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CS 410: Text Information Systems

**Technology Review: Ellipsis Health**

Interest in the use of artificial intelligence in healthcare has been prevalent since the emergence of computing hardware in the 1960s [1]. However, it is only recently that artificial intelligence has gained widespread, applicable use in health care systems. Natural language processing (NLP), which is a facet of artificial intelligence, has been increasingly popular in health care technology. NLP, which is concerned with replicating the ability to understand human speech and text in computers, has been used in this domain to improve electronic health records by standardizing unstructured textual data, allow health care providers to dictate notes using speech recognition, and most importantly, support providers in making clinical decisions [2]. However, NLP solutions are still unreliable and there remains a need for robust, accurate solutions for addressing more complex clinical problems. Naturally, many companies have emerged with a specific focus in advancing healthcare technology using artificial intelligence/NLP. Ellipsis Health is one such company, with a particular focus on mental health. The company has produced a "novel speech-based health assessment platform" [3] for providing patient risk estimates and other analytics for mental health diagnoses, such as depression, anxiety, and stress. The company has also appeared in peer-reviewed papers in speech technology and clinical validation for their NLP deep-learning architectures. This review explores the contributions of Ellipsis Health in this domain to determine the company's viability in the advancement of artificial intelligence in healthcare.

**The Ellipsis Health App Platform**

In a world of increasing mental health awareness and lack of access to health care, Ellipsis Health attempts to bridge the gaps by creating a screening tool to detect depression and anxiety in a person's voice by analyzing semantic-based and acoustic patterns. The screening platform, called Ellipsis Health App, is available as a mobile application and has already been leveraged by health care providers to screen for and monitor behavioral health in patients. The company describes the mechanisms of the tool in a research paper studying the efficacy of a learning-based mobile application in detecting depression and anxiety in senior populations [4]. According to the paper, users are given a range of topics related to their lives (e.g. health concerns, living situation, support structures) to verbally respond to for up to 5 minutes. The audio data (which is de-identified for privacy) is transferred to the cloud for binary classification using deep learning models. The Ellipsis Health App uses two machine learning algorithms: an NLP algorithm for semantic analysis and an acoustic algorithm for analysis of acoustic properties [5]. The NLP algorithm uses a long short-term memory (LSTM) language model pre-trained on publicly-available text data, such as Wikipedia, and then, on behavioral health-specific text data, such as health forums [5]. The model is further trained for prediction on labeled data from previous user recording sessions to capture word patterns associated with depression [5]. Similarly, the acoustic algorithm uses a combination of convolutional neural networks (CNNs) and LSTMs trained on labeled recorded data to predict depression in acoustic patterns[5]. The company continues to expand on the application with improved deep learning models and better usability and user experience of their application.

**The Pros and Cons of the Ellipsis Health App**

There is a large and growing number of free mental health mobile applications already available on the market. Popular applications are usually based in meditation, mindfulness, psychoeducation, peer support, or mental health tracking. However, Ellipsis Health App sets itself apart by being based in screening and speech analysis. Studies have shown that a major problem with current mental health applications is sustained engagement from its users [4]. Users tend to stop using these applications less than 30 days after first use. The results of research on the Ellipsis Health App showed that a sizable portion of participants used the application even after the end of the study, which may be attributed to "the cathartic response of verbalizing personal issues" [4]. Nonetheless, participants found the application easy-to-use, although repetitive. Ellipsis Health has worked with other groups to create more engaging applications; notably with the insurance provider, Cigna, to create an online test called StressWaves that screens for stress using speech analysis and produces visualizations of one's stress levels and steps to reduce stress [6].

It is evident that Ellipsis Health has high potential from a marketability standpoint but there are a lot of questions about whether artificial intelligence/NLP can be or should be used for mental health screening, especially in the way that Ellipsis Health proposes. Many computer scientists contest the idea that AI can detect mental disorders through speech with any high accuracy or precision. First, there is not much data that supports a link between speech patterns and all mental disorders [7]. Second, there are potential biases that voice-analyzing technology cannot account for, such as differences in languages and accents, non-native speakers, disabilities, and idiomatic differences between groups [7]. For people that are already discriminated against in medicine, such as people of color, women, or disabled people, the reliance on algorithms for clinical decision-making can worsen patient outcomes and quality of care. Ellipsis Health has tried to address these concerns with studies on the portability of their application across different demographics. In one study, the company reported that their depression classifier "showed great portability over age, gender, and ethnicity" [8]. However, as one AI researcher has pointed out [7], closer examination of the results shows that their deep learning model predicts depression in African-Americans correctly only 62% of the time, as compared to 75% for Caucasians. These type of biases in AI technology can be used for further discrimination and disempowerment in marginalized groups.

**Conclusion**

It makes sense that with recent advancements in artificial intelligence and the increasingly large amount of data in healthcare, that there is desperation to use AI to solve and manage some of the major problems in healthcare. Companies like Ellipsis Health have seized this opportunity to create innovative technology that tackle some of these problems. Mental illness has long been misunderstood and stigmatized in most societies and receiving proper mental health diagnoses and treatment is still challenging. Consequently, there is a strong desire by both patients and health care providers for solutions that can increase access to proper mental health care. However, one of the most important aspects of healthcare is the relationship between patients and their health care providers. This relationship can only be obtained through consistent communication between the patient and their health care providers. Moreover, there are aspects of mental disorders that can only be discerned through human communication. The Ellipsis Health App attempts to simplify this complexity by reducing the problem of mental disorder diagnosis to speech and vocal

patterns. While algorithms may perform substantially well for diagnosing and treating physical diseases (e.g. detecting malignant tumors), the results do not translate reliably for mental disorders. The reliance on algorithms for critical clinical decisions in mental health can widen the disconnect between patients and doctors and ultimately, lead to misdiagnosis and improper care.

Although I am wary of the widespread use of artificial intelligence/NLP for diagnosis of mental disorders, I think the Ellipsis Health App has a lot of potential as a self-therapeutic and self-monitoring tool. The use of guided prompts to allow users to speak freely about the concerns in their lives can be helpful to those who do not have any other resources or outlets. The NLP technology that measures stress levels can still be used as a baseline for users to track their stress levels over time. This could be used in combination with other mental health care strategies, such as meditation, medication, or in-person therapy, to improve health outcomes. However, that should be where it ends. I would be interested to see how the vocal-analysis deep learning models that Ellipsis Health has developed can be used outside of mental health diagnosis.

**References**


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