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Probing Human Minds to Uncover Underlying Mental Conditions with AI

Every stage of life is impacted by mental health diseases, which range from dementia to schizophrenia. The World Health Organization estimates that one in eight people worldwide suffer from a mental condition and that poor mental health costs the world economy $1 trillion in lost productivity each year.

Co-Directors of the Centre for Biomedical Informatics Asst Prof Bernett Lee and Asst Prof Wilson Goh. Image Credit: Lee Kong Chian School of Medicine, NTU Singapore.

Effective treatment for mental health illnesses depends on an early and precise diagnosis, just like it does for many illnesses. Nevertheless, unlike, for instance, a heart attack, which can be detected through tests that detect particular signs or "biomarkers" linked with the disorder, no clear-cut biomarkers for mental health issues have yet been identified.

This is due to the intricate interplay of factors that causes mental diseases, such as heredity, biological predisposition, and unfavorable living circumstances. It can be difficult to determine whether any specific symptoms are linked to a particular mental illness since patients with the same mental problem exhibit a wide range of symptoms.

Additionally, doctors must evaluate the symptoms that patients themselves report, which are then open to arbitrary interpretation.

The diagnostic arsenal of a mental health practitioner can now incorporate artificial intelligence. Artificial intelligence (AI) has the potential to find the mental disease biomarkers hidden among complicated profiles of genetic markers and behavioral indications because of its efficiency in processing and extracting insights from massive datasets.

The application of technology could also be able to forecast whether a patient's mental disability will get worse over time and contribute to the development of individualized treatment plans that are specific to each patient's needs.

Sussing Out Schizophrenia

Schizophrenia can be characterized as a severe mental condition in which patients lose touch with reality, typically starting in young adulthood. Psychosis, another name for the illness, is characterized by odd behavior and hallucinations.

Although its precise cause is uncertain, schizophrenia is thought to be brought on by a confluence of hereditary and environmental variables.

The recently established Centre for Biomedical Informatics at Nanyang Technological University, Singapore (NTU Singapore) is focused on utilizing the possibilities of artificial intelligence and data science to aid in the prediction of mental health issues.

The New Zealand-Singapore Data Science Research Program, a partnership between NTU Singapore, the Institute of Mental Health (IMH) in Singapore, and Auckland University of Technology (AUT), is one of the initiatives the center is working on to aid in the prediction of schizophrenia in young people.

The program is creating machine-learning computational models that identify biomarkers related to the emergence of schizophrenia symptoms, and it is co-led by bioinformatics scientist Assistant Professor Wilson Goh of NTU Singapore's Lee Kong Chian School of Medicine.

The interdisciplinary research team is analyzing the gene expression and metabolic profiles in blood samples taken from 600 young individuals using an AI algorithm built by AUT and comparing the results with clinical and behavioral data from the subjects.

The scientists want to determine how these factors relate to one another by combining all of this information into a single model.

> " *AI programs that analyze large datasets have made it possible for us to spot relationships between gene expression and metabolic data. Looking at more dimensions in the data may enable physicians to identify early indicators of schizophrenia and treat the disorder before the patient's quality of life deteriorates.*
>
> *Wilson Goh, Assistant Professor, Lee Kong Chian School of Medicine, NTU Singapore*

Decoding Dementia

Unlike schizophrenia, dementia is a brain condition that primarily affects the elderly. Advanced dementia patients have memory loss, impaired judgment, and confusion, which make daily tasks more difficult.

The Dementia Research Centre (Singapore) at NTU Singapore is creating AI-powered solutions to detect and postpone the advancement of the disease to address the rising instances of dementia in aging populations in Asia and around the world.

One of the initiatives at the center is the Biomarker and Cognitive Impairment Study (BioCIS), a five-year study to recognize what happens to the brain at the early stages of dementia. It works with local hospitals to recruit 1,500 patients from all ethnicities who have a mild cognitive impairment, the earliest stage of dementia.

By examining structural characteristics of the brain from brain scans, evaluating brain activity with functional magnetic resonance imaging (fMRI), and looking for protein biomarkers in the blood, BioCIS hopes to find biomarkers linked to cognitive impairment.

> " *This will help us develop personalized strategies which could potentially prevent and delay the development of dementia in each patient.*
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> *Professor Nagaendran Kandiah, Senior Consultant Neurologist, Lee Kong Chian School of Medicine, Singapore*

Prof. Kandiah is also the Director of the Dementia Research Center.

He added, "For example, we can formulate interventions to improve a patient's weak cognitive areas as well as enhance their strengths to delay the progression of dementia."

Detecting Depression

A non-invasive AI tool that could help in the early diagnosis of depression, a common mood condition that can strike at any age, has also been developed by NTU Singapore.

Millions of people experience depression, which can be brought on by upsetting life experiences. Nearly half of depression instances go undetected and untreated, and those who have the disorder frequently endure mood swings that make them retreat from society.

The NTU Singapore team has created AI software that analyses data from fitness trackers to find digital biomarkers of depression and determine a person's risk of acquiring it. This technology takes advantage of the increased popularity of wearable activity trackers.

Researchers led by clinician-scientist Prof. Josip Car of NTU Singapore's Lee Kong Chian School of Medicine and cognitive neuroscientist Associate Professor Georgios Christopoulos of NTU Singapore's Nanyang Business School conducted a survey involving 290 working adults in Singapore to build their machine-learning program, called Ycogni.

At the beginning and end of the trial, participants completed two health surveys that checked for depressive symptoms while wearing fitness trackers for two weeks.

The data allowed the researchers to link specific patterns in the fitness-tracking behaviors of the participants to depressive symptoms like helplessness and hopelessness, a loss of interest in routine tasks, and changes in food or weight.

The program could successfully identify those people with a high risk of depression and those without risk of depression with an accuracy of 80% in tests using data from depressed and healthy participants.

The findings, which were published in JMIR mHealth and uHealth in October 2021, provide new opportunities for AI to support depression diagnosis.

Plans are in the works to further validate the algorithm.

> " The advantage of using AI in combination with wearable technologies to monitor wellbeing is that it is an unobtrusive way to identify individuals at risk of mental illness, enabling these conditions to be diagnosed and treated early.
>
> Josip Car, Professor, Digital Health Sciences and Director, Centre for Population Health Sciences, Lee Kong Chian School of Medicine, NTU Singapore

Georgios Christopoulos, an Associate Professor in the College of Business (Nanyang Business School), stated, "We believe that Ycogni could be integrated with Smart Buildings or Smart Cities initiatives to help individuals, researchers, mental health practitioners and policy makers improve mental well-being."