

Explaining human emotions using Interpretable Machine Learning for Behavioral and Mental Healthcare

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I **Khushi Yadav**, Roll Number: **2K20/MSCBIO/08**, student of M.Sc. Biotechnology, hereby declare that the work which is presented in the Major Project entitled —**Explaining human emotions using Interpretable Machine Learning for Behavioral and Mental Healthcare** in the fulfillment of the requirement for the award of the degree of Master of Science in Biotechnology and submitted to the Department of Biotechnology, Delhi Technological University, Delhi, is an authentic record of my own carried out during the period from January- May 2022, under the supervision of Prof. Yasha Hasija.

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I hereby certify that the Project Dissertation titled “**Explaining human emotions using Interpretable Machine Learning for Behavioral and Mental Healthcare**” which is submitted by **Khushi Yadav (2K20/MSCBIO/08)**, Department of Biotechnology, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Science is recorded for the project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or full for any degree or any diploma to this university or elsewhere.

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ABSTRACT

The world is encountering an expansion in mental health problems, as one in each five grown-ups overall as of now experiences mental problems. Physiological, ecological, and natural factors all contribute fundamentally to the advancement of psychological instabilities. Utilizing artificial intelligence techniques enables the development of risk models for assessing an individual's proclivity to develop emotional disorders, consequently improving pre-conclusion screening apparatuses. Notwithstanding, mental and mental medical care are additionally profiting from progresses in AI, for example, PC work for considering, perceiving, and investigating, which can help doctors in distinguishing infections and treating patients suitably. Rather than psychiatrists, robots are being utilized in the cutting edge period to speak with care searchers and suggest treatment choices. The survey features contemporary mechanical progressions to exhibit their evident potential and to give an outline of future advancements. Various functional advantages have likewise been examined following that, which machine innovation brings to mental prosperity care. Humans increasingly use text-based input to share their opinions/emotions whether its about service via online social media or mental health problems. Humans are prone to making erroneous interpretations of emotions, particularly those extracted from the text. The essential target of this study is to foster a feeling acknowledgement and prognostication system that relies on text. The model is based on Ekman's four fundamental emotions: stressed, fear, caring, and loneliness. All models were evaluated against a benchmark dataset of tweeter tweets and reddit comments. A text-based emotion prediction system was successfully developed for the purpose of interpreting and comprehending human emotions that will further help psychiatrists and researchers to tackle mental health disorders.

CONTENTS

Candidate's Declaration	1
Certificate	3
Acknowledgement	4
Abstract	5
Contents	6
List of Figures	9
List of Tables	9
CHAPTER 1 INTRODUCTION	10
CHAPTER 2 MACHINE LEARNING	11
2.1 Types of Machine Learning	11
2.1.1 Supervised Machine Learning	11
2.1.2. Unsupervised Machine Learning	12
2.1.3. Deep Learning	13
2.1.4. Natural Language Processing	14
2.2 SOCIAL MEDIA DATA	15
2.2.1. Recurrent Neural Network	16
2.2.2. Convolutional Neural Network	16
CHAPTER 3 AI IN MENTAL AND EMOTIONAL HEALTHCARE	18
3.1. AI tools for Mental Health	18
3.1.1. Virtual and Augmented Reality	18
3.1.1.1 Virtual Reality	18

3.1.1.1.1. Imaginal Technology	19
3.1.1.1.2 Mental Imaginary	19
3.1.1.2. Augmented Reality	20
3.1.2. Brain Computer Interfaces (BCIs) and Implants	21
3.1.3. ROBOTICS	22
3.1.4. Supercomputing and Brain Simulation	23
3.2. TECHNOLOGICAL BARRIERS	24
3.3. BENEFITS OF AI IN MENTAL AND EMOTIONAL HEALTHCARE	25
3.3.1. AI is greater at some things	25
3.3.2. Self-care access to care	26
3.3.3. Economic Benefits	26
CHAPTER 4 HUMAN EMOTIONS	28
4.1 Literature Overview	28
4.1.1. Passionate Artificial Intelligence Is Critical for Mental Health Treatment	28
4.1.2. The Possibilities and Promise of Emotional AI in Mental Healthcare	29
4.1.3. Enthusiastic Artificial Intelligence for Chatbots Providing Personalized Therapy	30
4.1.4. Foreseeing Suicide Risks with Emotional AI	31
4.2. Effect of Social Media on Emotions	32
4.3. APPLICATIONS	33
4.4. XAI (Explainable AI)	34
4.4.1. XAI and Mental health	34
CHAPTER 5 METHODOLOGY	36
5.1. Data Retrieval	36
5.1.1. Tweet mental health classification	36
5.1.2. GOEMOTIONS	36
5.2. Building Model	37
5.3. Data feeding to the model	38

5.4. RESULT	38
5.4.1. WORD CLOUD	39
5.4.1.1 Stressed	41
5.4.1.2. Lonely	42
5.4.1.3. Caring	43
5.4.1.4. Fear	44
5.4.2. CONFUSION MATRIX	45
5.4.2.1. Truly Positive (TP)	45
5.4.2.2. Truly Negative (TN)	45
5.4.2.3. False Positive (FP) – Type 1 error	45
5.4.2.4. False Negative (FN) – Type 2 error	45
5.4.3. PYSS3 LIVE TEST	46
5.4.3.1. Stressed	48
5.4.3.2. Caring	49
5.4.3.3. Lonely	50
5.4.3.4. Fear	51
Conclusion	52
The Future of Emotional Artificial Intelligence and Mental Health Treatments	53
References	55

LIST OF FIGURES

Fig 1. Flowchart outlining various AI technologies used for screening, diagnosis, and treatment of mental health conditions.	13
Fig 2. Distribution of "Artificial intelligence and Mental health" term used in PubMed article publications on the scale of Year.	14
Fig 3. Recurrent Neural Network where I= input, H= hidden layer, O= Output	16
Fig.4 Convolutional Neural Network where II= Input image, CL= Convolutional layer, PL= Pooling Layer, FCL= Fully connected layer, and O= Output.	17
Fig 5. Virtual Reality (VR) used for observing users' behavior.	19
Fig 6. Augmented Reality (AR) used for treating phobias	20
Fig 7. Model accuracy	39
Fig 8. Word Cloud for stressed emotion	41
Fig 9. Word Cloud for lonely emotion	42
Fig 10. Wordcloud for caring emotion	43
Fig 11. Word Cloud for fear emotion	44
Fig 12. Confusion matrix	46
Fig 13. Live test example for stressed emotion	48
Fig 14. Live test example for caring emotion	49
Fig 15. Live test example for lonely emotion	50
Fig 16. Live test example for fear emotion	51

LIST OF TABLES

Table 1. AI technology used for the treatment of different mental health conditions	24
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CHAPTER 1

INTRODUCTION

AI empowers machines to perform routine assignments that require decisive reasoning, critical thinking, arranging, and thinking. Alongside Nathan Rochester and Marvin Minsky, PC researcher John McCarty authored the expression "AI" [1].

Simulated intelligence has formed into an integrative field that includes a wide scope of disciplines like software engineering, designing, etc. Computer based intelligence has an assortment of goals, one of which is to fill specific roles, for example, discourse handling, investigation, and expectation of information designs. Whenever a computerized reasoning plays out a particular smart errand, it is alluded to as feeble AI. The target of solid AI is to collect machines with academic limit that is undefined from that of people. The main aim of AI is not only to reflect people intuition, even, it is to make machines that far surpass human information's capacities [2].

CHAPTER 2

MACHINE LEARNING

Simulated intelligence is separated into subfields that incorporate a few strategies for engaging a calculation to enlist, one of which is known as AI, which centers around expanding exactness using factual techniques. Most of generally perceived "learning" styles utilized in clinical consideration are regulated, unaided, and profound [3].

Other AI strategies incorporate semi-coordinated and support learning. For this situation, the calculation goes about as an expert in a natural climate that advances through trial and error and prizes got from its own way of behaving and experiences. Nervous system specialists and therapists overall are using AI to encourage care approaches for clients that are being developed to identify some of the fundamental markers for ardent wellness problems before their beginning. Artificial intelligence empowers specialists to redo [4].

2.1 Types of Machine Learning

2.1.1 Supervised Machine Learning

The already-named data is present in this segment that is regularly alluded as the mark (like assessment of clinical sadness rather than the shortfall of stress). The calculation decides how to interface input features from an assortment of data streams, including financial, regular, and pediatric assessments, to foresee the names most precisely [5] [6]. Names can be authoritative (clinical sorrow or nonattendance of misery) or industrious (through the scope of earnestness).

SML is experienced by the machine because of the imprints going about as a "instructor," as though educating the estimation on the most proficient method to name the information for the computation to go about as the "understudy," viz sorting out some way to interface features with a particular name.

Ensuing to acquiring from a ton of checked planning data, the computation is taken a stab at unsorted sample data to determine if the outcome variable, such as Psychiatric conditions, can be clearly clustered. Assuming that the model's show, for instance, precision or another estimation, falls inside the assessment information, the praiseworthy will be seen as overfitting and incapable to be summarized to outer, independent models [6].

2.1.2. Unsupervised Machine Learning

The calculations in this educational experience are not named; accordingly, the estimation identifies similitudes between input features and finds the information's fundamental construction. It decides the item's closeness and distinguishes designs in the gathering's information for unaided learning. Grouping, affiliation, summing up, and succession revelation are a portion of the subsets [7]. UML is especially profitable for naturally distinguishing the construction of information when the informational index is unlabeled.

Unsupervised learning could help with perceiving gatherings of biomarkers those utilized to separate these subcategories, bringing about better determination and medical procedure activities [7].

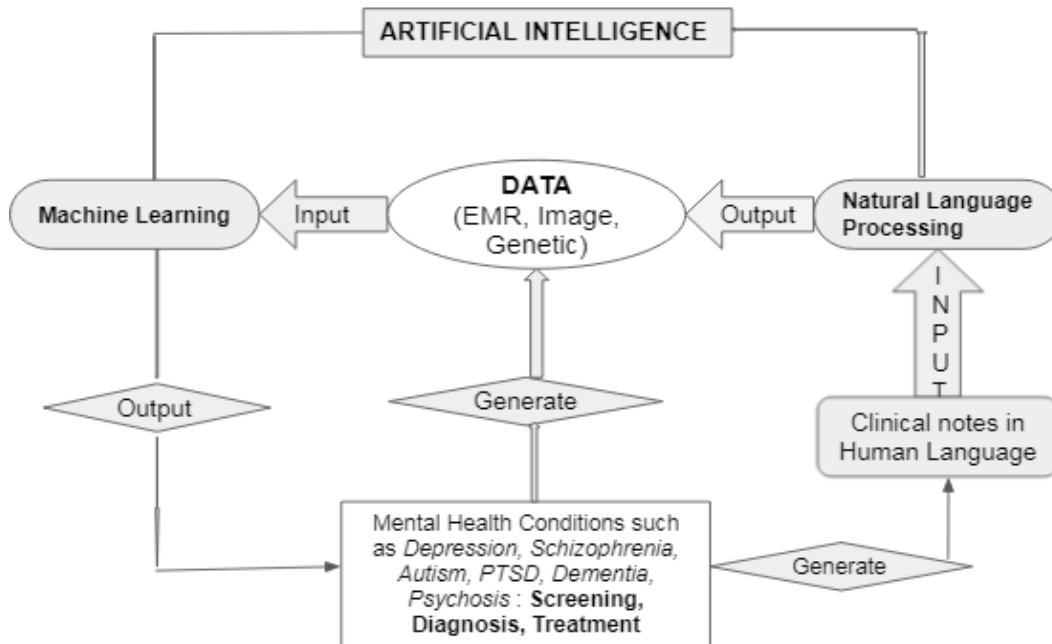


Fig 1. Flowchart outlining various AI technologies used for screening, diagnosis, and treatment of mental health conditions.

2.1.3. Deep Learning

These calculations gain without human course since they extricate data from crude information, which enjoys the benefit of uncovering torpid associations [8]. DL oversees composite information by using Artificial Neural Networks (ANN), which are equipped for working data by means of different secret layers. ANNs are a class of PC programs that mirror approach used by humankind frontal cortex [3]. Just like expression "DL" suggests, ANN ought to be made out of different mystery layers contained hubs. These hubs are liable for getting the result by intensifying the info information. DL is planned to be magnificent for putting away data gave by patients and to finding complex structures inside High definiton data generally written in psychiatrists records in Electronic health records (EHRs) [8]. Inside DL, a notable vigilance

present consist of mystery rows in ANNs could convey yield that is more hard to interpret, which is alluded to as a black-box model [9].

2.1.4. Natural Language Processing

NLP operates the algebraic strategies referenced already. NLP is a sub-discipline of computerized reasoning which unequivocally implies PCs working, analyze linguistic communication, decipher it, plus concentrate information [10]. For the most part, passionate health rehearses depend vigorously on NLP prior to using some other AI technique, as most of information is as satisfied or discussion inferred during treatment meetings. The capacity of a PC calculation to appreciate fundamental setting without the utilization of human language is viewed as a colossal jump forward in advancement and is basic for the utilization of mental clinical consideration [11].

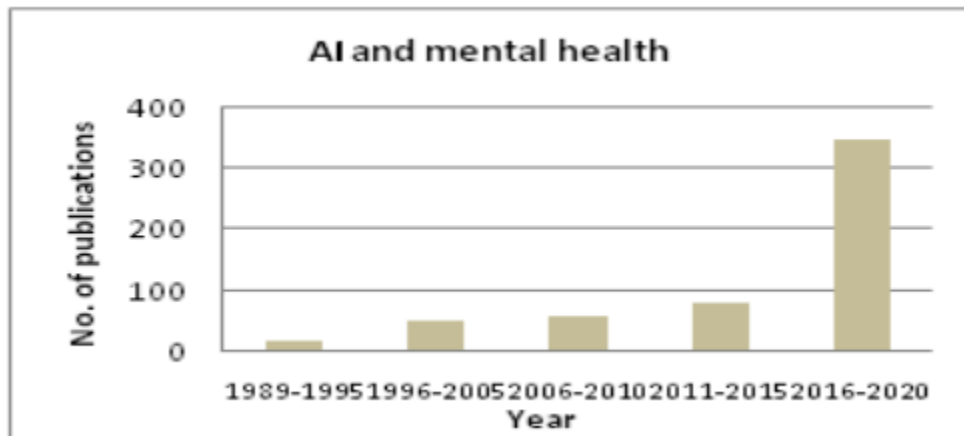


Fig 2. Distribution of "Artificial intelligence and Mental health" term used in PubMed article publications on the scale of Year.

The reason for this survey is to accumulate a rundown of articles distributed somewhere in the range of 2011 and 2021 to reveal insight into the distributing movement in the fields of man-made consciousness and psychological wellness care. Also, this study contributes novel and fascinating information about different advancements and their basic standards for identifying and diagnosing mental issues, underlining the job of online entertainment information use by means of RNNs and CNNs. RNN is referred to as Recurrent Neural Networks and CNN is Convolutional Neural Network. Mentioned audit provides a thorough picture of the area while additionally giving empowering data, and we accept that it will help not just researchers and the field overall, yet additionally people experiencing psychological well-being issues.

2.2 SOCIAL MEDIA DATA

People have gradually begun to discuss their ongoing mind-set, conduct, or some other issues they might be encountering via web-based entertainment stages like Instagram, Twitter, and Facebook. Utilizing the data with operating CNN plus RNN, the passionate health condition of one could resolved [12].

In particular, RNN is able to distinguish feed containing unsafe text connected with nervousness, discouragement, or mental issues, aiding the forecast of signs showing pointless ideations [13]. Aside from text, people additionally post pictures via online entertainment stages that contain not many signs of a person's enthusiastic prosperity status [14]. CNN recognizes clients experiencing psychological wellness conditions in light of the qualities of a picture, for example, its tone, immersion, splendor, variety subject, or sharpness. The specialists closed, utilizing these RNN and CNN information, that people who endure pressure are less associated with companions via virtual entertainment stages.

2.2.1. Recurrent Neural Network

RNNs were at first evolved to decide straight information like sound, reels, broadcast shows, speech on account of their inward storage, yet these are presently utilized to perceive mental issues by means of online entertainment posts. A feed-forward brain network communicates information in a solitary course and bumps no hub at least a couple of times. It starts with the info and advances through the secret layers to the result. Dissimilar to FFNN, RNN is equipped for putting away inside information in light of the fact that, in the wake of duplicating the result, it returns the information to the organization, which supports memory [15]. Subsequently, it works in a circle like style, helping them in remembering basic data and advising them regarding impending occasions.

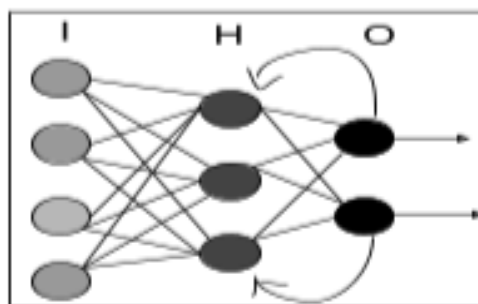


Fig 3. Recurrent Neural Network where I= input, H= hidden layer, O= Output

2.2.2. Convolutional Neural Network

CNN has fundamentally three kinds of layers. The preceding one is known as “convolutional layer” where mostly calculation part happens, bringing about the picture being converted into arithmetical qualities utilizing elements like info information, channel, and component chart. After that the subsequent row of layer is the “pooling layer”, intention of this layer is decreasing

the picture's pixel count and aspects for expanded productivity. The last layer is known as “completely associated layer”, which interfaces each hub in result row of layer to the former layer. Along these lines, CNN layers at first spotlight on picture tones and edges and afterward expansion in intricacy to perceive picture parts top to bottom, which will be utilized to distinguish psychological well-being conditions [16].

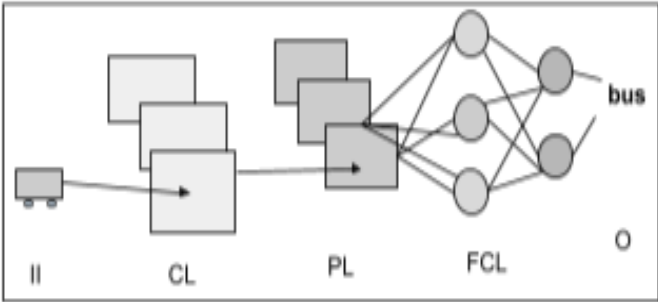


Fig.4 Convolutional Neural Network where II= Input image, CL= Convolutional layer, PL= Pooling Layer, FCL= Fully connected layer, and O= Output.

CHAPTER 3

AI IN MENTAL AND EMOTIONAL HEALTHCARE

For the most part, mental advisors depend on direct contact with previous patients experiencing emotional well-being conditions as opposed to using AI methods [17]. Advisors should notice their patients' way of behaving and take clinical notes, which is the reason they utilize conventional strategies. For this reason the emotional wellness discipline has been more slow to adjust to AI innovation than other actual wellbeing disciplines. Notwithstanding, AI gives another road to distinguishing and diagnosing psychological well-being conditions, which specialists, advisors, and patients have started to embrace. We will examine these advances exhaustively in this segment.

3.1. AI tools for Mental Health

3.1.1. Virtual and Augmented Reality

AR helps with the treatment of different fears and mental imbalance related messes, while VR empowers a specialist to suitably notice a singular's way of behaving and treat the problem.

3.1.1.1 Virtual Reality

VR is a human-PC interface that empowers clients to take part in and cooperate with a 3D PC based data set progressively by using their innate capacities and faculties [18]. VR aids the treatment of an assortment of mental issues, improving treatment and advancing huge change. VR might be profitable for reshaping bodies and analyzing the connection between the body (stance, activities, and developments), feelings, and comprehension [19]. The MTBA (Machine

to be another) innovation gives the wearer a charming encounter of seeing themselves in the body of someone else.

3.1.1.1.1. Imaginal Technology

It is basic for instigating inspiration by establishing a virtual climate, as it helps with easing strain or cynicism in our minds using creative mind. Holmes described that psychological made up go about as a speaker of social, mental, and mystic results [20].

3.1.1.1.2 Mental Imaginary

This term alludes to the presumption or entertainment of instinctive episodes across visual and hear-able modalities. It very well may be produced from quickly saw information or from recently put away particulars in long haul memory. In this manner, augmented reality frameworks help in the improvement of medicine adherence among schizophrenic patients, furnish gifted directions to patients with medically introverted messes, and give medical care data and backing. Man-made intelligence methods, for example, AI, normal language handling, and full of feeling registering empower the formation of more human-like, connecting with, and intuitive fake creatures.

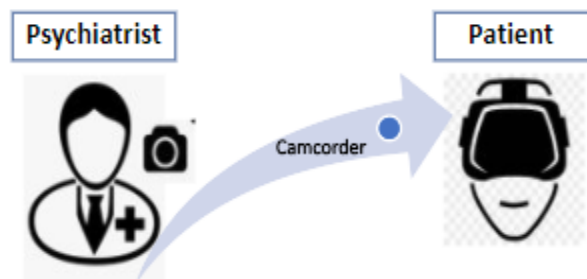


Fig 5. Virtual Reality (VR) used for observing users' behavior.

Members can encounter someone else's viewpoint by wearing a head mounted show that mirrors his/her development. The camera catches entertainers' abstract points of view by controlling their head development and body signals. Moreover, entertainers' sound is recorded by means of individual story. As indicated by Falconer's review [19], MTBA helps with the acceptance of compassion and benevolence toward members.

3.1.1.2. Augmented Reality

AR is a subset of computer generated reality that joins genuine and virtual components by superimposing realistic representations made by an information processor over live video symbolism [21]. By associating with GPS, expanded reality can give clients constant area data, which can then be applied to cell phones like tablets, PCs, and mobile phones. Some examinations are led utilizing progressed analysis on expanded reality innovation, that incorporates pics plus information within broadened wearable focal points and moreover straightforwardly onto the retina of the client. This empowers clients to drench themselves in the presence of drifting regular video in the space straightforwardly before them. AR associates youngsters with mental imbalance problem in appreciating looks and beating fears [22].



Fig 6. Augmented Reality (AR) used for treating phobias

AR can be utilized to treat fears, as exhibited by the cockroach concentrate on fear. The AR cockroach framework utilizes PC vision methods to decide the position and course of the camera

according to markers. The program identifies the actual marker distinguished by the camrecorder then actuates the fearable non real climate insect. The psychiatrist can analyze unbelievable or non-real boosts plus could utilize PC keys to control applications like the quantity of cockroaches, their size, and development. These joined choices guarantee member security, which lessens the probability that they will reject treatment, and furthermore permit the specialist to bit by bit start care and treatment [23].

3.1.2. Brain Computer Interfaces (BCIs) and Implants

Cerebrum PC points of interaction are mechanical gadgets that identify and process systema nervosum action prior to changing it over completely to a counterfeit result signal. Subsequently, it fills in as an immediate correspondence channel between the focal sensory system and outside gadgets, for example, PCs, wheelchairs, master framework robotics arms, alternately animate individual's own ligaments.

Brain computer interfaces have an expansive scope of utilizations in clinical medical care, including the improvement of brain problems like epilepsy, engine brokenness, and mental issues, as well as the therapy of non-innate visual impairment [24]. When joined with clinical machines, cerebrum PC interfaces can possibly reestablish general mental capacities in people and help with reinstalling information to region of the focal sensory system impacted by mind breakdown. Critical frontal cortex exercises can be identified through obtrusive or harmless strategies in people who use mind PC interfaces.

Three unmistakable kinds of CNS movement were seen in BCIs: Passive mind PC interfaces use cerebrum exercises that are not purposefully produced by the client, though dynamic cerebrum

PC interfaces use cerebrum exercises that require the client to utilize some psychological system, for example, envisioning moving an appendage.

Profound mind feeling has been effectively used to treat gloom; this is an incredibly reassuring and mimicking cutting edge advancement that includes cerebrum inserts. "The review found that one out of three individuals would agree to unimportant medical procedure to have chips embedded in their cerebrums to work on their psychological well-being."

BCIs are utilized to treat an assortment of conditions, including melancholy, fanatical enthusiastic problem, Epilepsy, OCD. DARPA gave 2 huge consensus amongst UCLA and some Hospital in 2014 in the interest of President Barack Obama's BRAIN drive for the improvement of electrical mind inserts fit for treating seven psychological maladjustments [24].

3.1.3. ROBOTICS

Robots are invading different features of clinical administration, including testing, describing, dissecting, treating, embedding, and supporting health programs. In the field of mental and dysfunctional behavior medical services, mechanical technology can possibly propel current consideration suppliers' strategies, as robots are presently intended to speak with individuals independently and urge individuals to talk about touchy points, for example, misery, substance misuse, and dietary issues.

Various robots are being created to help individuals with psychological well-being requirements. Paro was made at the side of the AIST, a Japan examination public affiliation, and is an automated child harp seal that was made to help more established grown-ups experiencing dementia, Alzheimer's-like sicknesses, and other degenerative illnesses [25]. With an alluring outside, it imparts a feeling of peacefulness in patients and gets touchy reactions from them. It

was likewise confirmed as a thrilling healing gadget by the US Food and Drug Administration in 2009.

Another model is Mabu, a voice-actuated robot created in San Francisco by clinical consideration the board. Mabu was intended to give mental treatment by coordinating patients through providing individuals daily needs then afterwards conveying patients health status amongst specialists [25].

3.1.4. Supercomputing and Brain Simulation

When joined with cutting edge programming activities, PCs with quick, tremendous, and gigantic memory abilities empower them to fill more roles significantly quicker and with more prominent capacities. IBM concocted a neuromorphic central processor called TrueNorth with 5.4 billion semiconductors, making it the world's most memorable prime created CPU. Neurogrid was created by Stanford University analysts and invigorates roughly 1,000,000 neurons and 6,000,000 neuromuscular intersections [26].

Various scientists are using supercomputing to guide and display the human cerebrum, and the idea past the arrangement is to foster programming kinds of neuronal and synapses organizations. Cerebrum planning amongst the neuronal level could possibly upgrade view native to specific significant nerve impulses tasks, for example, learning, navigation, memory, and discernment.

PC frameworks that can impact the human sensory system have the ability of improving both ordinary and strange anxious working. Uniting mimicked sensory systems into virtual PC bodies is likewise conceivable, permitting psychiatrists for determining specifically the reenacted procedure of CNS closing, handle, plus change its current circumstance. For example, mind

demonstrating led by analysts based on hereditary and other helplessness factors is oftentimes connected with sadness and stress. Following that, they can utilize feeling to copy ecological stressors that can actuate the ongoing circumstances [27].

TABLE I. AI TECHNOLOGY USED FOR THE TREATMENT OF DIFFERENT MENTAL HEALTH CONDITIONS

Artificial Intelligence	Treatment of Mental Health Conditions
VR and AR	Autism, Phobias, Schizophrenia, PTSD, Psychosis, Addiction, Social anxiety, Eating disorders
BCIs and Implants	Epilepsy, Motor breakdown, Psychiatric conditions, Non-congenital blindness, Depression, Parkinson's disease, OCD, Tourette's syndrome
Robotics	Dementia, Alzheimer's disease, Depression, Autism, Cognitive impairments
Supercomputing and brain simulation	Depression, Stress, OCD, PTSD, Addiction, Parkinson's disease, Dystonia, Obsessive-compulsive disorder.

Table 1. AI TECHNOLOGY USED FOR THE TREATMENT OF DIFFERENT MENTAL HEALTH CONDITIONS

3.2. TECHNOLOGICAL BARRIERS

- a. While AI enjoys various benefits and has achieved a lot, it additionally has various disadvantages. In the era of 1970s, AI development was compelled by individuals' ridiculous assumptions for it, bringing about AI disappointment in the resulting decade,

during which subsidizing was additionally fundamentally decreased, and this period was named "Man-made intelligence winter" [22].

- b. The main snag to AI has been advanced mechanics, which likewise fills in as an innovative obstruction. In any case, AI is as of now flourishing with regards to development and improvement. According to AI, learning maths like stuff that are difficult is very uncomplicated . In any case, AI misses the mark with regards to fathoming the idea driving something as basic as figuring out people and perceiving their appearances. Moravec's mystery, which expresses that complicated issues require less computational work however require progressed PC work [28].

- c. Moreover, people enjoy the benefit of applying judgment to daily existence circumstances, like knowing someone else's passionate state, however this will be a huge accomplishment for the field of man-made reasoning on the off chance that they are fit for planning smart machines with presence of mind capacities. Scholarly organizations and privately owned businesses' formative ventures and broad exploration are tempting marks of their obligation to the headway of keen machines.

3.3. BENEFITS OF AI IN MENTAL AND EMOTIONAL HEALTHCARE

Some of the important advantages of AI involved with mental health conditions has been discussed here.

3.3.1. AI is greater at some things

Savvy machines are equipped for performing profoundly complex errands all the more proficiently, dependably, and precisely [29]. Whenever machines are utilized to give care, they don't encounter weariness, burnout, or fatigue. In contrast with people, patients found it simpler and more agreeable to associate with a machine. They are not focused on and can impart anything to the machine unafraid of being judged [30].

3.3.2. Self-care access to care

People can profit from AI since it gives taking care of oneself options in contrast to people looking for self-treatment or looking for wellbeing related data. As indicated by the US government, almost 0.09 billion Americans live among regions where they can't get to a doctor to address society's issues [31]. The issue of scant assets can be settled through collaboration with people by means of non real manner, that is open amongst everybody and can be directed by mobiles. Aside from remedial mediation, information on medical issue are given, and Q & An advancements are led with the end goal of taking care of oneself directing. This advantage of AI has outperformed that of human clinical medical services, sites, and prearranged recordings.

3.3.3. Economic Benefits

As AI keeps on creating master frameworks in medical care, it assumes a basic part in producing financial advantages for the two purchasers and suppliers. Clinical choice emotionally supportive networks (CDSS) have expanded dynamic time, which has brought about a decrease in the interest for clinical staff. Because of reproduction strategies and computational demonstrating, complex medical services frameworks are turning out to be more proficient.

Computer based intelligence frameworks likewise contribute altogether to generally speaking medical services cost decrease using a ventured care approach [32]. With the help of a virtual consideration supplier, self-evaluation turns out to be substantially more open to people managing psychological wellness issues. Subsequently, the medical care framework's expense is decreased, and long haul therapy is made more reasonable. In any case, these machines or frameworks are very costly, which decreases request. Internationally, the assessed cost of treating emotional wellness is 2.2 trillion dollars, outperforming the weight of different sicknesses like diabetes, malignant growth, and cardiovascular illness [33]. The expense has been diminished and the cycle has become more productive with the help of AI advancements.

CHAPTER 4

HUMAN EMOTIONS

Human feelings can be communicated in two ways: verbally (through words, sounds, or discourse) or non-verbally (through non-verbal activities) (incorporates appearance through facial, signal, or body development). The technique for human-PC connection that empowers PCs to decipher and understand human passionate and attentional articulations is expected for an assortment of PC applications. Feeling acknowledgment (tenderly alluded to as the Artificial ability to appreciate anyone on a profound level) is a subfield of emotional figuring worried about the advancement of frameworks fit for recognizing, deciphering, and gauging human passionate states like displeasure, bliss, and trouble [34]. Full of feeling registering is an innovation that empowers PCs to interface with people, where "influence" alludes to feeling articulation and "figuring" alludes to the estimation, ID, and purposeful rise of feeling influence normally.

4.1 Literature Overview

4.1.1. Passionate Artificial Intelligence Is Critical for Mental Health Treatment

As of late, the field of psychological wellness has seen critical progressions. People are standing up more about it, breaking the disgrace, and looking for treatment. While this is a positive pattern, the quantity of people needing emotional well-being treatment keeps on being high.

Around one in every five grown-ups in the United States - 43.8 million altogether - will encounter dysfunctional behavior in a given year. Something like one burdensome episode will

happen in sixteen million grown-ups. Self-destruction is one of the main sources of death, with north of 47,000 individuals passing on by self-destruction in 2017. Confronted with these amazing measurements, psychological wellness experts are thinking about a pivotal new innovation to support the battle against dysfunctional behavior [34].

Feeling man-made reasoning (feeling AI) is a thrilling new innovation that gives medical care experts one more method for supporting and screening their patients' prosperity. This innovation is equipped for dissecting unobtrusive prompts contained in a singular's voice, composing, and looks and responding suitably - similarly to a human would. Not exclusively is this versatility wonderful, however, it is additionally very helpful. Most importantly, innovation can help with associating and connecting data holes between communications with human specialists [35].

4.1.2. The Possibilities and Promise of Emotional AI in Mental Healthcare

There are basically limitless applications for feeling man-made brainpower, remembering for brain science, and medical services. By examining patient records and creating reports in light of the information, taking care of authoritative errands, and in any event, helping with analysis or mediation, feeling AI can let loose specialists to invest more energy with their patients. Furthermore, feeling AI can help patients in creating attention to their passionate states and directing their feelings all the more actually under unpleasant or testing conditions.

Man-made reasoning can help doctors and specialists in expanding their patients' passionate mindfulness, for example, through the statement of compassion, and in giving analyses all the more rapidly and precisely [35]. Moreover, it very well may be a significant device for

foreseeing how patients will move toward treatment and doing whatever it takes to guarantee their prosperity and continuation in treatment.

By helping medical services suppliers, Emotional AI can help them in giving unrivaled consideration, invest more energy with patients, and bring down the expense of emotional wellness therapy.

4.1.3. Enthusiastic Artificial Intelligence for Chatbots Providing Personalized Therapy

While bantering with a PC is probably not going to strike a chord while thinking about treatment, for some, patients, associating with a chatbot or an automated friend fueled by feeling AI can have critical advantages. Various organizations are creating symbols and assistive robots to give patients restorative choices [36].

With regards to treating psychological maladjustments, chatbot innovation can play out an assortment of capacities. While it might create the impression that a PC is unequipped for playing out the profoundly private undertaking of treatment, it just so happens, that many individuals interface with symbols similarly they would with another human.

The chatbots establish a sincerely protected climate for sharing, similar as imagine play with virtual companions accomplishes for youngsters' passionate and social turn of events.

In particular, feeling AI innovates robotizes talk treatment and openness, taking into consideration expanded admittance to psychological well-being medicines, which are among the most costly and tedious kinds of treatment. Presently, the people who can't bear the cost of conventional treatment meetings or who can't plan arrangements have an elective strategy for finding and getting treatment. These choices can be made accessible to patients depending upon the situation instead of expecting them to plan an arrangement ahead of time. This component can possibly essentially build the utility of chatbots as a restorative guide that supplements more customary techniques for remedial conveyance. While chatbot-helped conduct and remedial mediation is as yet far off, chatbots that help us in turning out to be more mindful of our own feelings and more agreeable are staying put [37].

4.1.4. Foreseeing Suicide Risks with Emotional AI

While feeling AI can be utilized to treat patients, it can likewise be utilized to foresee patients' way of behaving, like a singular's gamble self-destructive way of behaving.

Facebook is one organization that utilizes feeling AI to screen client posts, search for content that might show self-destructive way of behaving, and inform neighborhood specialists. This interaction was made because of a famous component that permitted clients to report posts that might show self-destructive ideation and guided human arbitrators to examine and give assets.

Engineers are endeavoring to make feeling-based man-made brainpower that can help doctors in foreseeing self destruction risk and clinical administration. While this innovation is still in its early stages, it can possibly support the comprehension of the gambling factors that add to the

self-destructive way of behaving. Scientists at Vanderbilt University fostered a computerized reasoning model that anticipated self destruction risk with an exactness of 84 to 92 percent in no less than multi week of a self-destruction occasion and 80 to 86 percent in something like two years utilizing patient wellbeing records.

While it is still right off the bat during the time spent utilizing feeling AI to anticipate self-destruction chances and help direct medical services suppliers in forestalling suicides, it is energizing to watch this promising innovation empowered ability to create.

4.2. Effect of Social Media on Emotions

These days, the WWW is developed into Web2.0, which empowers people to convey by means of web-based entertainment stages (like Fb, Insta, YouTube), and websites [37]. People regularly speak with PCs by means of text, yet multimodal human-PC collaboration has been distinguished as engaging. It can't be rejected that most of individuals like to offer their viewpoints or feelings through web-based web-based entertainment or remarks. Along these lines, as the act of communicating feeling through texts or words turns out to be more predominant, a monstrous measure of information, especially text-based information, is produced, and distinguishing text-based feeling represents the best test for the two people and machines. Distributing negative or positive client surveys on noticeable sites improves the probability that the public will become mindful of the client's protest. For example, if an individual with an enormous number of "devotees" or "companions" distributed their viewpoints in a clear way via online entertainment stages (like Fb, Insta, and Twitter), the post might go "viral" [37]. Nonetheless, a negative remark can altogether affect the organization's standing. Accordingly, answering client

grumblings has turned into a very troublesome interaction for the business. They should prepare their representatives to be essentially as educated as conceivable about how to deal with client objections, especially those made by means of online entertainment channels. In this specific situation, it is basic to examine and gauge client feelings during the beginning phases of an assistance discussion.

4.3. APPLICATIONS

This kind of framework might have an assortment of gainful applications, for instance, it could be utilized to decide how charming the country's inhabitants are. Since the late 20th 100 years, most state-run administrations and relationships on this planet have been worried about joy financial aspects, which is the investigation of occupants' satisfaction progressions in regions like wellbeing, life quality, humanism, and financial matters. This framework is likewise helpful for self-destruction anticipation, as it deciphers client self-destructive considerations shared on internet based stages and afterward makes an extra move to save the client from encountering serious self-destructive contemplations. Also, feeling acknowledgment frameworks are utilized to dissect and understand clients' or alternately clients' fulfillment with items or administrations in view of client criticism. This has an aberrant advantage of expanding a business' benefit [38].

Positive feelings have been displayed to build understudies' advantage in learning, homeroom commitment, and inspiration, and cheerful understudies are by and large more spurred to accomplish their objectives. Distinguishing understudies' constant feelings has various benefits, remembering helping speakers for appreciating their understudies' learning ways of behaving and resolving issues, for example, disarray and fatigue that sabotage understudies' commitment.

4.4. XAI (Explainable AI)

XAI is another line of man-made consciousness and AI items. The headway of these advancements in an assortment of areas requires human confidence in the models' choices. The models are exceptionally numerical and hard to decode, which lessens their logic and builds their intricacy. XAI's role is to ensure that the end client comprehends the thinking at the back of the result, which fortifies the work on the models' unwavering quality [40]. Ongoing examination feature the job of XAI in various segments of the genuine world, however it likewise proposes that it requires a ton of work which is required to have been finished for using the greatest limit of such instruments. The progress in developments and hindrances are directly relating to one another. Consequently, it is incredibly key to perceive the disadvantage as well as to unsheathe the advantages. The climate of AI has been partitioned into express and understood information. Investigators are currently bringing these two into an agreement that could go about as impetuses for future stupendous difficulties. It likewise includes the distress of technophiles who can isolate the most extreme limit of XAI that outfits various areas and future exploration [41].

4.4.1. XAI and Mental health

While XAI approaches all by themselves can't give causal unthinking experiences into how the mind fills a given role or complex ways of behaving, both exploratory and robotic investigations (i.e., mental, emotional, and brain unthinking examinations). psychological wellness models) related to the consequences of XAI can be connected with information in different modes (e.g., EEG, neuroimaging, clinical, and ecological information). By recognizing prescient connections between different informational indexes These methodologies outflank unimodal grouping

exactness of information models. This involves additional opportunities, for example, for indicative purposes in the field of young life psychological maladjustment and then some. In particular, by coordinating XAI into ordinary web-based entertainment (wellbeing) office, and tangible information (as referenced beforehand) would without a doubt progress [42]. Our insight into the systems basic everything from psychological wellness to messes that will help with the forecast of chance and sickness directions, considering the advancement of customized and devices for identification and anticipation/intercession for a huge scope (e.g., electronic and versatile wellbeing). Thus, the field toward a model of medical services that is transdisciplinary, integrative, setting touchy, and individual focused [43].

CHAPTER 5

METHODOLOGY

5.1. Data Retrieval

Datasets has be extracted from Kaggle, which is an online community of information researchers and AI professionals. Kaggle permits clients to look and post informational indexes, investigate and develop models in an electronic information science climate, draw in with different information researchers and AI specialists, and take an interest in challenges to address information science assignments. Two types of data have been acquired named tweet mental health classification and GOEMOTIONS.

5.1.1. Tweet mental health classification

This dataset includes tweets from all over the world that crashed with the help of the Tweepy API. The zip file includes Train.csv as the training set, test.csv as the test set, and test submission.csv is an example accommodation document in the right organization is remembered for the bundle. Datasets include 29993 tweets on the basis of which emotions are being classified into stressed and lonely.

5.1.2. GOEMOTIONS

A corpus of 58k cautiously arranged remarks gathered from Reddit, with human explanations to 27 feeling classes or Neutral, GoEmotions is another sort of feeling information base. From which we have chosen fear and caring only. There are 37 columns and the number of examples is 58,009, in both the training and assessment datasets, the maximum sequence length is 30.

Additionally, we offer a version of the raw data that has been filtered according to a mutual agreement, and this version comprises a train/test/validation split.

Both the data have been compiled which will return 99,993 text-based data with four major emotions including fear, caring, stress, and lonely.

5.2. Building Model

With the SS3 text classifier, we have made a special and straightforward administered AI model for text arrangement. The model is interpretable, and that implies it has the ability to immediately (self)explain its thinking. In the past three releases of the CLEF's eRisk lab, this clear model reliably delivered the best and second-best results, separately, among every single partaking model. On account of its white-box nature, it empowers scientists and experts to send interpretable (for example self-logical) and, subsequently, more dependable models for text characterization (which might be especially valuable for those working with order issues that might affect individuals' lives). It is feasible to work with the SS3 Classification Model in an exceptionally clear, intelligent, and noticeable way by utilizing the PySS3 Python apparatus. Notwithstanding the execution of the classifier, PySS3 incorporates a progression of apparatuses that will help you in making your AI models in a more coordinated and proficient way than beforehand conceivable. You can inspect, screen, and comprehend your models with the assistance of these instruments since they permit you to see what they have truly realized and why they have learned it. PySS3 offers you three significant parts to do this: the SS3 class, the Live Test class, and the Test class. We imported pySS3 as follows:

```
In [25]: from pyss3 import SS3
         from pyss3.util import Dataset, Evaluation, span
         from pyss3.server import Live_Test

         from sklearn.metrics import accuracy_score
```

```
In [26]: clf = SS3()
         s, l, p, _ = clf.get_hyperparameters()

         print("Smoothness(s):", s)
         print("Significance(l):", l)
         print("Sanction(p):", p)
```

```
Smoothness(s): 0.45
Significance(l): 0.5
Sanction(p): 1
```

5.3. Data feeding to the model

Once the Pyss3 package is installed, data can be given as input to our model. The datasets were separated into two gatherings in light of an irregular appropriation in an 80:20 proportion: the preparation set and the testing set. Because of the new fame of AI strategies like SVMs, KNNs, and profound learning, in addition to other things, in disciplines, for example, omics information investigation, grouping information examination, biomedical imaging, and sign handling, it was chosen to utilize AI methods to dissect our datasets.

5.4. RESULT

Our model has achieved an accuracy of 88.5%. Finally, the best model was integrated to graphical user interface using pySS3 to complete the whole system development. Text-based emotion prediction system to interpret and understand human emotions was successfully developed.

	precision	recall	f1-score	support
caring	0.64	0.97	0.77	1602
fear	0.58	0.51	0.54	835
lonely	0.96	0.90	0.93	5397
stressed	0.97	0.90	0.94	5500
micro avg	0.89	0.89	0.89	13334
macro avg	0.79	0.82	0.80	13334
weighted avg	0.90	0.89	0.89	13334

Accuracy: 0.885

Fig 7. Model accuracy was found to be 88.5%

5.4.1. WORD CLOUD

A word cloud (on the other hand alluded to as a label cloud) is a graphical portrayal of words. Cloud makers are utilized to feature the most often utilized words and expressions in view of their recurrence and pertinence. They give fast and clear visual bits of knowledge that can prompt more nitty gritty examinations.

This sort of perception can help moderators in quickly gathering information from their crowd, underscoring the most widely recognized reactions, and introducing the information in an effectively reasonable arrangement. We imported word cloud as follows:

5.4.1.4. Fear

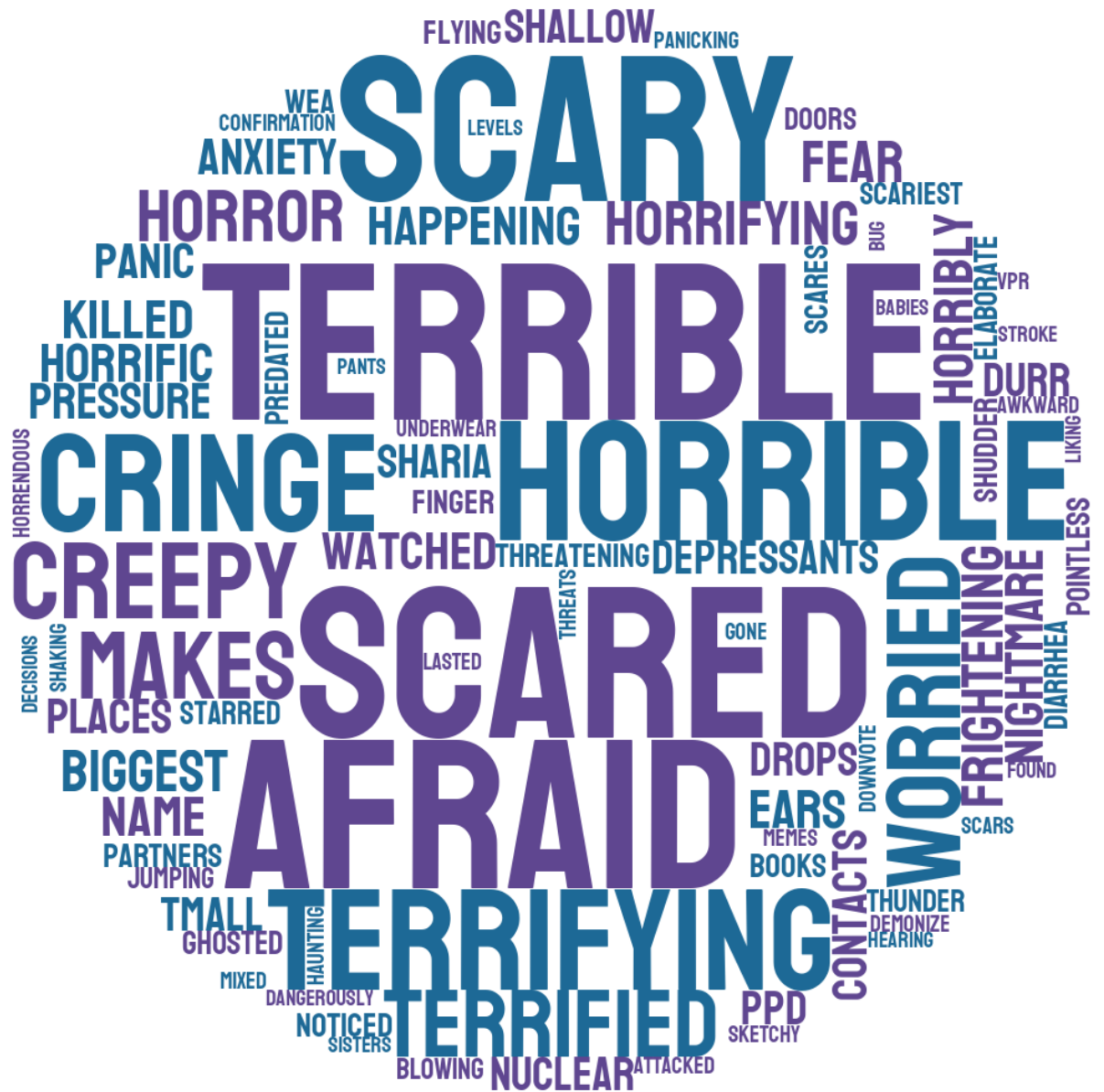


Fig 11. Word Cloud for fear emotion

5.4.2. CONFUSION MATRIX

A confusion matrix is a $N \times N$ grid that is utilized to assess an order model's exhibition, where N is the quantity of target classes. The framework analyzes the genuine objective qualities to the model's expectations. This gives us a comprehensive perspective on our characterization model's exhibition and the sorts of blunders it makes.

The network should be deciphered as :

The objective variable can take on either a positive or negative worth.

The sections contain the objective variable's genuine qualities.

The lines relate to the objective variable's anticipated qualities.

5.4.2.1. Truly Positive (TP)

The anticipated worth is indistinguishable from the noticed worth.

The genuine worth was positive, as anticipated by the model.

5.4.2.2. Truly Negative (TN)

The anticipated worth is indistinguishable from the noticed worth.

The real worth was negative, as anticipated by the model.

5.4.2.3. False Positive (FP) – Type 1 error

The anticipated worth was wrong.

Albeit the model anticipated a positive worth, the real worth was negative.

Moreover alluded to as the Type 1 mistake.

5.4.2.4. False Negative (FN) – Type 2 error

The anticipated worth was wrong.

Albeit the genuine worth was positive, the model anticipated that it would be negative.

Also alluded to as the Type 2 mistake.

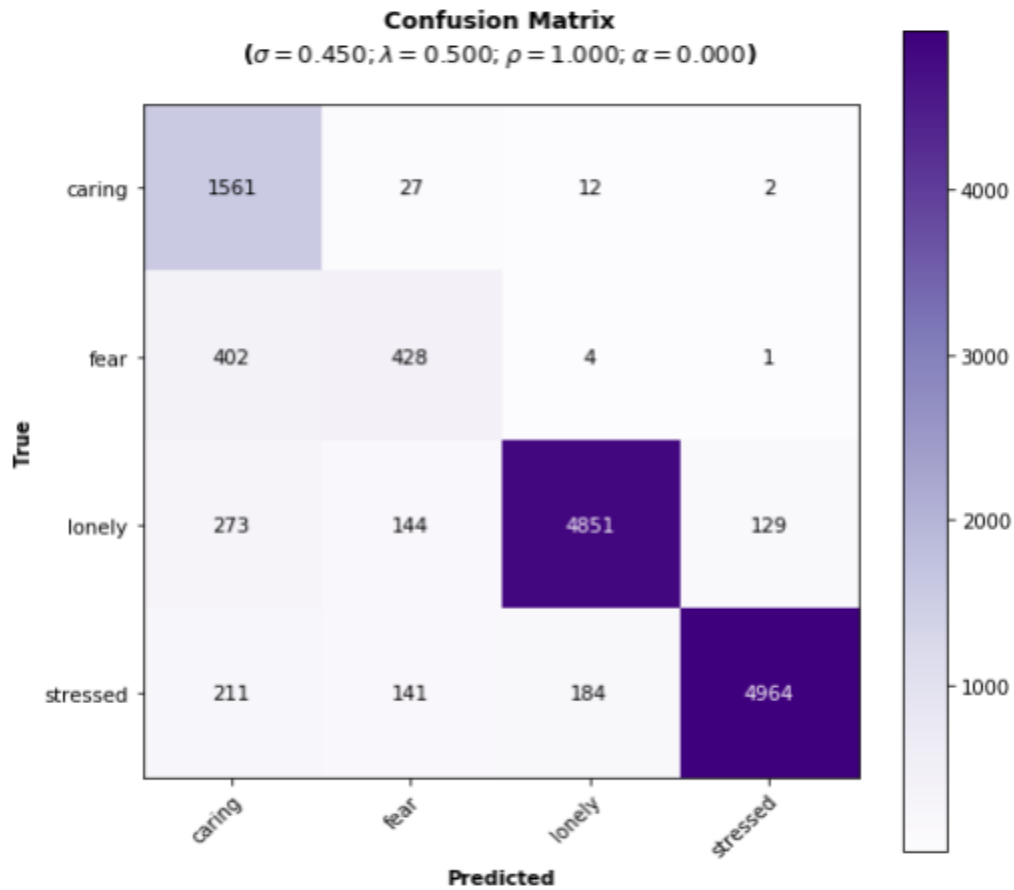


Fig 12. The quantity of True positive cases is shown by the light blue squares in the grid (TP), False-positive (FP) and False negative (FN) models are addressed by dark blue squares in the grid, while true negative (TN) events are addressed by white squares in a similar way.

5.4.3.2. Caring

The screenshot displays a web application interface for "khushi's project", powered by PySS3 (v0.6.4). The interface is divided into several sections:

- Test Documents by Class:** A sidebar on the left lists documents from doc_0 to doc_17. The "caring (1989)" class is highlighted with a 65.9% accuracy. Document doc_6 is selected and highlighted in red.
- MODEL INFO:** Located in the top right, it provides details about the model, including hyperparameters ($\alpha=0.44$; $\lambda=0.48$; $p=0.5$; $\alpha=0$) and class labels (caring, fear, lonely, stressed).
- Document Details:** The main content area shows "Document: doc_6 (caring)" and "Classification Result: caring". It includes "EDIT TEXT" and "NEW" buttons.
- Explanation:** A section titled "Explanation:" with a "Level:" selector set to "Words". Below it, a text box contains the sentence: "thank you for your open mind, stay strong, fight the good fight, and stay educ".
- Class Selection:** A "Class:" selector is set to "[MIXED]". A vertical bar chart shows the confidence scores for different classes: CARING (4.30cv), FEAR (1.83cv), LONELY (0.14cv), and STRESSED (0.00cv).
- Advanced Mode:** A toggle switch for "Advanced" is currently turned off.
- Footer:** A red banner at the bottom contains a logo and contact information for Khushi Yadav (khushi.yadav_2k20mehic09@dtu.ac.in) at Delhi Technological University, Delhi.

Fig 14. Live test example for caring emotion

5.4.3.3. Lonely

Test Documents by Class

Class	Count	Percentage
caring (1989)	1989	65.9%
lonely (6789)	6789	88.9%

doc_3038

doc_3039

doc_3040 !

doc_3041

doc_3042

doc_3043

doc_3044 !

doc_3045

doc_3046

doc_3047

doc_3048

doc_3049

doc_3050

doc_3051

doc_3052

doc_3053

doc_3054 !

khushi's project

powered by Py533 (v0.6.4)

MODEL INFO

Name: model;
Hyperparameters: $\sigma=0.44$; $\lambda=0.48$; $\rho=0.5$; $\alpha=0$;
Class labels: caring; fear; lonely; stressed

Document: doc_3064 (lonely)
Classification Result: lonely

Explanation:

Level: Paragraphs Sentences Words

need hug vent ladi physic know spiritu know wrap arm around m

Class:

- [MIXED]
- LONELY (1.16e)
- STRESSED (0.19e)
- FEAR (0.18e)
- CARING (0.17e)

Using the "Level" and "Class" options above you can set the desired class and detail level for the explanation. Additionally, you can click on individual words to see their g_i , t_i , and f_i frequency values at the bottom. Finally, enabling the advanced mode will show an interactive line chart illustrating how the model's confidence value changes as the document is processed.

Advanced Off On

Khushi Yadav (khushiyadav_2120mcsbio00@dtu.ac.in)
Delhi Technological University, Delhi

Fig 15. Live test example for lonely emotion

5.4.3.4. Fear

Test Documents by Class

- caring (1989) 65.9%
- lonely (6789) 88.9%
- fear (1049) 81.5%**

doc_1989

doc_1990

doc_1991

doc_1992

doc_1993

doc_1994

doc_1995

doc_1996

doc_1997

doc_1998

doc_1999 !

doc_2000

doc_2001 !

doc_2002

doc_2003

doc_2004

khushi's project

powered by PySS3 (v0.6.4)

MODEL INFO
Name: model;
Hyperparameters: $\sigma=0.44$; $\lambda=0.48$; $\rho=0.5$; $\alpha=0$;
Class labels: caring; fear; lonely; stressed

Document: doc_2054 (fear) EDIT TEXT NEW

Classification Result: **fear**

Also: caring

Explanation:

Level: Paragraphs Sentences Words

goosebump had the same take on those too. those book use to scare the shit out of me

Class:

- [MIXED]
- FEAR (8.70%)
- CARING (6.43%)
- LONELY (0.11%)
- STRESSED (0.00%)

Using the "Level" and "Class" options above you can set the desired **class** and **detail level** for the explanation. Additionally, you can click on individual words to see their g_i , f_i , and $frequency$ values at the bottom. Finally, enabling the **advanced** mode will show an interactive line chart illustrating how the model's confidence value changes as the document is processed.

Advanced Off On

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Delhi Technological University, Delhi

Fig 16. Live test example for fear emotion

CONCLUSION

The application of AI advancements and innovations to close to home prosperity care is a quickly developing field that, with its various advantages, imparts trust in individuals. Various headways in AI can help with settling a significant piece of the issues facing clinical benefits overall by giving important gadgets that work on the capability and nature of clinical benefits. The area progresses humankind's ongoing degree of creative mind, yet additionally adds to generally efficiency improvement by upgrading mental and actual capacities. From patients and purchasers to enormous clinics and clinical experts, these progressions keep on helping whole clinical benefit systems. To understand the maximum output of what AI and other progressions could result in psychological wellness care, a cooperative exertion between specialists, scientists, engineers, finance managers, clinical consideration supervisors, and technologists is essential. After such fast development, this field actually requires huge investigation, like human-PC and human-robot cooperation concerning clinical benefits, as well as the advancement of brilliant machines to further develop correspondence with care searchers. In particular, this study is important to find out individuals' mentalities and inclinations toward the utilization of savvy machines for clinical benefits, as well as to survey how successfully brilliant progressions convey treatment in contrast with customary strategies. Simulated intelligence is changing the manner in which we view social and mental prosperity care, and now, the information and capacities of clinical benefit specialists will at this point not be restricted to doctors, clinicians, instructors, or different experts; they will be integrated into the machines with which we will associate. Whenever we manufacture and distribute these developments, the canny devices

ought to be assembled exclusively based on patients' interest for reliable success administration. These machines should be developed so that they generally comply and act morally in light of a legitimate concern for human government assistance while staying inside a limit of reliability.

The Future of Emotional Artificial Intelligence and Mental Health Treatments

Obviously feeling AI will assume a critical part coming soon for medical services and emotional well-being. This promising innovation brings a ton to the table for patients and parental figures the same, and it's working constantly as committed experts put their skill into further developing AI models determined to help individuals — by expanding access, working on the nature of care, and bringing down costs [39].

There are as yet critical snags to survive assuming man-made reasoning is to be utilized actually to comprehend and treat emotional wellness conditions. The essential test is incorporating AI into the advisor patient identification, mindfulness, and, in particular, treatment circles. Worries about security and patient information should likewise be tended to, as AI models habitually decide and expectations utilizing touchy patient information.

Since Emotional AI capacities are as yet advancing, it is basic to guarantee that they are directed by people who will survey AI talks and medicines to guarantee patients are getting their expectations. While feeling AI models are working on their capacity to comprehend patient feelings, master human oversight is expected to guarantee that patients are not hurt by mistaken caregivers during machine-helped mediation [40].

Emotional AI anticipates a splendid future teaming up with care suppliers to address patients' issues. Later on, AI models will actually want to aid the arrangement of treatment and care for countless patients who wouldn't approach care in any case, whether because of time requirements or monetary imperatives. This innovation is very nearly altering our comprehension and treatment of psychological maladjustment.

While engineers face various difficulties, the fate of innovation support for mental medical care shows up splendid with proceeded with headways in feeling AI capacities.

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Artificial Intelligence and Technological Development in Behavioral and Mental Healthcare

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Abstract— The world is witnessing an increase in mental disorders and with the current rate, this is expected to rise. Physiological, environmental, and biological factors combined play an essential function in causing mental illnesses. As a matter of fact, if mental health problems are not addressed properly, it will give rise to a tremendous burden of diseases around the globe because with estimated surveys, one in five adults worldwide is already suffering from mental disorders. Leveraging artificial intelligence techniques allows formulating risk models for determining an individual's risk of developing mental illness and provides the potential for the betterment of pre-diagnosis screening tools. People who are unaware of the term AI may picture intelligent machines as driverless cars, drones, or ironman suits while others might imagine it as some sort of mysterious robotic computer confined to scientific advancement which will emerge in the future eventually. But the psychological and mental healthcare are also getting benefits from the development in AI such as computer work for studying, recognizing and analyzing that can help doctors with identifying the diseases and treat the patient accordingly. Instead of therapists, artificially intelligent virtual humans are also being used nowadays that can communicate with care searchers and come up with treatment solutions. In the review, modern hi tech advancements are highlighted in order to display appearing potentiality and to furnish a glance of innovations on the outlook. Many practical benefits have also been discussed afterward which machine technology introduce to psychological well-being care accompanying further deliberations.

Keywords— *Technological Development, mental disorder, virtual human, robotics.*

I. INTRODUCTION AND BACKGROUND

Artificial Intelligence (AI) makes machines with the ability to perform daily based tasks incorporating critical thinking, problem solving, planning, reasoning etc. Computer scientist John McCarty named this field AI along with Nathan Rochester, Marvin Minsky [1]. The motivation behind the gathering was to unite driving specialists for setting up another area of science that includes the investigation of smart machines. Allen Newell, J.C. Shaw and Herbert Simon exhibited the principal PC program purposely designed to emulate the critical thinking abilities of an individual during the gathering [2].

AI has become an integrative field which cover a large range in computer science engineering and so on. There are various goals of AI one of which is a specialized function, such as speech processing, analysis, and to predict the pattern in the data. Whenever there is a specific intelligent task, the AI is referred to weak AI. The achievement behind strong AI is along these lines to assemble machines with scholarly capacity that is indistinguishable from people. The principal

objective of AI is only not to fabricate machines that mirror human insights; rather they are intended to far surpass the abilities of human knowledge.

In this review, we will discuss the tools and technological developments that are benefitting the behavioral and mental healthcare field such as VR and AR which could treat schizophrenic, autism-like disorders with imaginal technology, embodied technology, and connectedness technology. AR could help in training and assisting surgeons, reminding patients to take medications on time, overcoming insect phobia by creating real time virtual stimuli via screen projections. BCIs and implants which can measure brain activity after inserting them in the brain and they can be used to treat conditions like depression, epilepsy. Some robots have been developed for helping people with psychiatric needs by providing cognitive therapy to patients enhancing social and emotional interaction among patients. Before proceeding, we will see the AI background that is used behind the tool's development for diagnosing medical health conditions.

II. MACHINE LEARNING FOR BIG DATA ANALYSIS

AI consists of subfields that include several techniques for empowering an algorithm to enroll and one of them is known as machine learning that focuses on using statistical methods for increasing accuracy. The majority of widely recognized styles of "learning" that are utilized for medical care motives incorporate supervised, unsupervised, and deep learning [3].

Some other techniques of ML are semi-directed and reinforcement learning. Here the algorithm goes about as a specialist in an intuitive climate that learns by experimentation utilizing prizes from its own behavior and encounters. Neurologists and psychiatrists all throughout the planet are utilizing ML to foster treatment plans for patients and to recognize a portion of the critical markers for emotional wellness issues prior to the risk they might set in. AI offers therapists the chance to customize [4].

A. Supervised Machine Learning (SML)

The information is pre-named here and it is generally referred to as the label (such as examination of clinical depression in contrast to the absence of stress). The algorithm figures out how to relate input highlights got from an assortment of information streams such as socioeconomic, natural, and pediatric estimations for best anticipating the names [5] [6]. Labels can be of both types i.e., definite (clinical depression or no depression) or persistent (through the range of seriousness). SML is encountered by the machine in light of the fact that the marks go about being an

"educator" as if let the calculation know how to name the information in order to the calculation the "student" viz figures out how to connect highlights with a particular name.

Subsequent to gaining from a lot of marked preparing information, the calculation is tried on unlabeled test information for deciding whether it can accurately group the objective variable such as Major depressive disorder. On the off chance that the model exhibition such as exactness or other measurement falls among the examination information, the exemplary will be reviewed as overfitting that can't be summed up to outer, autonomous examples [6].

B. Unsupervised Machine Learning (UML)

Labels are not given to the algorithms in this learning; subsequently, the calculation perceives resemblance amidst input highlights and finds the basic construction of the data. However, it can't connect highlights with a certain mark [7]. For classifying and distinguishing data into batch or model, and recognizing the most salient highlights of a dataset, UML utilizes clustering methods such as hierarchical and k-means [7]. If we want to decide the advantages of data yield then it should be deciphered by domain specialists. Though the absence of marks makes UML really testing, however, it is ready for uncovering the basic design in a dataset along with minor deduced predisposition. For instance, brain imaging biomarkers give enormous element datasets that might contain data with respect to obscure mental sicknesses subcategories such as schizophrenia. UML might assist with recognizing groups of biomarkers that can distinguish these subcategories, hence resulting in diagnosis and finest surgery operations.

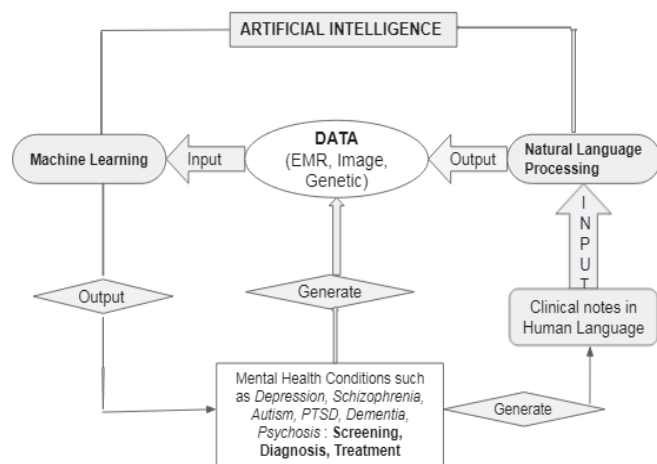


Fig. 1. Flowchart outlining various AI technologies used for screening, diagnosis, and treatment of mental health conditions.

C. Deep Learning (DL)

These algorithms do not need human direction for learning as they uptake information from raw data that gives the advantage of finding dormant connections [8]. DL manages composite data past utilizing Artificial Neural Networks (ANN) that can operate information through various hidden layers. ANN are some programs of PC that take after the manner in which a human cerebrum reflects [3]. As the name is "deep learning", it means an ANN should consist of several secret layers that are comprised of nodes. The function of these nodes is to achieve the output result by amplifying the input data. For storing information given by patients or finding complex

frameworks in HD information that are usually encompassed in clinician notes in EHRs, DL is meant to be great [8]. DL has a significant alert where the secret layers inside ANNs can deliver the output harder to decipher which is known as a **black-box model** where we are unsure about the way of the arrival of an output [9].

D. Natural Language Processing (NLP)

This language processing utilizes the previously mentioned algorithmic techniques. This is a subfield of AI that basically explicitly alludes to how PCs operate, examine human language, include language interpretation, and extraction of data [10]. Generally, emotional wellness practice depends vigorously on NLP before processing any other AI method because mostly the data is in content or conversation form that is derived during therapy sessions. The capacity of a PC algorithm to understand the basic context without using human language is considered a tremendous headway in innovation and fundamental for mental medical care use [11].

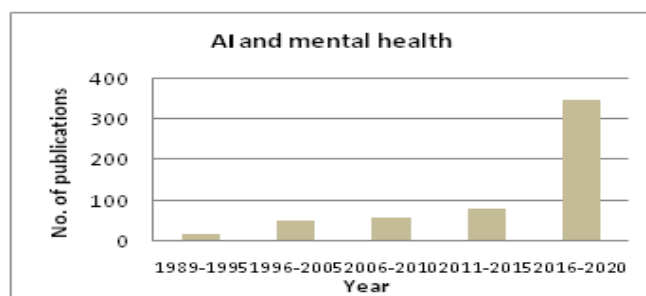


Fig. 2. Distribution of "Artificial intelligence and Mental health" term used in PubMed article publications on the scale of Year.

The objective of this review is to document the articles between 2011 to 2021 for providing insight into the publishing activity of AI and mental health care. Likewise, this study proposes unique as well as interesting knowledge regarding different technologies and their working principles engaged with detecting and diagnosing psychiatric problems, underlining the role of social media data use with the help of Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN). This review gives an extensive image of the field yet encouraging information and we believe that this review will be not only helpful to the scientists and the area as in all but also to the individual's suffering from mental health problems.

III. SOCIAL MEDIA DATA

People have progressively started sharing their current mood, behavior, or some other problems they may going through on social media such as Instagram, Twitter, Facebook. By using this information carefully with the help of RNN and CNN, the emotional wellness state of an individual can be detected [12].

Majorly RNN can identify the posts with risky texts related to anxiety, depression, or mental disorders that helps in predicting signals about self-destructive ideations [13]. Other than texts, people likewise post images too on a social media platform that give few signs for spotting an individual's emotional well-being status [14]. CNN uses the characteristics of an image such as its complexion, saturation, brilliance, color theme, or sharpness for detecting users suffering from mental health conditions.

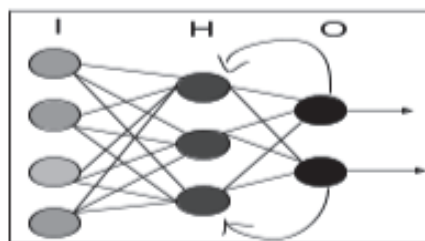
By using these RNN and CNN data, researchers concluded that individuals tolerating stress are less connected with friends on social platforms.

A. Recurrent Neural Network (RNN)

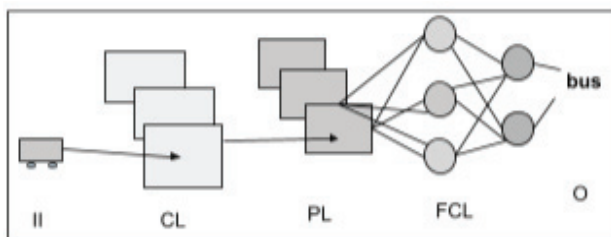
Basically, RNNs were first introduced for determining the linear data like audio, video, time-series, language, etc because of internal memory but now they are also being used for recognizing mental disorders by operating social media posts. In a feed-forward neural network, the data pass in one way only and it does not nudge any node more than once. It begins from the input and ends to the output through the hidden layers. Unlike FFNN, RNN is able to store the internal data because after copying the output, it gives the data back to the network that helps in remembering the information [15]. So, it works in a loop-like method that helps them in memorizing crucial things and lets them know upcoming events.

B. Convolutional Neural Network (CNN)

There are majorly three types of layers in CNN. The first one is the convolutional layer which is the key element of CNN and here most of the computation work is done that results in interpreting the image into the arithmetical values by using features such as input data, filter, and feature map [16]. The second layer is the pooling layer whose function is to reduce the pixels and dimensions of the image for improving efficiency. The third layer of CNN is the fully-connected layer where every node of the output layer is in connection with the preceding layer. So, first CNN layers focus on image colors and edges, then boost its complexity for recognizing the image parts deeply that will be further used in detecting mental health conditions [16].



a.



b.

Fig. 3. a. Recurrent Neural Network where I= input, H= hidden layer, O= Output. b. Convolutional Neural Network where II= Input image, CL= Convolutional layer, PL= Pooling Layer, FCL= Fully connected layer, and O= Output.

IV. AI IN MENTAL HEALTHCARE

Generally psychiatric therapists rely on maintaining former relationships with patients suffering from mental health conditions in a direct way rather than adopting AI techniques [17]. Therapists need to observe patients' behavior and make clinical notes due to which they go with

traditional ways. This is the reason why the Mental health discipline is slow in adapting AI technology when compared to other physical health conditions. But AI opens a new door to detect and diagnose mental health conditions that psychiatrists, therapists, and patients have started adopting. We will be discussing these technologies in detail here.

A. Virtual Reality (VR) and Augmented Reality (AR)

AR helps in treating different kinds of phobias and autism-like disorders whereas by using VR, a psychiatrist observes an individual's behavior and treats the disorder accordingly.

1) *Virtual Reality*: VR is a person to computer connection which lets users to be involved within and connect efficiently alongside a 3D computer-based database in actual time by utilizing their natural abilities and senses [18]. VR helps in treating various psychological disorders and enhance therapy and promote significant changes. VR can be useful for altering bodies bound and studying the correlation among the body (posture, actions, movements), emotions and cognition [19]. **MTBA (Machine to be another)** technology offers wearer an enchanting episode of having a glimpse of themselves in the body of further person.

a) *Imaginal technology*: It plays an important role in inducing positivity through creating a virtual surrounding as it helps in eliminating tension or negativity from our brain by relaxing imagination. Holmes described that mental imaginary act as a speaker of behavioral, cognitive and psychic outcomes [20].

b) *Mental Imaginary*: It refers to assumption or amusement of intuitive episode across visual and auditory modalities and it can be generated from instant noticed data or from past already saved particulars delegate in long-term memory. So, VR systems help in improving medication adherence among schizophrenic patients, give skilled instructions to autistic disorder patients, give healthcare information and support. ML, NLP and affective computing like techniques of AI build the artificial beings much person-like, engaging plus interactive.

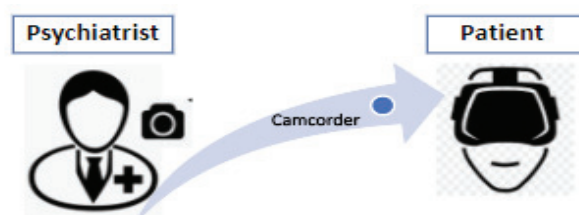


Fig. 4. Virtual Reality (VR) used for observing users' behavior. Here participants are able to see the perspective of another person using a head mounted display which mimics his/her movement. The camera captures performers' personal perspectives controlling the person's head motion and body gestures. Performers' audio is also recorded by personal narrative. MTBA helps in inducing empathy and kindness towards participants as studied by Falconer [19].

2) *Augmented Reality*: AR is a modification of VR which combines both real and virtual elements by overlying data processor created graphic illustrations with live video imagery [21]. AR can furnish actual time location information to users by connecting with GPS and then could

be practiced to phone devices like tabs, computers, cellphones. Certain tests have been done by advanced research on AR hi tech which proposes pictures and data into extended wear lenses and additionally directly onto the person 's retina. This helps users to experience the appearance of floating conventional video directly in the space in front of them. AR helps kids with autism disorder to understand facial expressions and in treating phobias [22].

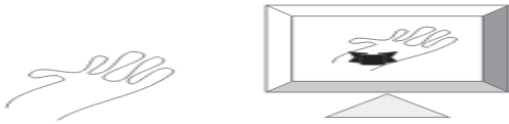


Fig. 5. Augmented Reality (AR) used for treating phobias

AR can be used to treat phobias which we can understand by cockroach study phobia example. Computer vision techniques are used by the AR cockroach system for obtaining the position and camera direction with respect to markers. Program recognizes the real-world marker found by camera and activates the feared virtual environment cockroach. The psychoanalyst can see the unreal or virtual stimulations and can control the applications like no. of cockroaches, size, movement using computer keys. All of these combined options ensure participant safety which decreases their chance for refusing the therapy and also allow the therapist to initiate the care and treatment gradually [23].

B. BCIs and Implants

Brain computer interfaces are technological devices that detect and process *systema nervosum* activity then convert those waves in the direction of artificial output. So, it's a straight transmission channel between the CNS and external devices like computers, wheelchairs, expert system robot hands or even to stimulate one's personal tendons.

BCIs has a large area of applications in medical healthcare like improving neural disorders such as epilepsy, motor breakdown, psychiatric conditions, treating non congenital blindness [24]. Brain computer interfaces if combines with medical appliances could repair general cognitive abilities in humans and assist in reinstalling data to areas in the CNS impaired by brain collapse. Salient cerebrum activities from person using brain computer interfaces can be recognized via invasive or non-invasive methods.

From BCIs three different varieties of CNS activity production was observed: Passive brain computer interfaces use brain activities which are not deliberately generated by person whereas active BCIs use brain activity that require the user to apply some mental strategy like imagining moving a limb.

Researchers have successfully used deep brain stimulation for treating depression, it is a highly encouraging and simulating hi tech development that involve brain implants. "The study found that one in three people would undergo non-essential surgery and allow insertion of chips in their brain for improving mental health".

BCIs can be used to treat conditions like depression, OCD, Tourette's syndrome and Parkinson's

disease. DARPA granted two great agreements in year 2014 to University of California and Massachusetts general hospital on behalf of USA President Obama's BRAIN initiative for constructing electrical brain implants which can treat seven mental illnesses [24].

C. Robotics

Robots are infiltrating various medical management domains that includes testing, characterizing, analyzing, treatment, implantations, and in wellness support program. In psychological and mental illness healthcare, robotics got vast possibilities to advance currently care providers methods as now robots are designed to communicate with people autonomously and encourage people to talk about sensitive topics associated with depression, drug and alcohol abuse, and eating disorders.

Various robots are advanced for helping people with mental health requirements. **Paro** invented by the Advanced Industrial Science and Technology (AIST), Japanese research national association, which is a robotic baby harp seal that was designed for helping older people who are suffering from dementia, Alzheimer's like diseases [25]. With an outside attractive presence, it creates a peaceful warmth in patients and hearten sensitive responses from them. It was also testified as some sort of sensational curative gadget by the US FDA in 2009.

Another example is a voice-activated robot called **Mabu** that was invented in San Francisco by medical care management, which was intended to give psychological therapy by directing patients on the basis of their everyday requirements and afterwards convey their wellness record to doctors [25].

D. Supercomputing and Brain Simulation

Computers with rapid, vast and immense memory abilities when gets associated with advanced software operations enables computers to achieve more functions in shorter time and with substantial capabilities. IBM invented a neuromorphic computer chip that was named as TrueNorth got 5.4 billion transistors and mark it as foremost prime developed computer chips. **Neurogrid** was engineered by researchers at Stanford University and it stimulates around a million of neurons and 6 million neuromuscular junctions [26].

For mapping and modeling the human brain several researchers are capitalizing on supercomputing and the concept beyond the plan is to develop software genre of nerve cells and neuron networks. For instance, the EPFL founded **Blue Brain Project (BBP)** in Switzerland, it was initiated for creating a software brain. Blue Gene supercomputer and NEURON software were used in this project that enables the likeness of a biologically indeed copy of nerve cells. The brain mapping at the nerve cell level can increment the perception of some high level neuromotor operations like learning, decision making, memory and perception.

Computer systems that have the ability to affect the human nervous system therefore has the understanding to boost both sane and insane nervous functioning. Grafting of simulated nervous system can be done as well into virtual computer bodies which will allow psychoanalysts to find how exactly the simulated CNS will intimate, grasp and modify inside specific environment. For example, Brain

modeling that is performed by the researcher on the basis of genetic and other susceptibility factors usually gets linked with depression and stress after that they can use stimulation responsible for mimicking the environmental stressors which can activate the present conditions [27].

TABLE I. AI TECHNOLOGY USED FOR THE TREATMENT OF DIFFERENT MENTAL HEALTH CONDITIONS

Artificial Intelligence	Treatment of Mental Health Conditions
VR and AR	Autism, Phobias, Schizophrenia, PTSD, Psychosis, Addiction, Social anxiety, Eating disorders
BCIs and Implants	Epilepsy, Motor breakdown, Psychiatric conditions, Non-congenital blindness, Depression, Parkinson's disease, OCD, Tourette's syndrome
Robotics	Dementia, Alzheimer's disease, Depression, Autism, Cognitive impairments
Supercomputing and brain simulation	Depression, Stress, OCD, PTSD, Addiction, Parkinson's disease, Dystonia, Obsessive-compulsive disorder.

V. TECHNOLOGICAL BARRIERS

- AI has various advantages and achieved a lot but still there are various drawbacks. For instance, during the 1970s the growth of AI has been restricted due to high expectations of AI by people which results in the AI failure in the past decade failed to which funding was also reduce remarkably and this period was considered to be "AI winter" [22].
- The biggest challenge of AI has been robotics which also act as the technological barrier. But currently AI has been robust towards growth and development. For AI it is very easy to learn and understand complex things which may be difficult for humans like solving mathematics. But AI lacks when it comes to understand the concept behind something like understanding human and recognizing human face. From this Moravec's paradox arises which states that complex problems need less computational works whereas less sensorimotor skills require advance computer work [28].
- In addition, humans have the advantage to put in the judgement to daily life situations like knowing other people's emotional state but this will be an achievement for the AI field if they are capable of designing intelligent machines with commonsense abilities. The developmental investments and substantial research by academic institutions, and private companies are captivating indicators of obligations towards intelligent machines advancement.

VI. ADVANTAGES OF AI MACHINES FOR PSYCHOLOGICAL AND MENTAL HEALTHCARE

There are several advantages of AI in mental health care and some of them we have described below but they are not limited to these only.

A. AI is greater at some things

Intelligent machines can do highly complex tasks with greater efficiency, reliability, and accuracy [29]. Machines don't get fatigued, burnout, or boredom that is used for care services. Patients found easy and comfortable to interact with a machine if compared to humans. They don't feel any type of stress and can share anything person with machine without having the fear of being judged [30].

B. Self-care access to care

People can avail from AI as it come up with self-care alternative for the people who are looking for self-treatment or maybe want get some health-related information. According to the US Health and Human Services Administration, 2013 nearly 80 million Americans are living in an area in which they are not able to find the medic so that they can align themselves to society's need [31]. The problem of scarcity resources can be solved by the interplay with humans through virtual mode which is being provided to everyone through their mobile phones. Delivering therapeutics intervention, data about heath condition are being provided apart from all the question and answers evolution are being conducted for the sake of self-care counselling. This benefit provided by AI has overcome human medical health care, website or scripted videos.

C. Economic Benefits

As AI has been developing the expert system in healthcare, it has an important role in providing economic benefits for healthcare consumers and providers. Decision-making time has been boosted up due to clinical decision support system (CDSS), which further results in reduced demand of clinical staff. Complex healthcare system is being more efficient due Simulation techniques and computational modeling.

With the help of stepped care approach AI systems also play a major role in reducing overall healthcare cost [32]. With the help of virtual care provider, it becomes very accessible to take self-assessment for the people who are dealing with mental health problems. Due to this, it reduces the cost of healthcare system and long-term treatment are being provided at low cost. But these machines or systems are very costly which lowers the demand. 2.2 trillion dollars is the estimated cost of treating mental health globally due to which it surpasses other diseases like diabetes, cancer, cardiovascular diseases burden [33]. With the help of AI technologies, the cost has been reduced and becomes more efficient.

VII. CONCLUSION AND MORAL ETHICS

The utilization of AI innovations and technologies in emotional well-being care is a quickly propelling region that brings out hope for people with its great advantages. Different advances in AI can assist with handling a considerable lot of the difficulties that are confronting medical services all through the world by giving valuable devices that work on the proficiency and nature of medical services. This field not only raises mankind's current

standards of its imagination but also assists with improving our overall productivity by enhancing the cognitive and physical abilities. From patients and consumers to large hospitals and medical professionals, means whole medical services frameworks all remain to profit from these advancements.

In terms to achieve the maximum capacity of what AI and different advances can bring to mental health care, the group of people that includes doctors, researchers, engineers, business people, medical care overseers, and technologists should work as a team.

After the tremendous growth, this field still requires a lot of exploration like human-computer and human-robot interaction with regard to medical services has to be examined in terms of optimization of smart machines so that communication with care searchers could be improved. Specifically, for comprehending individuals' perspectives and inclinations for utilizing smart machines for medical services, this study is needed that will also reflect how effectively smart advancements convey therapy in contrast to conventional methods.

AI is achieving a change in outlook for social and psychological well-being care and at this point, information and abilities of medical service experts will not be only limited to physicians, psychologists, counsellor, or other professionals; but it will be incorporated into the machines that we will be communicating with. As we fabricate and convey these innovations, the intelligent machines should be constructed strictly on the basis of patients' demand for consistently serving prosperity. These machines have to be built in such a way that they always obey and do the well-being of people in an ethical manner while living within a boundary of trustworthiness.

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CANDIDATE'S DECLARATION

I **Khushi Yadav**, Roll Number: **2K20/MSCBIO/08**, student of M.Sc. Biotechnology, hereby declare that the work which is presented in the Major Project entitled —**Explaining human emotions using Interpretable Machine Learning for Behavioral and Mental Healthcare** in the fulfillment of the requirement for the award of the degree of Master of Science in Biotechnology and submitted to the Department of Biotechnology, Delhi Technological University, Delhi, is an authentic record of my own carried out during the period from January- May 2022, under the supervision of Prof. Yasha Hasija.

The matter presented in this report has not been submitted by me for the award for any other degree of this or any other Institute/University. The work has been accepted in SCI/SCI expanded /SSCI/Scopus Indexed Journal OR peer-reviewed Scopus Index Conference with the following details:

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Certificate

I hereby certify that the Project Dissertation titled "Explaining human emotions using Interpretable Machine Learning for Behavioral and Mental Healthcare" which is submitted by **Khushi Yadav (2K20/MSCBIO/08)**, Department of Biotechnology, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Science is recorded for the project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or full for any degree or any diploma to this university or elsewhere.

Place: Delhi

Date:


05/05/22

Prof. Yasha Hasija
(Supervisor)
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05/05/22

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