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Developing a Machine Learning-Based Healthcare System to Investigate the Relationship between Depression and Quality of Life

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ABSTRACT: Recent technological advancements are reshaping the future of the healthcare system. Recognizing the factors contributing to depression is crucial for advancing research and developing innovative therapies, given the increasing prevalence of depression as a major global public health concern. This paper introduces a comprehensive methodological framework utilizing machine learning methods to process and explore heterogeneous data, aiming to enhance our understanding of the intricate relationship between depression and quality of life. The experimental investigation is structured into two main sections. The first section outlines a data consolidation procedure, where data connections are established using the Secure Hash Algorithm to uniquely identify each data relation. Hashing is employed to locate and index the real objects within the data. In the second section, a model is presented, incorporating both unsupervised and supervised machine learning approaches. The data consolidation technique facilitates the formulation and validation of research hypotheses. The Self-Organizing Map generates eight cluster solutions, and classification problems are derived from the clustered data to assess the performance of the posterior probability multi-class Support Vector Machine. The assumptions regarding the significance of sampling unveil factors contributing to despair. The proposed model significantly improves classification performance, achieving an accuracy of 91.16%

Keywords *– Depression, healthcare, quality of life, secure hash algorithm SHA-1, supervised learning, unsupervised learning.*

1. INTRODUCTION

Healthcare is one of the most pressing issues confronting the whole globe, regardless of whether the nation is developing or developed. Smart, efficient, and secure healthcare systems are being created as a major focus globally in order to improve people's quality of life. Early studies of human behaviour drew academics

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from several backgrounds to engage in the disciplines of psychology and neuroscience. The same is true for the expanding area of computer science and machine learning research. Identifying a patient's mental health difficulties is a persistent difficulty for physicians and healthcare organisations, particularly among younger individuals. Recent breakthroughs in the area of machine learning and deep learning have shown their ability to spot psychiatric illnesses in people as well as the effect of such disorders on their lifestyle. The most significant growth-related shift among individuals all across the globe is a change in mental health. As a result, sadness and anxiety are regarded as the two most serious age-related diseases. Both have a negative impact on patients' quality of life (QoL) and impair the decision-making system, resulting in a high degree of suffering and, in the end, a suicide attempt. "Depression" is regarded as one of the most complicated and dangerous psychological issues, with a negative effect and being the leading source of illness burden among all disorders. As a result, many scholars and medical personnel have directed their research efforts on the study of depression. Depression, according to the World Health Organization, will be one of the top causes of mortality and disease by 2030. After effective therapy, the influence of depression remains and continues its fight in reducing performance and overall impairing an individual's QoL.

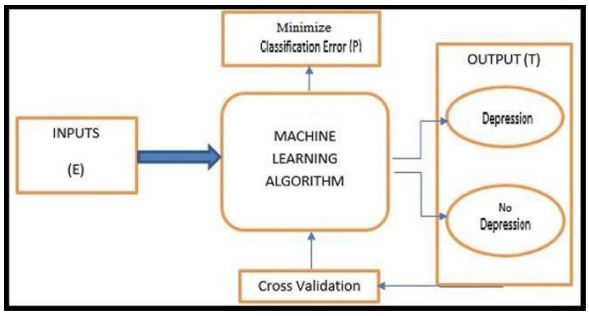

Fig.1: Example figure

The word "Quality of Existence" refers to several aspects of a person's life, such as emotional, physical, and psychological well-being. These characteristics describe an individual's life experience and are being studied by many researchers and health specialists. Similarly, [10] focuses on two points: (1) gaining information of the linkages between quality of life, nutritional status, and depression in patients; and (2) discovering the potential to improve patients' quality of life and psychosocial outcomes. Some people never discuss their personal troubles, such as financial difficulties, sex lives, and personal relationships, until they are questioned. As a result, assessing QoL traits reveals underlying difficulties in these patients and leads to better treatment. Numerous research have been conducted in the past 30 years to examine QoL in a variety of medical fields. Determine the importance of QoL in connection to mental issues, particularly in psychology and psychiatry. Machine learning has the potential to explore for QoL factors in a wider method to uncover the relationship between depression and QoL qualities.

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2. LITERATURE REVIEW

Big data and machine learning meet the health sciences:

In health sciences research, big data and machine learning are gaining popularity. They might give prediction models for clinical practise as well as public health systems. Big data is a general word that refers to massive amounts of complicated measurements. Big data encompasses administrative, molecular, therapeutic, environmental, sociodemographic, and even social media information in addition to genomics and other "omic" domains. Machine learning, also known as pattern recognition, refers to a set of methods for analysing large amounts of data by discovering patterns of interaction between characteristics. In contrast to conventional statistical approaches, which generally give average group-level findings, machine learning algorithms enable forecasts and segmentation of clinical outcomes at the individual subject level. In this chapter, we offer a brief historical overview of some significant events in health sciences, as well as the analytical tools used to identify causes and cure disorders. The overarching goal is to understand why big data and machine learning have lately emerged as potential tools for defining, predicting, and treating diseases, and how they might change the way we think about care in health sciences.

Machine learning in mental health: A scoping review of methods and applications

The purpose of this study is to synthesise the literature on machine learning (ML) and big data applications for mental health, emphasising current research and practical implementations. Methods: To quickly map the field of ML in mental health, we used a scoping review process. For articles addressing this subject, eight health and information technology research databases were searched. Two reviewers evaluated the articles, and data on the article's mental health application, ML approach, data type, and research findings were retrieved. After that, the articles were synthesised using narrative review. Results: Three hundred publications on the use of machine learning to mental health were discovered. The literature identified four major application domains: I detection and diagnosis; (ii) prognosis, treatment, and support; (iii) public health; and (iv) research and clinical administration. Depression, schizophrenia, and Alzheimer's disease were the most prevalent mental health issues treated. Support vector machines, decision trees, neural networks, latent Dirichlet allocation, and clustering were among the ML approaches used. Conclusions: The use of ML in mental health has showed a variety of advantages in diagnosis, treatment and support, research, and clinical administration. With the bulk of research concentrating on the detection and diagnosis of mental health issues, it is clear that there is much opportunity for applying ML

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to other areas of psychology and mental health. The difficulties of using ML approaches are highlighted, as are chances to enhance and progress the subject.

Persuasive technology for mental health: One step closer to (Mental health care) equality?

The worrying trend of rising mental health disorders, along with the worldwide failure to discover effective solutions, is impeding both individual and society success. There are many and significant barriers to accessing mental health treatment, ranging from socioeconomic inequality to personal stigmas. This affords technology, particularly artificial intelligence-based technology, the ability to assist ease the problem and provide several distinct advantages. The multidisciplinary and interdisciplinary study on persuasive technology, which aims to influence behaviour or attitudes without deceit or compulsion, has promise in boosting well-being and thereby increasing equality. This article provides a short introduction of such systems, as well as general, technical, and critical perspectives on implementation and effect in terms of possible advantages and hazards. We think that such technology may supplement current mental health care solutions by reducing access inequities as well as those caused by a lack of access.

Assessing anxiety and depression with respect to the quality of life in cancer inpatients receiving palliative care

The study used the Hospital Anxiety and Depression Scale (HADS) to assess the presence of anxiety and depression in cancer inpatients receiving palliative care at an oncology department, and to determine whether anxiety and depression contribute to a lower quality of life when pain and illness severity were controlled for. The participants in this cross-sectional research were 225 advanced cancer patients (a mean age of 65.1 years). The HADS, EORTC QLQ-C30, and Karnofsky Performance Status scale were used to gather data. Anxiety (HADS-a 8) was discovered in 33.9% of patients, while depression (HADS-d 8) was observed in 47.6%. Patients living with a spouse ($p = 0.042$) and non-religious patients ($p = 0.045$) had higher anxiety levels. Anxiety, depression, and all quality of life characteristics were shown to have correlations ($r = 0.31$-0.63). Anxiety and sadness, according to multiple regression analysis, correlate to worse physical and emotional functioning. Anxiety (HADS-a 8) and depression (HADS-d 8) patients reported worse overall quality of life (p 0.01). Conclusion: Managing anxiety and depression in cancer patients getting palliative care may help to enhance some aspects of quality of life.

Fast screening of depression in cancer patients: The effectiveness of the HADS

L. CASTELLI, L. BINASCHI, P. CALDERA, A. MUSSA, and R. TORTA (2010) European Cancer Care Journal The usefulness of the HADS for rapid screening of depression in

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cancer patients In oncology clinics, there is a growing need for quick and reliable screening scales and processes to assess cancer patients for depression. The current research compared the Hospital Anxiety and Depression Measure (HADS), a self-report screening scale, with the Montgomery-Asberg Depression Rating Scale (MADRS), a semi-structured clinician-rated scale, in identifying depressed individuals in 151 patients with diverse cancer pathologies. The MADRS recognised 73.5% of patients as depressive, but the HADS identified 36.4% and 58.3% of patients as depressed, using cut-offs of 11 and 8, respectively. The findings show that when a cut-off of 8 is employed, there is considerable agreement between the MADRS and the HADS (K-test: 0.44), however adopting a HADS cut-off of 11 leads in a much larger underestimating of depressive individuals (K-test: 0.29). Finally, the findings imply that the HADS may be used as an adequate first-step screening tool for depression in mixed oncology settings.

3. METHODOLOGY

Support Vector Machine (SVM) is a fast and reliable classification technique that is utilised in a variety of real-world applications. SVM's performance and efficiency are mostly determined by its parameters. When compared to other classification algorithms, SVM has a greater recognition rate. Vapnik presented the SVM theory at Bell labs. Though SVMs were initially designed to be binary classifiers, there have been various suggested adaptations to support multiclass classification. Additional parameters and restrictions are introduced to the optimization problem in these additions to manage the separation of the distinct classes. The most frequent approaches for applying SVMs to multi-class classification issues divide multi-class problems into two-class problems. Because of its ideal learning efficiency, SVM has been a research hotspot in machine learning in recent years.

Disadvantages:

1. The model's inefficiency

2. The identification of elements that cause depression may lead to novel research and therapies.

3. Because depression is becoming a major public health problem across the globe.

Using machine learning methods, this paper proposes a comprehensive methodological framework for processing and exploring heterogeneous data in order to better understand the relationship between quality of life and depression. As a result, the experimental investigation is separated into two sections. The first section describes a data consolidation procedure. The data connection is constructed, and the Secure Hash Algorithm idea is used to uniquely identify each data relation. Hashing is used to find and index the data's real objects. The second section offered a model that used

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both unsupervised and supervised machine learning approaches. The consolidation technique aided in the creation and confirmation of the research hypothesis. The Self organising map generated 08 cluster solutions, and the classification problems were drawn from the clustered data to verify the performance of the posterior probability multi-class Support Vector Machine.

Advantages:

1. The suggested model was used to enhance classification performance.
2. The results demonstrated that our suggested model has a good level of classification accuracy.

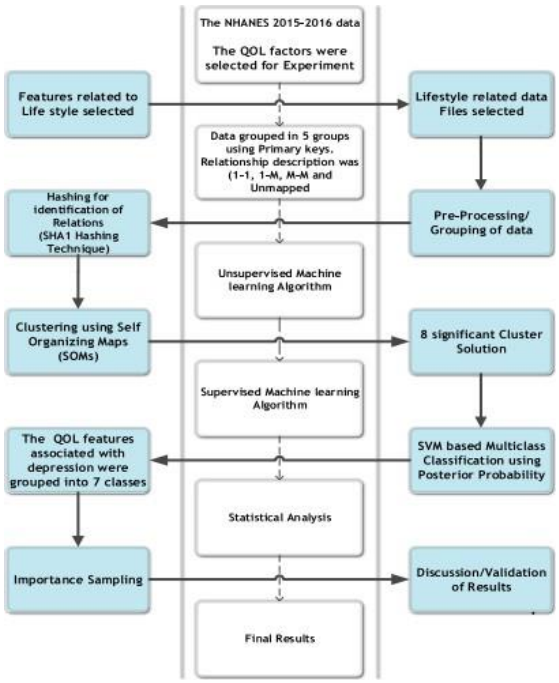

Fig.2: System architecture

MODULES:

To carry out the aforementioned project, we created the modules listed below.

- Data exploration: we will put data into the system using this module.
- Processing: we will read data for processing using this module.
- Data splitting into train and test: Using this module, data will be split into train and test.
- Model generation: Random Forest - Decision Tree - Naive Bayes - Support Vector Machine - Voting Classifier - PPMCSVm - KNN.
- User registration and login: Using this module will result in registration and login.
- User input: Using this module will provide input for prediction
- Prediction: the final projected value will be presented

4. IMPLEMENTATION

ALGORITHMS:

Random Forest: A Supervised Machine Learning Algorithm that is commonly utilised in Classification and Regression applications. It constructs decision trees from several samples

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and uses their majority vote for classification and average for regression.

Decision Tree: Decision trees use numerous methods to determine whether or not to divide a node into two or more sub-nodes. The development of sub-nodes promotes the homogeneity of the sub-nodes that arise. In other words, the purity of the node rises in relation to the target variable.

Naive Bayes: A probabilistic classifier, the Naive Bayes classification technique. It is based on probability models with high independence assumptions. The independence assumptions often have little effect on reality. As a result, they are seen as naïve.

SVM: Support Vector Machine (SVM) is a supervised machine learning technique that may be used for both classification and regression. Though we call them regression issues, they are best suited for categorization. The SVM algorithm's goal is to identify a hyperplane in an N-dimensional space that clearly classifies the input points.

Voting classifier: A voting classifier is a machine learning estimator that trains numerous base models or estimators and predicts based on the results of each base estimator. Aggregating criteria may be coupled voting decisions for each estimator output. A voting regressor is a meta-estimator ensemble that fits numerous base regressors on the whole dataset. The individual guesses are then averaged to give a final prediction.

KNN: KNN is a basic algorithm that maintains all existing examples and classifies incoming data or cases based on a similarity metric. It is often used to classify a data point based on the classification of its neighbours. Because it delivers very precise predictions, the KNN algorithm can compete with the most accurate models. As a result, the KNN method may be used for applications that need high accuracy but do not require a human-readable model. The accuracy of the forecasts is determined by the distance measure.

5. EXPERIMENTAL RESULTS

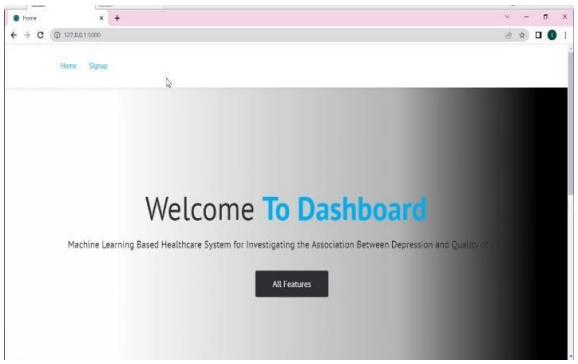

Fig.3: Home screen

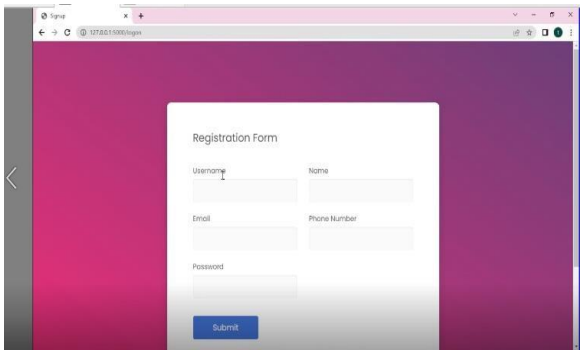

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Fig.4: User registration

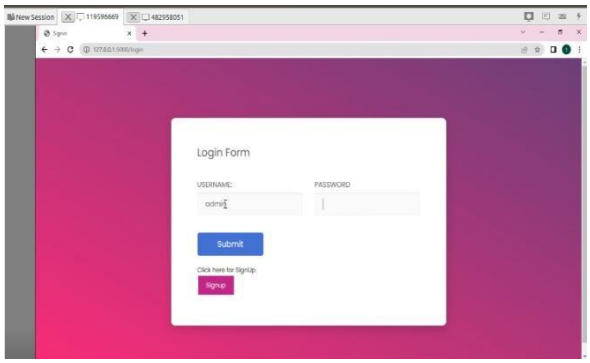

Fig.5: user login

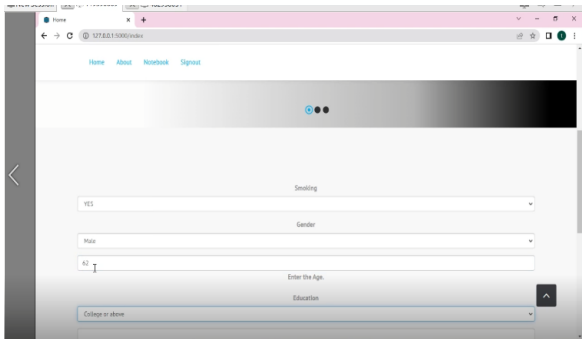

Fig.6: Main screen

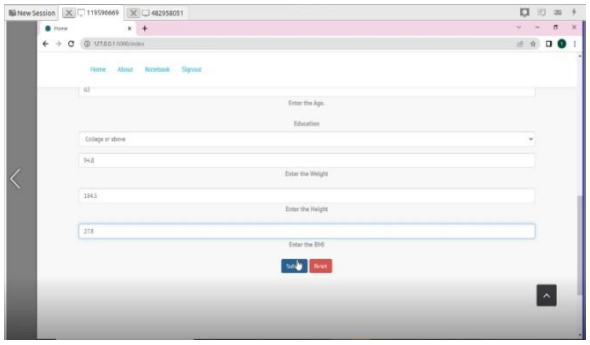

Fig.7: User input

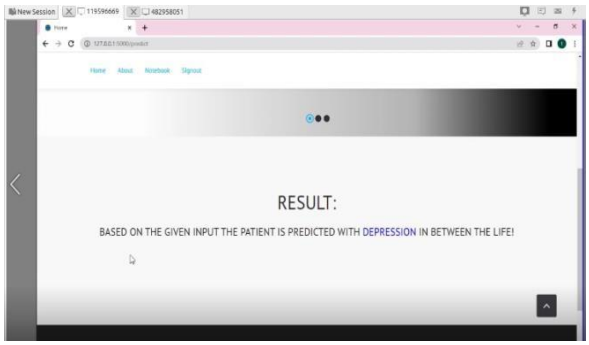

Fig.8: Prediction result

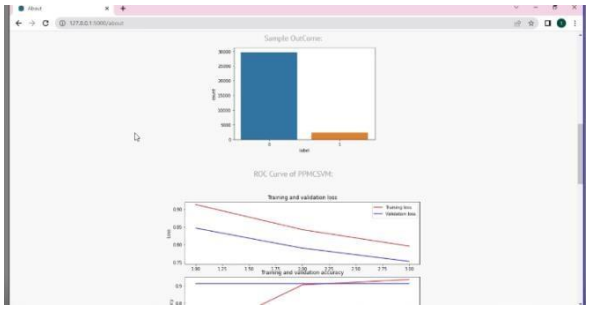

Fig.9: Graphs

6. CONCLUSION

Identifying mental health issues is seen as a difficulty by physicians and healthcare organisations. Using NHANES data, our results reveal that there is a relationship between depression symptoms and specific quality of life indicators. Clustering is the initial stage in grouping factors linked to quality of life in order to better investigate the varied data connected with mental health concerns. SOM restructures the clusters, and the data in the classes is readjusted to achieve a balanced collection of groups. PPMCSVM is an extension of conventional SVM that is used to take classification issues and estimate the correlation between data points. The multi-class model

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ECOC was trained using SVM. As a result of the results, the suggested model may successfully predict elements that cause depression. Importance To characterise the correlation between the two distributions, sampling is used to choose the final samples from the aforesaid groupings. The samples are chosen based on the sampling ratio, which serves as a correction factor to compensate for the probability sampling from the distribution. Finally, this research discovered a link between the expected quality of life indicators and depression. Comparisons with the most renowned state-of-the-art approaches and previously published work show that the suggested strategy produces much more trustworthy findings. However, further research is needed to enrich the dataset, which contains numerous characteristics, and determine the severity levels of depression based on many parameters. For example, which component has a low, medium, or high degree of depression? This will aid other researchers and doctors in recognising risk factors for depression and other psychiatric illnesses.

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