An investigation into diagnosing Alzheimer’s disease type and progress by applying NLP techniques to a combination of Interactional and Linguistic features.

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**[1/4]**

Front Page -1 page

Disclaimer 1 page

Acknowledgements 1 page

Content list 1 page

Abstract ½ - 1 page

**[2/4] - (6-8 pages)**

**Introduction**

**Project Objective**

After memory loss due to medial temporal lobe damage , language impairment and changes in a patient's behaviour are part of the top symptoms of Alzheimer’s disease. A number of studies have already been carried out using computational techniques on linguistic features in order to identify Alzheimer’s Disease[[1]](#footnote-0)[[2]](#footnote-1)[[3]](#footnote-2)[[4]](#footnote-3), however few studies have been done using computational techniques on features that describe the patient's behaviour.

The aim of this study was to create a set of interactional features (IF) that represent common behaviour changes in Alzheimer’s Disease patients such as hesitation, anxiety and restlessness[[5]](#footnote-4) (eg. filler terms, pause length, conversation restarts) and to investigate the usefulness of these features, using a backward greedy feature selection algorithm, in classifying the different AD severities both on their own and combined with the linguistic features that are already proven to be useful [1] in making these predictions. An exploration into the specific features and subsets of features that correlate with the target variables (diagnosis) will also be carried out in order to explore why certain features and combinations perform better than others.

**Background:**

**What is Dementia/AD?**

Dementia describes different brain disorders that trigger a loss of brain function. It is a terminal condition and affects millions of people worldwide. Symptoms of dementia include memory loss, confusion and problems with speech and understanding. There are 850,000 people with dementia in the UK, with numbers set to rise to over 1 million by 2025. This will soar to 2 million by 2051. This is due to the general rise of elderly individuals in the population. (statistics recorded 2017) [[6]](#footnote-5).

Alzheimer's disease (AD) is a degenerative brain disorder and the most common type of dementia, affecting 62% of those diagnosed. Other types of dementia include; vascular dementia affecting 17% of those diagnosed, mixed dementia affecting 10%. [6] The risk of developing AD becomes greater with age. AD can refer to a set of symptoms in different cognitive and linguistic domains, and characteristically, these symptoms are persistent and progressive, causing a deterioration of skills and knowledge. The domains affected are memory, executive functions, language, visual-spatial processing, personality and general behavior and interaction skills[[7]](#footnote-6). This project focuses on exploring the effects AD have on both the the impairment of linguistic and interaction skills.

**Literature review: What have other done? (1.5 - 2 pages)**

In ‘Linguistic Features Identify Alzheimer's Disease in Narrative Speech’, Fraser, Meltzer and Rudzicz demonstrated state-of-the-art accuracy in automatically identifying Alzheimer’s disease from short narrative samples elicited with a picture description task, and to uncover the salient linguistic factors with a statistical factor analysis. They obtained classification accuracies of over 81% in distinguishing individuals with AD from those without based on short samples of their language on the Boston ‘Cookie-Theft’ picture description task.

This picture task has the participant look at a picture of a scene in a kitchen where a boy is robbing cookies. The participant is then asked to describe everything they see happening in that picture. Verbal picture description is one of the most sensitive tests for detecting language disorders in early AD[[8]](#footnote-7) and is the reason this task is appears to be used in a number of studies relating to dementia. [2][[9]](#footnote-8)[[10]](#footnote-9) This paper also investigated the heterogeneity among the participants of the study, using factor analysis, where four clear factors emerged: semantic impairment, acoustic abnormality, syntactic impairment, and information impairment. The results and feature groupings from this study played a significant role in the design for the model built throughout this project. They also were used as a baseline for the evaluation of the classifier built as well as the comparison of IF against non-IF.

‘Comparative Study of Oral and Written Picture Description in Patients with Alzheimer’s Disease’ [2] uses the same ‘Cookie-Theft’ picture task as before on its participants. These participant consisted of 22 patients with AD and 24 healthy elderly subjects The purpose of the study was to provide comparative information about lexical, syntactic, and semantic aspects of oral and written picture descriptions in AD patients and healthy elderly subjects. They analyzed the similarities and differences of oral and written descriptions by comparison of the results obtained in each group and identified specific impaired features of description processing in AD patients by making an intergroup comparison of the results obtained for each task. The result was that AD patients had a significant reduction of all word categories, which, similarly to controls, was more pronounced in written than in oral texts and in sum, AD descriptions were always shorter and less informative than control texts.

This paper's definition of “information unit” was used to build certain variables for the classifier. An information unit was used in this study as a means to measure the information content that the participant described. The amount of information mentioned in the texts was evaluated by means of a list of items constructed with the help of previous studies (Yorkston & Beukelman, 1980; Hier et al., 1985; Nicholas et al., 1985; Henderson et al., 1992). The list consisted of 23 information units in four key categories: subjects, places, objects, and actions. For example, the three subjects were: the boy, the girl, and the woman. If a participant mentioned mother or female, this would count as a mark for the woman information unit.

‘Dementia, interaction, and bilingualism: An exploratory case study’

Motivation - criticize other people’s work ½ page

There has been no study done on Interaction Features using computational techniques.

Why use interactional features?

Where did not using IF not perform as well?

Where did not using IF not perform as well?

Define your interactional features.

Include studies on IF’s - fillers, pauses, etc

**[3/4] Methods & Materials: - What have you done? (24 pages)**

Requirements:

A model needed to built in order

Model design: (7 pages)

Feature plan - based *loosely* off Fraser top 30. Plan was to add in IF’s to investigate improvement.

Describe what higher level groupings that Fraser used. -Did not use acoustic features.

Feature extraction:

List of NIF’s - Fraser (~30) 2

Your version of each features.

Include references and paper for “Info Units” etc

List of IF’s (37) - 2-3 pages

Hypothesis and theory behind each code up of each feature

Dataset (2-3 pages)

Talk Bank - Dementia Bank

Implementation: (3 pages)

Python Used (NLTK)

PreProcessing Transcripts (CHAT/CLAN)

Regex used

Applied stanford parser - Higher accuracy rate and statistically sounder when compared against Fraser

Wary of using Transcript data - Fine for NIF, not so fine for IF

Evaluation methods: (6 pages)

Used NIF as baseline

Different labelings of target

Investigated DT, LR, KNN, NB models (LR - L2 regularizer)

How you came to build result table:

Took top NIF features

Selected top using kbest (k = count of feats with score>mean of scores) & Correlation charts

Evaluated P/R/F1

Took top IF features

Selected top using kbest

Evaluated P/R/F1

Merged 2 Tops and reran to find if any IF features performed better than any NIF

Hypothesis (see email): My reasoning is, that if the new top 22 include any IF, then that means a Non-IF has been "bumped" from the kbest selection. (½ page)

Discussion/Conclusion (½ page)

The final 22 features resulted in being made up of 40% IF (Count: 9) and 60% Non-IF (Count: 13) so one can argue that IF's can be used to improve the classification of the diagnosis.

Critical Analysis (2 pages)

Talk through results table

Talk through why some features improve the classifier more than others.

Honest appraisal (2 pages)

Why LR worked so well.

Think it’s a poor predictive model but when just investigating IF vs NIF it works well.

My NIF’s probably not as robust as Fraser

Further work (Prepare before viva - Big question! ) What would you do if you had time (6 pages)

STIR - more work on repair - Similarity comparison of spoken and intended word

Rerun through DA

Analysis of other non-Cookie data

Need to find proxy controls for it

[4/4] (1-2 pages) - At LEAST 10 refs, ideally 20

References/Bibliography

Appendices

More detailed material that is not crucial to understanding of main message

**FORMAT - AIM FOR 50 PAGES INCLUDING APPEN**

MAX 60 (75 pages with appen)

MIN 38 (without appen)

Deadline - Aug 23rd Final report, code (zipped), presentation slides

Campus vivas - Tues 26th Aug - Fri 8th Sept (Maybe week of 11th)

**VIVAS**

Presentation - 10-15 mins (10 slides ish, 15 max)

Demonstration - if appropriate, 5-10 mins

Q and A - 10 mins

Aims:

Explain and justify your work

Demonstrate what you have achieved

Impress and interest examiners

Show ability to respond to related questions.

Bring laptop as back up - slides ready to go

1. "Linguistic Features Identify Alzheimer's Disease in Narrative Speech." Accessed July 30, 2017. <https://www.cs.toronto.edu/~kfraser/Fraser15-JAD.pdf>. [↑](#footnote-ref-0)
2. "Comparative study of oral and written picture description in patients ...." Accessed July 30, 2017. <https://www.ncbi.nlm.nih.gov/pubmed/8722896>. [↑](#footnote-ref-1)
3. "Language Analysis of Speakers with Dementia of the Alzheimer's Type." Accessed July 30, 2017. <http://csbapp.uncw.edu/data/mscsis/annalspaper.aspx?v=6&i=1&p=11>. [↑](#footnote-ref-2)
4. "Analysis of spontaneous, conversational speech in dementia of ...." Accessed July 30, 2017. <https://eprints.soton.ac.uk/18566/>. [↑](#footnote-ref-3)
5. "Behaviour changes - Alzheimer's Society." Accessed July 30, 2017. <https://www.alzheimers.org.uk/info/20064/symptoms/87/behaviour_changes>. [↑](#footnote-ref-4)
6. "Facts for the media - Alzheimer's Society." Accessed July 30, 2017. <https://www.alzheimers.org.uk/info/20027/news_and_media/541/facts_for_the_media>. [↑](#footnote-ref-5)
7. "Dementia, interaction, and bilingualism: An exploratory case study." Accessed July 30, 2017. <https://www.hf.uio.no/multiling/personer/kjernegruppe/jansv/svennevig---lind.pdf>. [↑](#footnote-ref-6)
8. "Communication and Aging: Creative Approaches to Improving the ...." Accessed July 30, 2017. <https://books.google.com/books?id=Fp0rCgAAQBAJ&pg=PA47&lpg=PA47&dq=Bayles,+K.+A.,+Kaszniak,+A.+W.,+%26+Tomoeda,+C.+K.+(1987).+Communication+and+cognition+in+normal+aging+and+dementia.+Boston:+College-Hill+Press/Little,+Brown+%26+Co.&source=bl&ots=z4ulbsw1Ur&sig=HKDcpCXYPvTHuZ6Mh7Lngcx_3hs&hl=en>. [↑](#footnote-ref-7)
9. "Performance on the Boston Cookie theft picture description task in ...." Accessed July 30, 2017. <http://www.tandfonline.com/doi/abs/10.1080/02687039608248419>. [↑](#footnote-ref-8)
10. "The rise and fall of frequency and imageability: noun and verb ... - NCBI." Accessed July 30, 2017. <https://www.ncbi.nlm.nih.gov/pubmed/10872636>. [↑](#footnote-ref-9)