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Performance Evaluation of Predictive Analytics Algorithm for Mental Healthcare using Data Science Techniques

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Abstract: *This paper throws light on the recent technological innovations to illustrate capabilities and effectiveness in an interdisciplinary domain, which attempts to merge Healthcare and Technology, successfully. The symptoms of the psychiatric diseases or mental illnesses cannot be measured easily. Applying Soft Computing (SC) techniques in depression prognosis and predicting the severity of it yields a huge research challenge. Modern trends in artificial intelligence provide an ability to gather and scrutinize data that is broader in all aspects. Though the field has been explored, this application proposes a system which can calculate depression level in the user and provide treatment on the basis of its degree. It involves sending an alert message to user's acquaintance thereby preventing the user from causing harm to himself. It tries to instil positive thoughts and optimism into the user to motivate him to overcome all difficulties. We have also tried to incorporate a chatbot which can support user's interaction with the system in a confidential way within mental health care context. Thus, this system can have a meaningful impact on people's lives by improving their mental health.*

Keywords: *Fuzzy Logic, defuzzified, fuzzified, Artificial Intelligence, fuzzy inference system (FIS), psychotherapist, depression level.*

I. INTRODUCTION

As indicated by the August 2018 reports – about 800 000 individuals die because of suicide which happens at an alarming rate. Suicide happens all through the life expectancy and is the second driving reason for death among 15year-olds all around. Suicide represented 1.4% of all deaths around the world, making it the seventeenth driving reason for death in 2017. Successful and proof-based involvement can be executed at individual dimensions to avoid suicide and suicide endeavours. In India, more than 5 crore individuals experience the ill effects of despondency.

Every 3 seconds a person attempts to die in India. These numbers suggest that there is a desperate need of taking measures in the direction of mental healthcare. In today's times, the one thing that can actively and efficiently prevent such actions is a mobile application. People, especially in the age bracket of 16 to 19 years trust their phones too much. For every simplest thing there exists an application. So, to leverage this fact, we need an application which will help people to deal with depression, anxiety, social distress, relationship stress, career stress, body image and loneliness.

Artificial Intelligence (AI) advances and procedures have now ruled each area of emotional wellness care including clinical based decision making, medications, appraisal, self-care and much more.

The inbuilt obscurity of AI is a blessing. Patients, who are frequently embarrassed to uncover issues to a specialist they've never met, let down their guard with AI-controlled devices.

The lower cost of AI medicines as opposed to seeing a specialist or therapist is another addition. These focal points help AI uncover the undiscovered, accelerate required treatment, and enhance the chances of positive results. At the very least, AI helps specialists to carry out their responsibilities better. They gather and break down reams of information considerably more rapidly than people could and after that recommend successful approaches to treat patients.

Expert system is a part of Artificial Intelligence which offers benefits in many areas of health care. The system allows the experts(psychiatrists) without the knowledge of algorithms to build and analyses complicated disease models or psychiatric schedules which condense signs, symptoms and social factors into mental health classifications. The information given by domain expert in mental sickness is transformed and often programmed into the knowledge base using a fuzzy logic which then provides the degree of any disorder. [3][4]

II. LITERATURE SURVEY

A neuro-fuzzy system studies a Fuzzy-neural hybrid model to identify the real-world depression problems. It aims at overlapping diagnostic areas.

- A. Collects and processes data from hospitals. Principal Component Analysis (PCA) was selected to extract important characteristics by reducing symptoms.
- B. For, diagnosing depression it extracts various features of depression by different patients.
- C. It creates input vector matrix with symptoms. Fuzzy-neural hybrid model development using Mamdani’s fuzzy logic controller mapped onto a Feed Forward Multilayer Neural Network (FFMNN), and it’s tuning with a back propagation (BPNN) algorithm.
- D. While training and testing it might be noticed the samples is separated arbitrarily into two sections around 70% for training and remaining 30% for testing the hybrid model.
- E. Sugeno’s controller is not used due to trouble associated with mapping of the output polynomial capacity with the clinical decisions. It tests the efficiency of proposed framework on the real-world medical cases. [2]

TABLE I
GAP IDENTIFICATION

Sr no.	Gap Identification	Summary	Solution
1.	Domain Expertise	It is difficult for computer experts to analyse the clinical processes and it’s evaluation. While for the psychiatrists it’s difficult to realize the merits of any algorithms and implementations.[1][5]	Implementing under expertise of both domains. (psychiatry and computer science)
2.	Application Assessment	Apps regarding suicide prevention are less, and are more driven towards [1][5]	Uses AI for chatbot with REBT therapy for depression levels with various features of safety tools

Rational Emotive Behaviour Therapy is a complete, lively-directive philosophically based on psychotherapy identifies on resolving emotional as well as behavioural issues and disturbances and permitting human beings to steer happier and more pleasant lives. It is a momentary type of psychotherapy that causes you distinguish pointless contemplations and sentiments, challenge the objectivity of those sentiments, and supplant them with more advantageous, increasingly beneficial convictions. REBT centres generally around the present time to enable you to see how undesirable considerations and convictions make enthusiastic trouble which, thus, prompts unfortunate activities and practices that meddle with your present life objectives. When recognized and comprehended, pessimistic musings and activities can be changed and supplanted with increasingly constructive and gainful conduct, enabling you to grow progressively effective individual and expert connections.

REBT is grounded in the possibility that individuals for the most part need to do well throughout everyday life. For instance, the least that you need to do is to realize your objectives and discover satisfaction. Be that as it may, now and again, silly contemplations and emotions act as a burden.

These convictions can impact how you see conditions and occasions - typically not to improve things.

model of REBT:

- 1) signifies the activating experience
- 2) Belief: represents how a person thinks about any experience.
- 3) Consequence: emotional reaction to B
- 4) Dispute: disputing irrational thoughts
- 5) effective thoughts

Three main types of techniques in REBT:

- a) Problem Solving techniques
- b) Cognitive restructuring techniques
- c) Coping techniques [8]

III. PROPOSED WORK

With the help of artificial intelligence, we can recognize the symptoms and signs using prediction model if the student is in depression with a form of questionnaire. The symptoms can't be classified without an expert but we can provide the students the necessary help using our chatbot that students can reach out to answer. Further we can provide them help by advising them to meet an expert if their depression level is high. Students are afraid to talk about it, but this application can save the lives of many as they are not comfortable with a face to face conversation. With the recent tragedies, we can contribute towards the mental awareness. Our focus is based upon the teenage students and the expert questionnaire based on them by a registered psychiatrist.

IV. SYSTEM OVERVIEW

A. Operational Feasibility

In 2015, a survey of 15,000 Mobile health apps by World Health Organization (WHO) revealed that only 29% focus on mental healthcare treatment or support. The U.S National Institute of Mental Health Organization (NIMH) have come to a conclusion that mental healthcare apps are cost effective and have scalable solutions provided the efficacy of these apps are consistent. In India, mental healthcare has a stereotypical outlook and thus suicide rate has been increasing constantly. According to 2014 statistics, 32,308 are educated youths who are pressurized. Thus, more literate people are falling into depression and thus can have an access to applications which can be helpful. NIMH classifies mental health app into 6 categories such as:

- 1) self-management,
- 2) cognition improvement,
- 3) skills training,
- 4) social support,
- 5) symptom tracking,
- 6) passive data collection.

By taking all these aspects into consideration the application has been created. Various apps are available but most of the apps are not valuable and do not have a clear picture. It is important that the domain experts of other fields as well as developers incorporate for real world effectiveness. Mobile applications have been proven a good choice and clinically effective compared to other platforms. [7]

B. Methodology

The severity of clinical depression can be identified by using a fuzzy-neural hybrid model. For this, fuzzy logic controller (FLC) has been used to analyse the depression level from the user inputs in the form of questionnaire provided to them. Asymmetric triangular membership function distributions (TMFD) for measuring the severity of clinical depression is considered. Assuming the number of questions, the total score is calculated with some numeric ranges and labelled such as Large Positive (LP), Medium Positive (MP), Small(S), Large negative (LN), Medium Negative (MN) and the output are calculated with the grade of depression. Fuzzification Module – This module converts the crisp numbers which are given as inputs, into fuzzy sets. It distinguishes the input signal into five steps such as –

LP	x is Large Positive
MP	x is Medium Positive
S	x is Small
MN	x is Medium Negative
LN	x is Large Negative

Fig1: Fuzzy system inputs.

In the mapping of hybrid model, the first layer is the input layer which are the answers to the questions, second layer is the hidden layer which applies fuzzification tasks and calculates the membership values(μ), the third layer is the hidden layer 2 which performs AND operations and then the next hidden layer 4 computes the values based on the rule base which is provided by the domain experts. OR operation is performed before the output layer to calculate the sum of the values to grade the depression. [2]

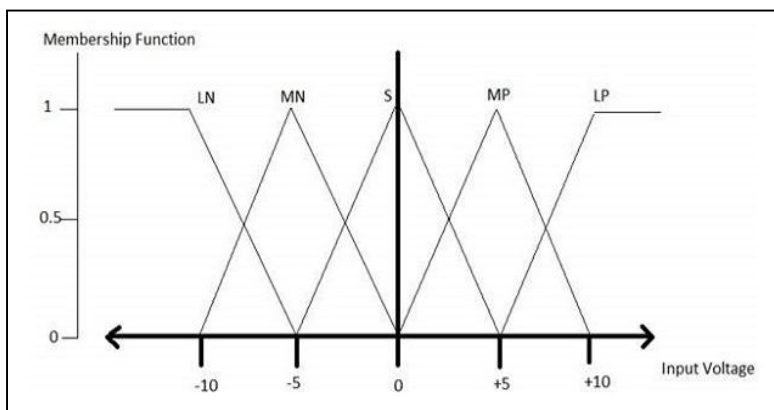


Fig2: Triangular membership function distributions (TMFD)

C. Architecture

The system consists of following components:

- 1) **Input:** The user installs the application, registers with some user information It interacts with the application using a chatbot by answers few questions. The answers have some values assigned which are the crisp inputs.
- 2) **Fuzzification:** It takes crisp values as the input and fuzzifies them. The membership values are mapped into fuzzified values with the rules stored in the rule base and produces a fuzzified output.
- 3) **Fuzzy Inference system:** It is the core component of decision making for predictive analytics algorithm. A fuzzy logic controller (FLC) is proposed for controlling the application and Asymmetric Triangular Membership Function Distributions (TMFD) are computed for measuring input and output function. It consists of various functional blocks such as the rule base which maps the calculated total score to the depression levels. Knowledge base has the therapies and various aspects which is provided by the domain expert. The knowledge base is built in consultation with the Expert psychiatrist. It produces a fuzzified output. (predicts the depression level). Fuzzification and defuzzification are the functional blocks for the FIS construction.
- 4) **Defuzzification:** The output is then defuzzified and stored in the database by fuzzy logic controller (FLC).
- 5) **Output:** The output is displayed by the grades of the depression and hence, REBT is applied to the user’s output depending upon the severity of depression.

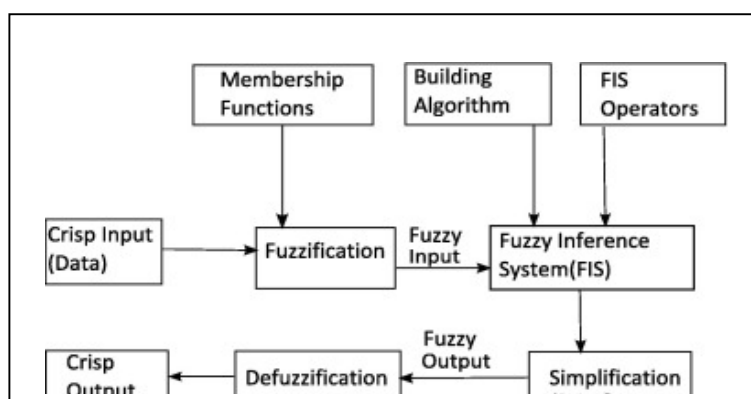


Fig3: Fuzzy system analysis.

D. System Process

The user registers with few information, user-id and sets the password. All the information is stored in the database the user may login and start the virtual human conversation by answering few questions. The answers provided by the user are applied as an input to the predictive analytics algorithm and measures the symptoms of clinical depression and sends positive thoughts throughout the conversation. The test is again followed according to the results (in weeks) to again check the depression grade and if it has lessened.

The application provides user with a document according to the user's depression results with the help of domain experts. Psychological exercises and positive strength are provided. Other features include meditation tips, some video links to guide the user and some yoga tips. If the user is at high risk and cannot cope up with the depression, the app provides psychiatrists reference. In extreme cases if the user can harm himself or anyone else it sends an alert message to the acquaintance number from the registration of the person who the user feels comfortable with.

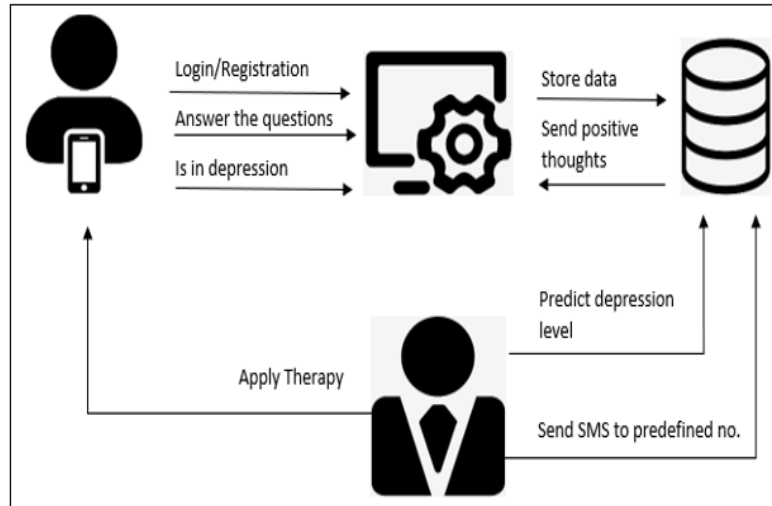


Fig4: Overall system review.

- 1) Patient information - like name and age for registration
- 2) Expert will start communicate with Patient using chat bot.
- 3) A.I need to apply to chat bot
- 4) Expert will ask some predefined questions to Patient (MCQ's)
- 5) Need to apply Fuzzy logic to above questions set
- 6) Predict depression level
- 7) Apply REBT Therapy, safety tools references
- 8) Always send positive thoughts to Patient
- 9) If Patient want to commit suicide and If depression level is high then SMS to predefined number.
- 10) After some time, again need to repeat the process from MCQ's to check depression level of same Patient.

V. CONCLUSIONS

There are very few apps related specifically to suicide prevention and awareness is small. Technology based mental healthcare remains understudied as there is little information available from literature survey. Many applications have no features and are not clinically effective. It is important to verify the accuracy of the results of different apps that are available on iOS and Android. These apps can be beneficial to users as they provide comfort and also monitors mental health. Given the current versatility and variety of development options for mobile applications, the key is to determine what platform the users are easily accessible to and are comfortable with. Mobile applications are a powerful tool for connecting with consumers, businesses, and users, and their functionality and value is only increasing as the world continues to move towards mobility.

(Disclaimer: The app is meant to be a supplemental resource to assist those who can be at high risk, but they're no longer intended to replace scientific or mental-health help. If you or someone else you know is experiencing suicidal thoughts, please seek professional help.)

VI. ACKNOWLEDGEMENT

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