Artificial Emotional Intelligence:

Catching Anxiety & Depression

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Abstract: The integration of Emotional Artificial Intelligence in the medical field, poses a number of opportunities for Healthcare Providers, Physicians, Front-line Healthcare workers, Telehealth delivery models, and the like. Specifically, with Major Depressive Disorder as one of the largest disabilities across the globe, finding non-invasive methods to retrieve real-time mental health data, while empowering the patient with real-time access to such data, and the opportunity to modify patient behaviors in real-time, also provides a tool for the prevention of suicide and murder or mass-killings, while allowing the patient to peer into him/herself like never before in the history of modern medicine.

Accelerated Computing; Deep Learning; Machine Learning; Artificial Emotional Intelligence

1. Background

Dedication: We would like to dedicate this work to those impacted by anxiety, depression, or suicidal thoughts and acts. This algorithm is for you.

Providence, using the most powerful graphics cards in the world. We chose to initially focus on commercial opportunities with Anxiety and Major Depressive Disorder (MDD) for obvious reasons. MDD is the leading cause of disability in the U.S. for ages 15 to 44. MDD also affects more than 16.1 million American adults, or about 6.7% of the population age 18 and older in any given year. 1 Additionally, the same study shows that nearly 50% of adults that visit a primary care physician during a depressive or anxiety disorder episode, also suffer from a co-morbid, secondary depressive or anxiety disorder. This research shows that a presence of co- occurring depressive and anxiety disorders is associated with greater chronicity, slower recovery, increased rates of recurrence, and psychosocial disability. Symptoms of MDDinclude the following: Significant weight loss; Insomnia or hypersomnia; Psychomotor agitation; Fatigue or loss of energy; Feelings of worthlessness or excessive guilt; Impaired ability to think or concentrate; Recurrent thoughts of death, and suicide ideation or attempts.

Providence has its appointed hour for everything. We cannot command results, we can only strive. – Mahatma Gandhi

Infinite Emotion is a division of Infinite 8 Institute, a national social enterprise whose mission is the design and

finance of social impact systems and emerging technologies, with locations in Omaha, NE, Fremont, NE, Kansas City, MO, and Washington, D.C. The inception of Infinite Emotion began through Infinite 8's long-standing work with non-cognitive development, character development, and trauma informed care. Infinite 8 has likewise worked for many years to address anxiety and depression through the use of non-cognitive and character development to positively influence and impact the emotional state of youth as well as adults. Only over the last two years, having worked intimately with Artificial Emotional Intelligence, did we begin to dive deeper into human emotion through the act of interpreting and communicating such emotion to a machine. Our initial work with emotion began during our inclusion in the IBM Global Entrepreneur Program, utilizing IBM's Watson supercomputer to analyze emotion for the first time. While powerful, we, like many other thought leaders in the field, questioned the security of utilizing cloud-based systems, rather than running applications locally. This desire to utilize hardware to run A.I. locally, led us to our current participation in Nvidia's Inception Program for Artificial Intelligence Startup's, which allowed us to develop our application, Likewise, according to the World Health Organization (WHO), 1 in 13 globally suffer from anxiety. The WHO reports that anxiety disorders are the most common mental disorders worldwide with specific phobia, major depressive disorder and social phobia being the most common anxiety disorders. Both anxiety and depression, can ultimately lead to suicide. Close to 800,000 people die from suicide every year. Suicide is the second leading cause of death in 15-29-year-olds.

2. Current Methodologies for MDD Detection:

MDD among in-patients or hospitalized patients is often undiagnosed due to a lack of recognition, which leads to non-treatment. Current research shows that there is a prevalence of MDD among hospitalized patients of 33%.

Also, several studies from hospitals found depression to be associated with poorer functional outcomes, worse physical health, and returns to the hospital after discharge. Available tools for screen MDD were many. We discovered a number of software applications that were active, such as *Woebot,* an automated conversational agent or chatbot that monitors the moods of users and provides a venue in which users can express their thoughts and emotions through therapeutic conversations. The application asks users how they are feeling and what is going on in their lives, talks to them about mental health and wellness, and sends videos and other useful tools depending on the user's current mood and needs. *Daylio*, in contrast, is a free application that serves as a micro-diary without having to write down your feelings. A patient just has to select videos and icons that correspond with your mood to track how your feelings ebb and flow. A more traditional and well-known screening tool is the *PHQ-9*, which is a Available tools for screening MDD were many. We discovered a number of software applications that were active, such as Woebot, an automated conversational agent or chatbot that monitors the moods of users and provides a venue in which users can express their thoughts and emotions through patient stress questionnaire often used in primary care settings for screening, diagnosing, monitoring, and measuring the severity of depression. The PHQ-9 is short and well received in clinical practice.

The PHQ-9 is completed by the patient in minutes and is rapidly scored by the clinician. The PHQ-9 can also be administered repeatedly, showing signs of improvement or worsening conditions. Anxiety and MDD, utilizing Machine Vision. Providence has been deployed on embedded systems, such as Nvidia's TX2 embedded supercomputer on a module. A locally available GPU provides the power necessary to provide signal and inference low-latency, and thus higher levels of accuracy. Locally running Deep Neural Networks, also enhances the security of such applications, by allowing them to be deployed on local hardware, on-site, without the need for an internet connection, and therefore reducing cyber security challenges substantially. Each of these screening tools are active, requiring the patient to engage with the screening application. Second, the software applications also require the patient to be truthful concerning their responses to the screening tools and questionnaires. In both cases, the applicant may not be conscious or coherent to adequately respond to a questionnaire, or they may choose not to speak up, or may not recognize signs of anxiety, MDD, and suicidal thoughts and/or behaviors. Additionally, the PHQ-9, while a worthy screening method, does not provide accuracy objectively. Providence provides up to 99.87% accuracy, which can be shared in real-time with patients and physicians. The live screening is done simply with a USB camera connected to the GPU. The device can be deployed in a number of real-world environments, and without the need for an internet connection or wired power source, the mobile device can prove reliable in dynamic settings. The simplicity of the hardware and implementation make it ideal for a complex and high-volume medical environment. While the tool is not meant to supplant current methodologies for screening depression, the application is meant to serve as an additional layer in a comprehensive early warning system, notifying patients and medical professionals earlier of signs and intensity of MDD, ultimately saving society more lives, workforce productivity, and tax payer dollars.

Economic Impact: According to the Scientific American, Depression in America costs society $210 billion per year. This number includes workplace costs, such as missed days and reduced productivity. The next contributor, which is 45% of total costs, include medical claims and pharmaceutical costs. The remaining costs, stem from suicide-related costs, which include loss of earnings.

Future Endeavors: Infinite Emotion is currently inviting formally diagnosed MDD patients to volunteer for an anonymous 8-week clinical trial, using a randomized control and non-control group to determine the impact of Providence, when integrated with traditional medical screening tools, such as PHQ-2 or the PHQ-9.

New Technology Solution: Infinite Emotion has developed Providence, which is a Deep Neural Network that can detect a large number of emotional states, also providing context through the interpretation of body gestures in real time. While Providence can detect a large number of emotional states, the most important are its ability to detect Anxiety and MDD, utilizing Machine Vision. Providence has been deployed on embedded systems, such as Nvidia's TX2 embedded supercomputer on a module. A locally available GPU provides the power necessary to provide signal and inference low-latency, and thus higher levels of accuracy. Locally running Deep Neural Networks, also enhances the security of such applications, by allowing them to be deployed on local hardware, on-site, without the need for an internet connection, and therefore reducing cyber-security challenges substantially.

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