning model is trained using ML Algorithm that builds the ML Classification model to classify the individuals into different levels of mental stress and decline in cognitive performance.

4 Machine Learning (ML) Model: The ML model builds predictive models trained on data to forecast future cognitive health outcomes for individual users. This may involve predicting the chances of developing certain mental health conditions, cognitive decline trajectories, or response to different intervention strategies. According to the predictive models, the ML model assesses the risk levels linked to different mental health factors and conditions. It can identify individuals at higher risk of experiencing cognitive decline or mental health issues, enabling proactive interventions and preventive measures.

The system architecture for the proposed system is depicted in Figure 3.1

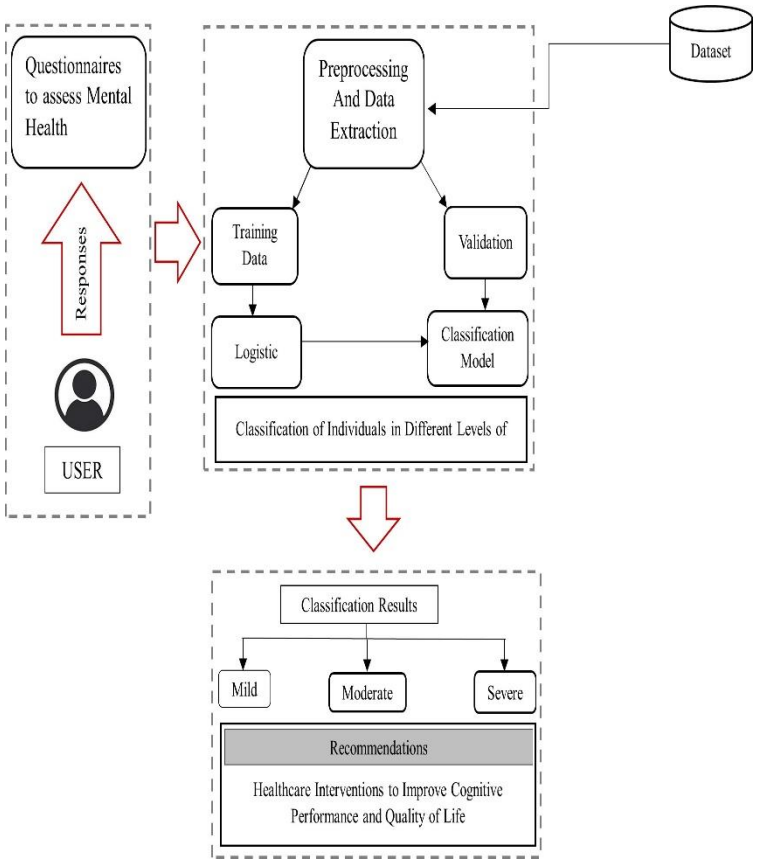

Figure 3.1: System Architecture

We have compared following three ML algorithms for training the model. These techniques comprise Random Forest, Support Vector Machine, and Logistic Regression. After comparing their performance, we selected the most effective method for prediction, which in this case is Logistic Regression.

Various factors can indicate mental health status, and selecting relevant factors depends on the

specific context, population, and goals of the assessment. We have considered the following factors: Age, Gender, Sleep quality, Physical activity level, Diet quality, Substance use (alcohol, drugs), Stress level, Perceived social support and mental health background, History of treatment (therapy, medication), Relationship status etc.

4.1 Logistic Regression: Logistic regression predicts the likelihood of an observation belonging to a specific class by initially calculating a linear combination of predictor variables. For a binary classification problem with n predictor variables, the linear combination can be written as:

$$\text{logit}(p) = \beta 0 + \beta 1x1 + \beta 2x2 + \cdots + \beta nxn \quad (4.1)$$

logit(p) is the log-odds of the probability p of the positive class.

$\beta 0$ is the intercept term (bias).

$\beta 1 + \beta 2 + \cdots + \beta n$ are the coefficients (weights) associated with the predictor variables $x1 + x2 + \cdots + xn$ respectively

The linear combination is then transformed using the logistic function (also known as the sigmoid function) to constrain the output between 0 and 1. The logistic function is defined

$$\text{logistic}(x) = \frac{1}{1+e^{-x}} \quad (4.2)$$

The transformed equation becomes:

$$p = \frac{1}{1+e-(\beta 0+\beta 1x1+\beta 2x2+\cdots+\beta nxn)} \quad (4.3)$$

Where p represents the probability of the positive class.

4.2 Mental Health Score Calculation: Mental Health score is calculated based on user inputs for factors indicating mental health, and then categorizes the severity of depression based on the score. Depression severity is categorized into three classes mild, moderate and severe. Depression severity categories encoded into numerical variables suitable for logistic regression. We have assigned weights to each feature and each category of depression severity based on their perceived importance or contribution to depression severity. After feeding an individual's features into the logistic regression model, We derive estimated probabilities for every level of depression severity (for instance, mild, moderate, severe).

We calculate the mental health score as the weighted sum of features and predicted probabilities.

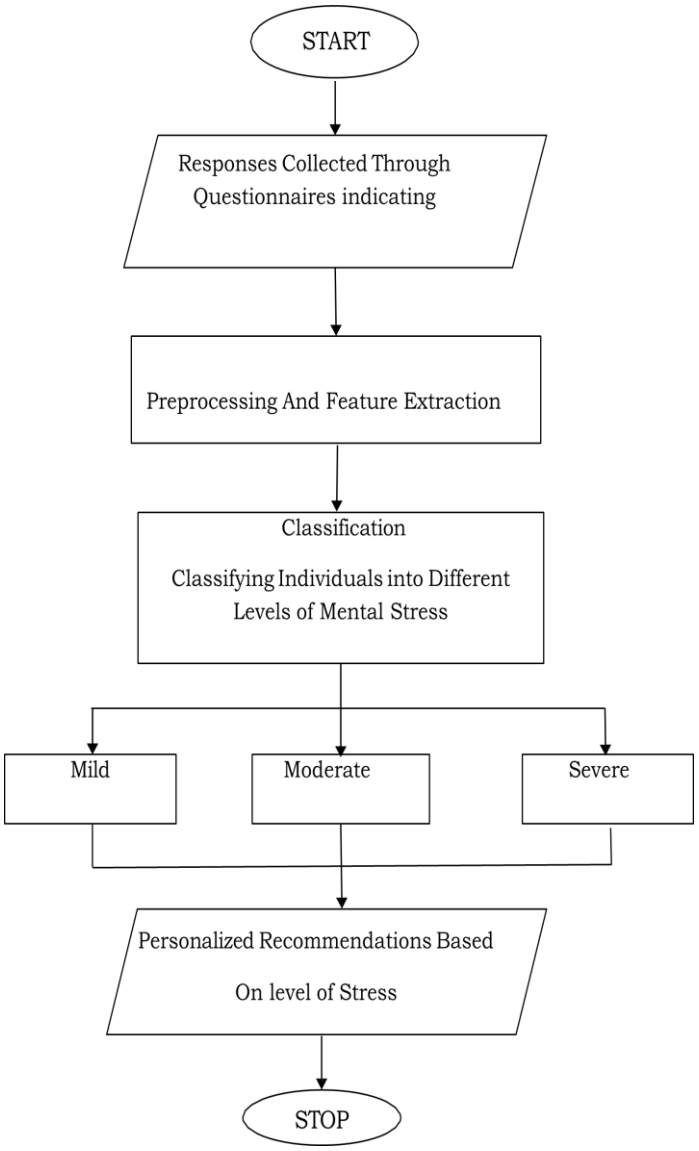

Figure 3.2: Flowchart of Proposed System

We calculate the mental health score as the weighted sum of features and predicted probabilities.

$$MHS = w_1 \times f_1 + w_2 \times f_2 + \cdots + w_n \times f_n + w_{n+1} \times P(mild) + w_{n+2} \times P(moderate) + w_{n+3} \times P(severe) \quad (4.4)$$

Equ(4.4) gives formula for mental health score calculation.

MHS is the mental health score.

f_i are the values of the features associated with depression severity.

w_i are the weights assigned to each feature f_i

P(mild), P(moderate), P(severe) are the predicted probabilities of each depression severity category obtained from the logistic regression model.

IV RESULTS:

The results of eight different user's whose mental health score is calculated based on the inputs provided by them is shown in the figure 4.1.It categorises the individuals into three different classes the score below 300 is categorized as severe depression, between 300 and 450 is categorized as moderate depression and above 450 is categorized as mild depression. We derive estimated probabilities for every level of depression severity (for instance, mild, moderate, severe).

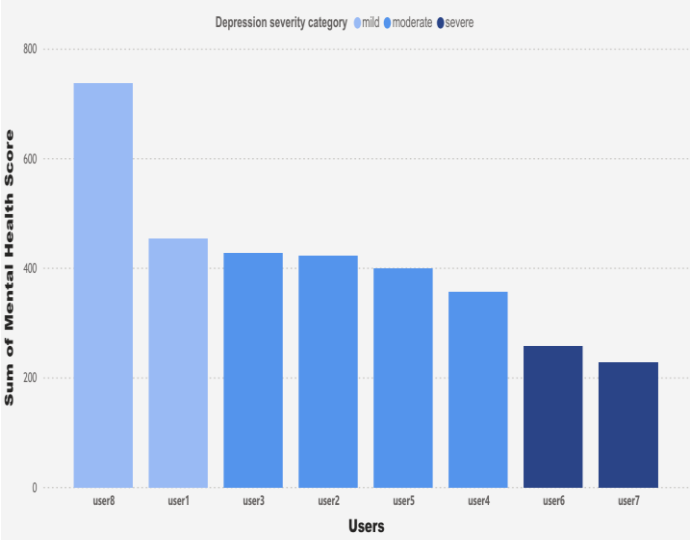

Figure 4.1: Categorization of user on mental health scores

V. CONCLUSION:

Our study demonstrates that logistic regression can effectively predict depression severity based on demographic and Lifestyle Factors. While our discoveries offer valuable understandings into evaluating depression, They are bound by specific constraints., including reliance on self-reported data and potential selection bias. Subsequent investigations should concentrate on validating the findings in larger and more diverse populations and exploring the practical applicability of the logistic regression model in real-life scenarios. Overall, our study contributes to advancing our understanding of depression assessment and classification, laying This forms the basis for future research endeavors aimed at enhancing mental health outcomes and reducing the burden of depression on individuals and society.

REFERENCES:

[1.] Massod Habib, Zhelong Wang, Sen Qiu, Hongyo Zhong, Aparna S. Murthy, "Machine learning healthcare system for investing the association between depression and quality of life", IEEE Access, vol.26,1-13 pp,2022.

[2] M.Srividya, S. Mohanavalli, N. Balaji,"Behavioural Modelling For Mental Health using Machine Learning Algorithms", Springer Science, 2018.

[3] Prerna chikersal, Afsaneh Doryab, Michael Tumminia,et.al, "Detecting Depression and Predicting its Onset Using Longitudinal Symptoms Captured by Passive Sensing: A Machine Learning Approach With Robust Feature Selection", ACM Transactions on Computer-Human Interaction, Vol. 28, No. 1, Article 3. 2021.

[4] Adenrele Oduntan, Oladapo Oyebode , Amelia Hernandez Beltran, Jonathon Fowles, Darren Steeves, and Rita Orji, ""I Let Depression and Anxiety Drown Me…": Identifying Factors Associated With Resilience Based on Journaling Using Machine Learning and Thematic Analysis", IEEE journal of biomedical and health informatics, vol. 26, no. 7, 2022.

[5] Yamiko Joseph Msosa , Arturas Grauslys , Yifan Zhou , Tao Wang Steven Foster, Michael Walker, Michael Pearson, Amos Folarin Simon Maskell , Iain Buchan , Paul Langan, , Angus Roberts , Member, IEEE, Richard Dobson , Cecil Kullu , , and Dennis Kehoe,"Trustworthy Data and AI Environments for Clinical Prediction: Application to Crisis-Risk in People With Depression", IEEE journal of biomedical and health informatics, vol. 27, no. 11, 2023

[6] Sergio Grueso and Raquel Viejo-Sobera, "Machine learning methods for predicting progression from mild cognitive impairment to Alzheimer's disease dementia: a systematic review", Grueso and Viejo-Sobera Alzheimer's Research & Therapy, 2021.

[7] Syed kumayl raza moosavi , muhammad hamza zafar,filipposanfilippo , malik navee dakhter and Shahzaib farooqhadi, “Early Mental Stress Detection Using Q-Learning Embedded Starling Murmuration Optimiser-Based Deep Learning Model”, IEEE access,2023.

[8] Christopher Burr , Jessica Morley, Mariarosaria Taddeo, and Luciano Floridi, “Digital Psychiatry: Risks and Opportunities for Public Health and Wellbeing”, IEEE transactions on technology and society, vol. 1, no. 1,2020.

[9] S. C. Daniel, A. Azuero, O. M. Gutierrez, and K. Heaton, “Examining the relationship between nutrition, quality of life, and depression in hemodialysis patients,”, vol. 30, no. 3, pp. 759–768, 2021.

[10] Ruba S. Skaik And Diana Inkpen, “Predicting Depression in Canada by Automatic Filling of Becks Depression Inventory Questionnaire”, IEEE Access, vol 10,2022.

[11] Hsiu-Sen Chiang , Mu-Yen Chen Member, IEEE, And Li-Shih Liao, “Cognitive Depression Detection Cyber-Medical System Based On EEG Analysis And Deep Learning Approaches “,IEEE journal of biomedical and health informatics, vol. 27, no. 2, February 2023.

[12] Alice Othmani , Bechir Brahem, Younes Haddou, And Mustaqeem,” Machine-Learning-Based Approaches For Post-Traumatic Stress Disorder Diagnosis Using Video And EEG Sensors: A Review”, IEEE Sensors Journal, Vol. 23, No. 20, 15 October 2023.