A computational approach to the psychiatric diagnosis

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One of the most important aims of computational psychiatry (CP) is to provide computational tools to help with earlier diagnoses in psychiatric disorders. CP implements different computer science tools to assist the medical professional in the path to the diagnoses. The paradigm where CP works is to understand the patient as a producer of data from differents cognitive levels. These data could come from physiological studies (as functional magnetic resonance imaging or electroencephalography) or from more abstract levels like patients' thoughts. In our research line, we use spontaneous speech as source as a window into the patient's minds.

In 2014 we presented in the NIPS Workshop "Machine Learning and Interpretation in Neuroimaging: Beyond the Scanner" a work titled "Automated speech analysis for psychosis evaluation" [1] . In this work we developed three algorithms to quantify the disorganized thought in 20 psychotic patients. Two of them are based on graph representations of speech where we measure topological features of the graphs (such as mean degree, graph diameter, etc) and study how these correlate with standardized psychiatric test. The third technique measures coherence in speech, i.e. how topics in sentences are connected along the text (see [3] for details). Combining these methods, we performed automatic classification of psychiatric conditions (control subjects vs psychotic) and compared how these algorithms combine and perform. Using different classifiers with a cross-validation schema we got a performance greater than 82% (20 schizophrenic patients and 20 control subjects). This result obtained presented similar results to manual screening procedures providing a new method to complement standard psychometric scales and fostering automated psychiatric diagnosis.

In 2015 we presented in the NIPS Workshop "Machine Learning and Interpretation in Neuroimaging: Beyond the Scanner" a work titled "Emotional Intensity analysis in Bipolar subjects" [2]. In this work we proposed a simple algorithm to quantify the emotional intensity of a text. Here we tested our algorithm with 20 bipolar subjects and 20 control. We obtained a 75 % performance in the automatic classification (in the same conditions mentioned before).

In 2015, we published in NPJ Schizophrenia a paper titled "Automated analysis of free speech predicts psychosis onset in high-risk youths" [3]. In this work, we presented the coherence algorithm mentioned before. The method measures the coherence level of a text by analyzing the path in a semantic space. We applied the developed algorithm to characterize speech of 34 clinical high risk subjects, based on SIPS/SOPS standardized interview. Based on these

interviews, subjects were classified as high-risk of probably presenting a psychotic event in the near future, but at the moment of producing their speeches did not present any psychiatric condition. After 2.5 years six of them developed psychosis episodes. With our coherence measure and the application of machine learning classifiers we could predict which subjects would develop the mental disorder with 100% performance (using cross-validation schema).

These techniques open a new window into the human mind, and may change psychiatry into a more quantitative discipline. As a clinician asks for a blood laboratory for a cholesterol checking, psychiatrists will ask for a quantification of speech measures for mental diagnosis. Currently, this model is being integrated in a cognitive computing system to support the psychiatric practice, including data collection, automatic text transcription, and natural language processing for mental state inference using cloud-based services providing a world-wide scalable support.

[1] F. Carrillo, N. Mota, M. Copelli, S. Ribeiro, M. Sigman, G.A. Cecchi, D. Fernandez Slezak. "Automated speech analysis for psychosis evaluation". NIPS - Machine Learning and Interpretation in Neuro Imaging (2015), Lecture Notes in Artificial Intelligence - Springer (in press), 2015

[2] F. Carrillo, N. Mota, M. Copelli, S. Ribeiro, M. Sigman, G.A. Cecchi, D. Fernandez Slezak. "Emotional Intensity analysis in Bipolar subjects". NIPS - Machine Learning and Interpretation in Neuro Imaging (2015).

[3] Bedi, G., Carrillo, F., Cecchi, G. A., Slezak, D. F., Sigman, M., Mota, N. B., ... & Corcoran, C. M. (2015). Automated analysis of free speech predicts psychosis onset in high-risk youths. npj Schizophrenia, 1.