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# Research Interventions with Machine Learning and AI for Psychiatric Care

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## ABSTRACT

With mental health being an exponential issue in the world, mental health care has begun to utilize more technological advancements within their work. With AI techniques becoming more normalized within society, the mental health field has started incorporating Machine Learning (ML) systems and Deep Learning (DL) models into their relevant professional interventions. Psychiatry specialists have begun to use ML and DL techniques for detecting psychological disorders, providing personalized mental health support, raising the effiency rate for clinical applications, and preventing additional diseases. With all the assistance gained from AI use, many limitations have begun to emerge, specifically related to the data privacy of customers, with the information derived from platforms being misabused by scientists and technologists. All of these following components will be discussed in depth within this publication, by analyzing the efficacy of AI platforms, optimal diagnostic tools, in conjunction with the rise of AI-based platforms that can help identify optimal solutions to patients diagnosed with neurodegenerative diseases. Ultimately, this research publication aims to shed light on various ethical contradictions, legal frameworks and psychiatric interventions that can enable researchers to better expose the traction of Machine Learning tools for future researchers to adopt.

## Introduction to Machine Learning and Mental Health Diagnostics

As technology has started revolutionizing the world, an increasing application of Artificial Intelligence (AI) techniques in different fields has been predominantly evident in multiple emerging industries. Specifically, the use of Machine Learning (ML) systems and Deep Learning (DL) models have been new methods of reforming the mental health industry as a whole. Through applying different ML and DL techniques, doctors are now able to identify, assess and monitor psychological disorders amongst youth, provide an emergence of personalized mental health aid through the introduction of virtual therapists and chatbots, and conduct clinical applications. Within the rapidly-evolving field of Artificial Intelligence, researchers have identified how AI can be implemented in clinical care and adaptations, where these forms of technology can eliminate barriers to convenience, access, or privacy. In fact, the US.'s behavioral health market has predicted a growth within the market from an initial $79.69 billion net worth in 2022 to $105.14 billion by the year of 2029. Researchers predict this is linked to the increase and surge of mental health illnesses and behavioral disorders as a result of the pandemic, coupled by how a transition to relying on online products and services has led to the growth of various mental health platforms and counseling services. (Giubilini, 2023) This publication will analyze the efficiency of the AI techniques used by doctors, emergence of accessibility for mental health services as a result of AI, analyze the impact of AI technology in mental healthcare, and discuss the ethical limitations of applying AI tools for the security of all patients receiving psychological care.

## Pre-Deep Learning Approaches to Analyze and Identify Psychological Disorders

Before the introduction of AI, physicians have relied on long and inefficient techniques to help identify the root causes and behaviors exhibited by those diagnosed with mental health disorders. Through the use of AI techniques, such as ML and DL, expert systems have been developed for the purpose of targeting specific disorders before the illnesses may continue to progress negatively within its course. Depression has been an ongoing problem, especially amongst youth; nowadays, many teenagers are visiting their psychiatrists or psychologists on a regular basis. Back in April of 1996, through the use of a depth-first search method with backward search strategy, researchers have been able to diagnose depression or dementia. (Basavappa et al., 1996) They developed an expert system (DAD) using the patient's symptoms and answers from a series of neurological tests to diagnose depression or dementia. (Basavappa et al., 1996)

The system contains 3 total databases, holding multiple variables. Database 1 pertains to their social activity and appearance, database 2 pertains to emotional trauma and or stressors, and database 3 pertains to neurological disturbances and results from the series of neurological tests. In Database 3, the computer matches a series of facts creating 4 subprograms. Using a depth-first search method, the computer works on one subprogram at a time, tracing downwards in the domain until a dead end is hit, in which it moves to another subprogram. The results from the subprogram get matched with the four parameters of a fact from the Database 3, causing the fifth parameter of the fact to be the final diagnosis. (Basavappa et al., 1996)

Furthermore, it is equally important to consider the efficacy for diagnosing illnesses as it is to obtain an appropriate diagnosis. A misdiagnosis can lead to different damages, which is why no expert system can be developed without being tested. For the efficacy of DAD to be tested, a series of cases were derived from the neurology and psychiatry department of NIMHANS, Bangalore. Case 1 was conducted on a 75-year old male who had little sleep, poor memory, was sad, and had no intuition was diagnosed with senile dementia by both the treating team and DAD. Similar to him, all the other cases were on people who were of older age, on lack of sleep, and tendency to feel sad or irritable. DAD and the treating team were able to properly diagnose all of these cases with dementia. With all four cases matching up, DAD was pronounced to become the first expert system with validation. (Basavappa et al., 1996)

## Efficacy of Deep Learning Models – Artificial Neural Networks, Convolutional Neural Networks, and Recurrent Neural Networks

Deep Learning has been one of the most successful developments of AI in recent years. Nonetheless it is widely used across mental healthcare due to the efficacy of deep learning models. Deep Learning contains different neural networks, which contain multiple layers (input, hidden, and output) and have the purpose of analyzing data like the human brain. This publication will examine threede of the many Deep Learning Models. Artificial Neural Networks (ANN), one of the Deep Learning Models, has the specific purpose of copying how the human brain operates. Convolutional Neural Networks (CNN), another one of the Deep Learning Models, provides the processing of clinical images and expression data in mental health condition detection. Recurrent Neural Networks, the final one of the Deep Learning Models mentioned, was designed in analyzing data relating to language, speech, and video, which makes it possible to detect mental health conditions from processing clinical notes and social media posts. (Su et al., 2020) Similarly to ML expert systems, DL models need to have efficacy. Without efficacy, misdiagnosis would be given.

In another research publication, the importance of deep learning models and networks were identified — it was uncovered that CNN has been identified as one of the most popular and used DL networks that automatically detect significant features without any human supervision or interventions. However, some of the

outlining challenges are pertaining to the lack of training data, imbalanced data, model compression and underspecification of deep learning. (Rahman, 2022). When researchers looked into the various machine learning techniques that are being implemented towards mental health detection and disorders, it was uncovered that the least used machine learning or deep learning techniques was the Convolutional Neural Network (CNN), in comparison to the Support Vector Machine (SVM), which was identified to be one of the standard machine learning tools that can help solve both linear and nonlinear problems. (Alvarez, 2019).

## Emergence of Interventions of Personalized Virtual Health, AI-Generated Platforms and Prototypes that Help Treat Mental Health Disorders

Regarding the most optimal solution towards increasing accessibility towards mental health services, through the use of AI and technology, personalized virtual health platforms have increasingly been generated as a resolute platform that patients can utilize for their mental health conditions. In recent years, within 45% of the global population, there is one psychiatrist for every 100,000 people. On the other hand, 50% of the same population owns a smartphone. (Lovejoy, 2019) Since the 1990s, the Internet-based cognitive behavioural therapy (CBT) has been provided for the treatment of mental health disorders. Though classified by low adherence, it has assisted in the development of CBT chatbots. The CBT chatbots, through the analyzing and mimicking of human interaction, were able to increase adherence. They rely on models from the range being straightforward, like Eliza, to complex AI models using NLP and ML. Chatbots function generally in response to the user's text message with a text or voice response. (Boucher et., al)

The most common application of AI-Generated chatbots in regards to mental health is the operation of psychotherapeutic interventions. Chatbots use various psychotherapeutic approaches such as teaching various therapeutic techniques, acceptance and commitment therapy and mindfulness. Vivibot is an example of a chatbot that helps young cancer survivors to learn and utilize psychological skills to help in anxiety reduction after treatment. (Boucher et., al)

Nowadays, a single AI system could replace a whole set of psychotherupeuatic. This works in favor of people who have conditions that prevent travel of long distances, since there is no longer much need to travel to high end clinics. Accessibility can also be increased through the destigmatization of mental illnesses. Compared to therapists, chatbots are able to avoid such stigma, due to not being a part of any social circle or associated with various cultural standards (Lovejoy, 2019).

## Applications of AI towards Neurodegenerative and Neurological Diseases

Amidst the rise of prevalent neurodegenerative diseases, AI has served as a gateway to unlocking the proper classification, diagnosis and treatment plans through the usage of various deep learning models. Machine learning has been encouraging researchers to better analyze medical images in constructing new forms of therapies and effective treatments. Neuroimaging is a sector of neurology that has benefited from the use of machine learning to optimize diagnostic results; in addition, to reducing the time necessary to conduct clinical examinations. Furthermore, machine learning has been presented as a promising tool for disease predictions and the classification of patients' symptoms. In anticipation for future therapeutics and treatment plans, machine learning is advised to be incorporated into neurology practices. (Myszczynska et al., 2020)

Particularly in identifying the onset and proper diagnosis of Alzheimer's Disease, some of the machine algorithms utilize multi-modal neuroimaging data that can secure high accuracy and classification. Furthermore, machine learning has also been employed to better detect onset of Parkinson's Disease by differentiating between abnormal and normal hand behaviors. Specifically, the two machine learning-based systems that are used to detect neurodegenerative diseases are the Parkinson's KinetiGraph and the Kinesia system. In order to detect

these motor disorders, instead of the CNN that has been outlined in the earlier paragraphs, system outputs including the SVM algorithm (machine learning algorithm) have been proven to be the most efficient. It is imperative for researchers to use the combination of neuroimaging, multi-modal data and clinical points. (Khaliq et al., 2023)

## Clinical Applications Including Brain Imaging Tools and CNN

With the accelerating implementations of AI applications in the branch of neurology, many significant impacts have transpired in the specifics of neuroimaging and radiation reduction with the help of brain imaging tools. In neuroimaging applications, with the aid of AI, the efficiency rate of clinical applications has heavily increased causing AI to be able to complete numerous sets of commands, one of these being predicting patient wait times. AI is now able to predict patient wait times for many medical examinations, such as "computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, and X-ray imaging". By identifying the variables that affected most of the inefficient wait times for patients, AI was able to discontinue inefficient wait times, as well as discover different areas of improvement for patient processing. A more specific application of this is using DL approaches to decipher whether an MRI is required to be repeated through an initial screening approach. It is estimated that around 20% of MRIs costs doctors and patients a massive waste of time and money. (Monsour et al., 2022) Because of the initial screening approach, more patients no longer need to make frequent visits to the doctor, and less stress is strained upon the neuroradiologists.

With the application to CT and help of DL models, AI has also become an influential part of reducing radiation exposure. One example of this is when a CNN was used to "transform low-dose CTs of anthropomorphic models with calcium inserts and cardiac patients to normal-dose CTs." (Monsour et al., 2022) With the hope of improving the signal-to-noise ratio (SNR) through training a noise destroying CNN and a noise generating CNN together, AI aided towards the preservation of images' features. This improvement became a direct application for the imaging of cerebral vasculature, including the calcification, which in hopes prevents additional strokes and diseases from happening. (Monsour et al., 2022)

## Ethical Contradictions, Limitations and Discussion of Machine Learning and Mental Health

Despite the positive implications that AI can increase accessibility to mental health, ethical issues have come to life as a result of the lack of humane connections, potential data breach and lack of security issues, alongside lack of appropriate consent involved. Koko, a free mental health service, "allowed its users to use ChatGPT to help them develop responses to 4,000 users who sought help through the service." (Biron 2023) Robert Morris, Koko's co-founder, described the operation as a "co-pilot approach with humans supervising the AI as needed." Though this approach was rated significantly higher compared to the human written messages, much outrage in the public sparked. The approach was called "hard", "cheap", and "unauthentic." (Biron 2023)

"Grossly unethical" is what Arthur Caplan, a professor of bioethics at New York University's Grossman School of Medicine, called it. In spite of the continuous adaptation and applications of machine learning systems in mental health diagnostics and therupeatics, many public healthcare professionals argue the use of such applications should be deemed dangerous in regards with their data security, privacy, and consent. In the Facebook-Cambridge Analytica scandal, the misuse of personal data was very evident within the case. Healthcare professionals argue that companies may continue to violate their users' privacy, which if it happens in healthcare, there would have serious repercussions. (Biron 2023)

Thirdly, although virtual chatbots have revolutionized the mental health space, a lot of the output and outcomes generated from AI lack diversification of all ethnic groups. At the end of the day, chatbots cannot

completely eradicate the human experiences of connecting with proper therapists and licensed professionals as non-verbal cues and social connections cannot be implemented on digital platforms. Furthermore, physical body languages including eye-to-eye contact and verbal cues are difficult to transcribe and interpret through the introduction of virtual chatbot platforms. Fourth of all, the introduction of chatbots could not replace the benefits of attending therapy sessions in a clinical space to establish social communications in times of chronic mental illnesses. Lastly, social isolation is another potential limitation to depending on AI-based platforms, as many patients can positively benefit from the inclusive space of connecting with loved ones. (Lovejoy, 2019)

## Conclusion

In summary, through the integration of Artificial Intelligence techniques in mental health clinics, psychiatric care has been substanstially amplified. Through the development of diagnostic tools, such as expert systems like DAD, the efficacy of Machine Learning and Deep Learning Tools to effectively diagnose pyschological disorders like depression and dementia has improved exponentially. With AI techniques such as DL models, many neural networks have been utilized in efficiently providing patients with correct diagnoses without having to undertake human interventions. As well as, with the emerging personalized chatbots like ChatGPT, people no longer have to travel far to psychotherapists when there is access to an AI-generated continously. In the region of a hospital, the utilization of AI has enhanced the efficiency rates of applications, minmized the tension for the doctors, and further prevented diseases. In contrast, while AI is being employed for countless clinical applications, it's necessary for people to be cognizant of the ethical limitations of the adaptations in regards to the breach of data security, being unable to be humane, and inability in eliminating feelings of social isolation. In conclusion, AI will be very crucial in the future of mental healthcare, with personalized treatment being offered based on extensive data analysis. Chatbots will continue to evolve to become better virtual therapists, offering real-time and on-demand support, and other devices will provide more advanced monitoring metrics to develop better diagonseses.

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