Utilizing spontaneous speech to quantify dementia

11 JAN 2020

PROBLEM STATEMENT AND POTENTIAL SOLUTION APPROACH

Dementia is a terminal disease with significant heterogeneity in the rate of progression among individuals. Several frameworks exist to classify the severity of dementia and provide for disease staging which guides treatment, the level of care needed and, the extent of caregiver involvement. These frameworks use cognitive assessments, functional assessments, or a combination of the two to stage subjects on a 7-point scale.

While these frameworks help with disease staging, they are not designed to provide the frequent assessment that is required to understand how fast the condition is progressing *within* a stage. The most commonly used instruments to measure dementia are cognitive assessments like Mini-Mental State Exam (MMSE) and Montreal Cognitive Assessment (MoCA); these need to be administered by a trained professional in a clinical setting and are not reliable when administered too frequently due to "learning-effects".

Without measuring the rate of disease progression on a frequent basis, it is very difficult and nearly impossible to establish the impact of specific care activities. So a measurement tool that can be deployed by a caregiver, in the comfort of their home, on a frequent basis is a very useful addition to the toolkit required to effectively tackle this condition.

One potential solution is to use language, specifically generated from spontaneous speech. Communication and language skills are well-documented areas of impact during the early stages of dementia, and signals from spontaneous speech have been shown to be accurate in the early diagnosis of Alzheimer's related dementia. However, there is little research on the use of signals derived from spontaneous speech to measure the extent of dementia progression in post-diagnostic subjects. A picture-description task (where a subject is presented with a picture and is asked to describe what they are seeing in the picture) that generates spontaneous speech, can be easily administered by a caregiver, can be modified to resist learning-effects and, can be administered in the comfort of the subject's home setting.

PROJECT GOALS

The goal of this project is to create an easy-to-administer measurement tool that can be used by caregivers (without the need for a trained clinical professional), to assess the level of disease progression during the early and moderate stages of dementia. The measurement tool would use spontaneous speech data recorded during a picture-description-task.

The data science challenge here is to use advanced machine learning techniques and natural language processing to identify and extract features that carry signals about the cognitive capacity of the subject.

DATA AVAILABILITY

There is a specific corpus of data that is available for research purposes that include audio recordings, detailed verbatim text transcriptions, demographic information, and the MMSE score (ground-truth). The audio available is from a specific picture-description task that was administered across all subjects, with a wide spectrum of disease-condition (dementia stage/ MMSE score). We expect the project to utilize this freely available data for the purposes of training and developing a model to predict MMSE scores.

PROJECT DELIVERABLE

The project deliverable would be a system that records the spontaneous speech generated during a picture-description task, derives key features from the audio as well as the transcribed text of the audio, and outputs the predicted cognitive score.