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ADVANCING FRONTIERS OF PSYCHIATRIC THERAPEUTICS



PK Singh

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CHAPTER

Artificial Intelligence-based Therapies

Debasish Sanyal

INTRODUCTION

Tremendous advancement in the field of computer science and information technology over last few decades has touched every facet of human life. Computers, internet, and smartphones are everywhere and being its user includes academics, technologists, businessmen as well as common people. Medical science including the field of mental health and psychiatry has also been influenced by this revolution of technology. Computers cannot only do huge calculations, handle huge information accurately, but also they have intruded into areas which were assumed to be prerogative of human intelligence. Thus, computers can now defeat even Grandmasters in game of chess. People began to talk about computers becoming intelligent like human beings and possibly exceed human capacity. IBM's Watson supercomputer may be able to beat humans at game of jeopardy, but currently match the cognitive capacity of a human being.

Controversies exist about what exactly is human intelligence. Large number of academics from diverse areas has argued against machine being able to truly approximate functions of human mind. Philosophers like Searle[1] and physicists like Penrose[2] to name a few have strongly emphasized eminence of human intelligence over computer.

Many researchers have proposed following essential requirements of artificial intelligence (AI):[3-6]

- Reason
- Use strategy
- Make judgments
- Plan
- Learn
- Natural language communication capability
- Work toward common goal.

Humans can recognize patterns, learn new knowledge by applying insights and experience, create mental models of reality, think abstractly, and innovate.[7]

However, our thinking is extremely slow due to slow neural transactions.

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Machine intelligence includes the ability to remember billions of facts precisely and recall them instantly. And, can share their knowledge at extremely high speed.

John McCarthy, the father of AI; coined the term "artificial intelligence" in 1956.

The modern definition of AI is "the study and design of intelligent agents" where an intelligent agent is a system that perceives its environment and takes action which maximizes its chances of success.

TYPES OF ARTIFICIAL INTELLIGENCE

There are three types of AI:

1. *Narrow AI:* Developed and trained for a particular task—weather forecast.
2. *Artificial general intelligence (AGI):* It is an AI system with generalized cognitive abilities which find solutions to the unfamiliar task it comes across, still not achieved.
3. *Artificial superintelligence (ASI):* It refers to the position where computer/machines will surpass humans and machines would be able to mimic human.

APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN PSYCHIATRY

- AI in psychiatric diagnosis
- AI in psychiatric treatment.

AI in Psychiatric Diagnosis: How Machine Learning Algorithms are Used in Psychiatry

Limitations of current psychiatric diagnosis are that many conditions overlap. At least 50% of patients receive more than one psychiatric diagnosis. People visiting more than one provider may be diagnosed differently, leading to confusion, straining trust, and complicating recovery planning.

Approaching psychiatric diagnosis by using mathematical tools to search for consistent patterns inherent in clinical data, avoid error from human bias and the risk of holding onto familiar categories in favor of more accurate approaches. By using AI type approaches, researchers can leverage computation power to see consistencies in how symptoms cut across received diagnostic categories to develop "transdiagnostic" perspectives. Machine learning has already made its way into clinical research and analyzes the psychological traits of the patients using unsupervised techniques (unlabeled samples are to be divided into groups of related cases) and semi-supervised techniques (both labeled and unlabeled cases are present).[8,9] This method is used to broadly classify depressed individuals from the healthy ones.

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Below I describe some areas where AI approach has been used in psychiatric diagnosis.

Psychosis Early Detection[10]

Artificial intelligence could be used to notice relevant symptoms and acts as an early detection mechanism, as demonstrated by two recent case studies.

Veterans are considered as a typical high-risk group for developing mental health difficulties. Cogito—a company funded by the Defense Advanced Research Projects Agency—teamed up with the US Department of Veterans Affairs to try an application named Companion, to monitor veteran subject's phone 24/7. The sound of the user's voice and their frequency of mobile phone usage, changes in inflection, energy of pitch may translate into mental health indicator using AI.

IBM's Computational Psychiatry and Neuroimaging group, alongside several universities, built an AI that used a method called natural language processing (NLP) analyzing patient's speech for different indicators, such as coherence of speech and ideas and achieved 83% retrospective accuracy of detection.

- Researchers from Harvard University and the University of Vermont used color analysis, metadata, and algorithmic face detection using AI to get 70% accuracy in detecting signs of depression from Instagram pictures. Depression patients were more likely to post bluer, grayer, and darker-colored photos. Using computer vision to diagnose attention-deficit hyperactivity disorder (ADHD) in children.
  Scientists at the University of Texas at Arlington and Yale University used computer vision and machine learning to assess children while they are performing exercises to test a child's attention, decision-making, and ability to manage emotions and were able to diagnose ADHD more accurately.
  Computer game Cyberball, which measures social rejection can be used to assess borderline personality disorder.
- Virtual reality offers method to study behavior under controlled conditions such as assessing interpersonal behaviors such as distance regulation, gaze direction, and posture.

Neuroimaging biomarkers: They have been studied for major depressive disorder (MDD), schizophrenia, obsessive-compulsive disorder (OCD), and chronic pain syndromes. Taking data from 200 patient samples, and looking at 10,000 neuroimaged connections and 140 brain lesions, and using sophisticated AI algorithms to select the 16 functional connections that are specific for and discriminate autism spectrum disorder (ASD) from normal (typically developed) brains, could not distinguish MDD patients from their controls, but showed some ability to discriminate between patients with schizophrenia and controls. By pinpointing the lack of emotional response in the brain, an artificially intelligent system can alert a doctor to psychotic symptoms, and

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calculate the probability of a patient developing schizophrenia by analyzing the functional magnetic resonance imaging (fMRI) and speech pattern data that the program has gathered. The sum of the information a computer gathers allows the system to develop a full mental profile of a patient, which can then be shared with a psychologist or psychiatrist for double-checking and administration of care. Patterns of disjointed speech may appear in very mild form years before a patient develops schizophrenia and the breaks may be so subtle that even a trained *professional* could miss them.

AI in Psychiatric Treatment

Improve Mental Health Access[10,11]

Less than *one psychiatrist for every 100,000 people* in more than 45% of world populations. AI enabled programs may be used to screen people for mental illness.

AI Provides Personalized Treatment

An online platform Ginger.io can tailor its suggestions to the needs of the user and provide access to a variety of treatments.

Stigma Avoidance

Stigma of mental illness makes people reluctant to seek help. As opposed to fellow humans, an AI does not necessarily form part of any wider social construct and may be perceived as *nonjudgmental, nonopinionated* and neutral.

Psychotherapy Uses

The main advantages offered by the use of information technology in psychotherapy are:

- Supplementary time for supervised treatment gained by the patient
- Decrease the time append in direct interaction with the practitioner
- Decrease the cost of the treatment
- Some help in taking treatment decisions.

The main applications of computer in psychology refer especially to psychotherapy:[12]

- Self-help internet sites
- Computer administered therapy
- Screening and assessment using web applications over the internet
- Adjunctive palmtop computer therapy
- Online consultation
- Advocacy
- Virtual reality therapy
- Interactive voice messaging systems
- Biofeedback via ambulatory physiological monitoring

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- Virtual spaces for support groups (can be based on social network instruments or by a custom solution).

STRESS MANAGEMENT

Macquarie University in Sydney helps students develop better coping techniques, particularly in connection with examination stress using AI techniques.

Kavakli and colleagues proposed a virtual companion that can be readily available to provide support. The virtual counselor offers advice and support with stress management. AI can play in making people feel socially more connected. Example, being Melbourne, Australia, Moderated Online Social Therapy (MOST) project.

CHATBOTS AND VIRTUAL AI THERAPIST[10,13,14]

Online cognitive behavioral therapy (CBT) which is available 24/7, accessible easily and instantaneously is just as effective as human counselor-based CBT. The first randomized control trial with Woebot showed that after just 2 weeks, participants experienced a significant reduction in depression and anxiety. A virtual therapist named Ellie has also been launched and trialed by the University of Southern California's Institute for Creative Technologies (ICT). Initially, Ellie was designed to treat veterans experiencing depression and post-traumatic stress syndrome. What is so special about the technology is that Ellie can detect not only words but also nonverbal cues (e.g. facial expression, gestures, and posture), which are subtle and difficult to pick up.

FUTURE SCENARIO

Artificial intelligence in future may be used for finding the neurodevelopmental trajectory of humanity by doing dataset clustering and letting unsupervised machine learning and find the potential points where interventions can change trajectory of development, and thereby develop probable therapy for neurodevelopmental diseases and possible answer to aging.

Other possible ways in which AI may be used in future are as follows:

- Smartphone behaviorometrics
- Body sensor behavioriometrics
- Social media behaviorometrics
- Natural language processing monitoring
- Behavioral assessments from real-life behavioral observation
- Social media behavioral assessment
- Regular assessment of various biomarkers in a transdiagnostic way
- AI-based rehabilitation of neurodevelopmental and neurodegenerative disorders
- Whole brain simulation or mind transfer—immortal humans!!
- Robotic playmates and companions
- Social AI for social reintegration

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- Enhancement by implants, merger of human and AI for augmented human intelligence
- Detailed microscopic level knowledge about organization of human brain and connectomes so that its interactions can be understood (Blue Brain Project, Human Connectome Project).

CONCLUSION

Amidst the technological revolution we are witnessing, it is hoped that proper and judicious use of artificial intelligence is going to help psychiatry and patients in near future. It is a powerful resource. The way we use it will decide whether it proves to be a bane or boon for us.

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Advancing Frontiers of Psychiatric Therapeutics

Therapeutic science is a weapon in our adaptive fight against the diseases and the disorders, which increases the survival potential of human race as a member of the biosphere. Complexity of human mind is reflected in the equally complex nature of its disorders which require varied inputs of a very wide spectrum to reclaim the orderliness. The intervention-spectrum for psychiatric disorders is very broad and its advancing frontiers require to be viewed together at one place. The rich talent of Indian Psychiatric Society has been harnessed to give shape to this multi-authored and multi-hued book on the cutting-edge contents of psychiatric therapeutics. Hopefully this book will prove useful for both the clinicians and researchers of the science of psychiatry.

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