Dementia detection system

- Diarisation (who talks when) (Kaldi diarisation toolkit).
- ASR (Kaldi toolkit).
- Feature extraction (NLTK python + Praat toolkit).
- Classifier (Linear Regression from Scikit-learn python).
- IVA (https://www.botlibre.com/pre-recorded human voice).

Dementia detection system

- `Figure 2: Block diagram of dementia detection system`

Introduction

Dementia

- can affect a person’s cognitive abilities, memory, speech and language.
- the number of people developing dementia is increasing, and early diagnosis (using automatic, accurate and low-cost tools) is desired.
- qualitative methodology of Conversation Analysis (CA) can identify communication problems of people talking with neurologists [1, 2], but it is expensive and difficult to scale up for routine clinical use.
- we have developed an Intelligent Virtual Agent (IVA) [3, 4] who asks a series of memory-probing questions, mimicking the style of questions used during the history taking part of a normal face-to-face consultation.

Research focus

- feasibility of eliciting conversations with people with memory problems, i.e. the IVA acts as a neurologist or a Digital Doctor.
- applicability of using an IVA in the diagnostic pathway by augmenting the initial conversation-based assessment to include more standard test procedures, such as administering verbal fluency tests.
- expanding our diagnostic categories to include healthy elderly controls, Mild Cognitive Impairment (MCI), as well as Functional Memory Disorder (FMD), and Neurodegenerative Dementia (ND) to reflect the variety of conditions seen in practice.

Results

A. Diarisation and speech recognition

The hallam and seizure data sets were used for training the i-vector based diarisation module (using the Probabilistic Linear Discriminant Analysis (PLDA) and the Bidirectional Long ShortTerm Memory/Time-Delay Neural Network (BLSTM)-TDNN based ASR).
- totally unseen data
- for the 18 recordings of the IVA with manual transcripts, the Diarisation Error Rate (DER): 11%, and the Word Error Rate (WER): 59%.

B. Classification accuracy

- k=10 fold cross validation
- Methodology: comparing conversation-only to fluency test-only and then to the combination of conversation and fluency test.

Conclusions and further work

Conclusions

- we explored the feasibility and applicability of using the IVA to administer standard dementia screening tests.
- we extracted a variety of features.
- adding the fluency test improves accuracy for the 4-way classification achieving 62%
- applying the feature selection the ND/HC was the easiest binary classification (94%), while the ND/MCI was the hardest (68%).

Future work

- Expanding to include more types of feature
- Improving the ASR, diarisation and feature extraction modules.
- Improving the IVA to make it more responsive.

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References


C. Feature selection

Recursive Feature Elimination (RFE)

Table 3: The most significant (22) features.

D. Receiver Operating Characteristic curve