# ALZHEIMERS DIAGNOSIS THROUGH LINGUISTIC FEATURES IN NARRATIVE SPEECH

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**ABSTRACT:** An end-to-end system for diagnosing Alzheimer's disease is the goal of the project Alzheimer's diagnosis through linguistic features in narrative speech using deep neural networks. This system will make use of Natural Language Processing techniques and take into account a variety of factors, including the suspected patient's gender, age, speech patterns, and parental history. To differentiate Alzheimer's patients, sophisticated word embedding is used in conjunction with deep neural network models like LSTM, BiLSTM, CNN-LSTM, and BERT, as well as their combinations. The speech linguistic features-based Alzheimer's disease detection method developed for this project has the potential to be quicker and less expensive than the standard image scanning method. To expand the openness of such a strategy, this drive looks to foster an Android application for infection location in light of the expected patient's discourse.

***Keywords*** *– Linguistic Features, Word Embedding, Speech Pattern, Neural Networks, Natural Language processing, Health care.*

## 1. INTRODUCTION

The pathogenesis of Alzheimer's disease is linked to the injury and death of neurons, starting in the hippocampus, which is associated with memory and learning, and spreading throughout the brain. Alzheimer is an ever-evolving sickness, importance its side effects deteriorate after some time. Alzheimer's disease or another type of dementia kills one in three people 65 and older, according to current statistics. Alzheimer's disease kills a greater number of individuals than both bosom and prostate malignant growth set up. fatalities from other essential drivers have lessened extensively recently, yet official records and experiences exhibit that fatalities from Alzheimer's disease have extended basically. Somewhere in the range of 2000 and 2019, the quantity of passings brought about by Alzheimer's disease that are recorded on death authentications dramatically increased, while the quantity of passings brought about by coronary illness diminished by 7.5 percent. 61% of 65-year-olds with Alzheimer's dementia are anticipated to kick the bucket before the

age of 80, though about a third of those without the condition are. Patients with Alzheimer's disease beyond 65 a three six years old to six-year endurance rate, with some getting by as long as 22 years. This is a reflection of the disease's sluggish and unpredictable progression, which calls for greater attention to its prevention and diagnosis.

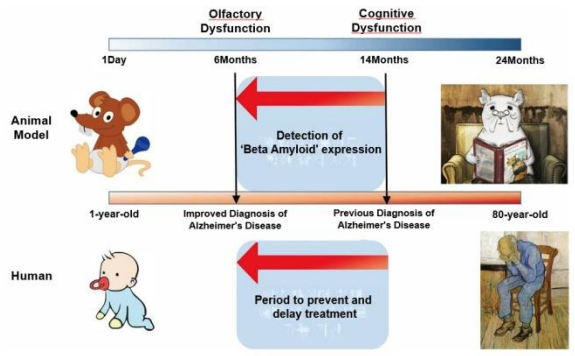


Fig.1: Example figure

Among the different kinds of dementia, Alzheimer's disease (AD) is the most well-known. It is presently incredibly hard to analyze Alzheimer's disease and different types of dementia physically. As indicated by the accessible documentation, broad neuropsychological assessments and MRI checks using a progression of mental tests containing a progression of inquiries and pictures have recently been utilized to analyze AD. The Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA), for example, are screening instruments that assess different mental capacities through a progression of inquiries and mental tests.

The manual association of these psychological tests presents a difficulty and bother. Likewise, the precision of the tests is dependent upon the clinician's level of association and their capacity to dissect the disease's subtypes. Researchers and clinicians a large part of the time get the MMSE together with other mental assessments. Neuropsychological tests might have restricted indicative precision for Alzheimer's disease and related dementias, as per research. The Alzheimer's disease and the Public Foundation on Maturing's analytic rules workgroups have asked the improvement of precise techniques for diagnosing AD and related dementia.

A compelling symptomatic test should incorporate amnestic and nonamnestic introductions that catch mental shortfalls from retelling an as of late noticed situation, language show (lexical, syntactic, and other), visuospatial show of items and their semantic and primary translations, and chief capability like prevailing upon a feeling of judgment in playing out a particular undertaking. These introductions ought to likewise be remembered for a viable demonstrative test. The patient's phonetic capacity as estimated by their verbal expressions might be an amazing sign of Alzheimer's disease and other dementia-related illnesses, instead of the specially appointed utilization of neuropsychological assessments. Neurodegenerative disorders (ND) cause the passing of nerve cells that control mental, discourse, and language processes. This meaningfully affects how individuals with ND compose words. The discoveries in regards to syntactic handling in grown-ups with gained language problems like Aphasia are empowering and require extra examination into the ID of proficient syntactic procedures. Along these lines, the meaning of a language's lexical-semantic parts, some of which can be seen during early expression procurement, was stressed. The lexical

and syntactic cycles that control language and verbal articulations might be impacted by a language issue.

## 2. LITERATURE REVIEW

Sweta Karlekar et al. [1] NLP strategies were utilized to group and analyze the semantic attributes of AD patients by utilizing the DementiaBank dataset. The language tests of AD and control patients were recognized utilizing three brain models in light of CNNs, LSTM-RNNs, and their mix. The paper even incorporates heatmaps for various factors and accomplished benchmark accuracy.

Chen, Pei-Ying et al.[2] The majority of previous research used a feature selection procedure to extract statistics-based features; A novel Feature Sequence representation has been proposed by them. Explored different avenues regarding both unidirectional and bidirectional RNN and LSTM models.

Daniela Beltrami et al.[3] fostered a benchmark paper for stage-wise dementia identification. makes use of statistical and lexical diagnostic strategies. Data on the acoustic, syntactic, and pronouncial markers of the AD control patients that are relevant to advanced feature selection.

Randa Ben Ammar et al.[4] A model-based machine learning classifier is used to perform classification, which consists of a phase for feature extraction and an essential attribute selection step. Accuracy is 79%, enveloping a critical weakness of different frameworks, for example, the amount and nature of choice elements.

Ahmed M.Al-Harrasi et al.[5] This finding depends on measurable procedures. Speech and motor signs are the primary focus. Significant discoveries with respect with the impact of AD on age and heredity.

Go Eun Heo et al.[6] It is stated that precise syntactic analysis of language is important. Co-event is stressed as an essential sign of Promotion. Entity co-occurrence must be precisely analyzed for precise diagnosis, and the proposed method emphasizes strong word embedding. Comparisons are made between COALS, Glove, Word2Vec, and Bert models.

Shaker El-Sappagh et al.[7] said that brain imaging data could detect multiple layers and modes of Alzheimer's disease. For feature selection, it is essential to classify symptoms by stage.

Alejandro Puente et al.[8] The aforementioned disease diagnosis is based on MRI scans and includes biomarker data as well as crucial information about the difficulties and difficulties of this kind of diagnosis.

Anani Venugopalan et al. [9] as stated, fundamental classification and multimodal Alzheimer's disease detection on brain imaging data. For feature selection, it is essential to classify symptoms by stage.

Jochen Weiner et al.[10] provided crucial information regarding the acoustics, speech rate features, speech pause-based features, and linguistic features of possible AD patients' speech, such as speech vocabulary richness.

Bahman Mirheidari et al. [11] introduces efforts to create a self-contained dementia screening test that enhances patients' interpersonal communication and

interaction skills. a cognitively taxing task that typically reveals early signs of dementia. Such a test would help non-specialist general practitioners make better decisions because current tests lack interpretability and sensitivity.

AlexandraKönig et al. [12] Vocal markers and verbal expressions were tested for their capacity to distinguish between HC, MCI, and AD. Also, they included getting ready modified classifiers for distinguishing MCI and AD using machine learning techniques and surveying the accuracy of area.

Tóth, László et al.[13] The extraction of vital boundaries like the faltering proportion, discourse rhythm, length and number of quiet and filled stops, and verbal expression length from physically recorded discourse signals utilizing the Praat programming and afterward consequently utilizing an ASR-based device was the essential focal point of this review. Prior to applying ML methods, factual examination was performed on the removed boundaries.

Katrina A et al.[14] The study found that instruments measuring semantic processing abilities showed a high percentage (>70 %) of AD patients performing below the cutoff. At the point when the perplexing form of the capability was used, deficiencies were noticed and identified even in patients in the earliest phases of the sickness. Utilizing an undertaking that includes breaking down pictures, it is feasible to recognize the inconspicuous unconstrained language hindrances brought about by AD even at a beginning phase of the infection.

Jacob Devlin et al. [15] A brand-new language representation model was introduced under the name BERT, which comes from Transformers and stands for "Bidirectional Encoder Representations." Rather than language depiction models (Peters et al., 2018a; Radford and other, 2018), BERT is planned to comprehend significant bidirectional semantics from unlabeled text by integrating goals on both left and right setting across all layers.

Kimberly D. Mueller et al. [16] This illustrates, as per their examination, that image portrayal errands are helpful devices for identifying contrasts in a great many dialects and, surprisingly, open measures.

Sylvester Olubolu Orimaye et al.[17] As a variation of deep neural network language models (DNNLM), they proposed a robotized symptomatic strategy that can be applied to the verbal expressions of any burdened person.

Ulla Petti, Simon Baker et al.[18] This paper's key discoveries incorporate a precise writing survey supporting the dispute that language and discourse can be utilized effectively to identify dementia consequently.

Federica Comuni et al. [19] The Bayesian Network and the Long Short-Term Memory (LSTM) Recurrent Neural Network, as per their paper, are the two ML calculations in natural language processing (NLP) that are generally exact and can be used to recognize Alzheimer's disease side effects in records of discussions.

Antoine Slegers et al. [20] They gave a precise survey that provided scientists with an outline of the

most predominant areas of impedance in the AD talk as it appeared in the patient's image portrayal undertakings.

### 3. METHODOLOGY

Existing techniques for distinguishing dementia incorporate the assessment of imaging and the perception of discourse phonetic examples that are novel to dementia patients. Standard MRI looks at rely upon state of the art development that empowers and perceives changes in living tissues by choosing the bearing of the rotational turn of protons. For this situation, the most common way of social affair information isn't just tedious yet in addition expensive. Phonetic component examination would be the best treatment since language changes are an indication that a patient's mental capabilities have been impacted. Also, data variety would be decently modest. DNNs have become more valuable and significant as of late. Deep neural networks incorporate Convolutional Neural Networks. The natural visual cortex filled in as motivation for CNNs, which are used in many fields like shrewd observation and checking, wellbeing and monitoring, health and medicine, sports and recreation, robotics, and drones, among others. We can plan DNNs so they can be coordinated with semantic component determination conventions for the recognition of an assortment of high-need sicknesses. One of these common diseases is AD. Three brain models in view of CNNs, LSTM-RNNs, and their blend are utilized to recognize AD and control patients' language tests. Nonetheless, the current models are unequipped for recognizing control patients (those without AD) from AD positive patients. Insights from the World Health Organization (WHO) demonstrate that around 50 million individuals are impacted by dementia, with almost 10 million new cases being analyzed every year. Somewhere in the range of 60% and 70% of cases are ascribed to Alzheimer's disease. It could be reasonable to utilize the carried out framework given that clinical notes are presently accessible, setting mindful word-implanting procedures have arisen, and Classifier models like BERT have been fruitful in defeating the limits of the current framework.

**Disadvantages:**

1. Exorbitant Mental Tests The finding of Alzheimer's disease normally requires broad neuropsychological assessments and an expensive arrangement of mental tests.

2. Lacking Context oriented Data Existing frameworks used hand-created parts that are currently old. Interpretability is compromised by the lack of context awareness of the employed neural networks.

3. Common clustering patterns The pattern was analyzed using neural networks, but crucial parameters like gender were left out and cluster patterns were used with general parameters.

4. Time-consuming Activities Examining conventional MRI and brain image scans takes a lot of effort and time. As clinical notes containing segment data are promptly accessible, etymological examples can save a lot of time.

This undertaking proposes a start to finish Artificial intelligence based Alzheimer's conclusion application that utilizes discussion and setting mindful, strong brain organizations to bunch, dissect, and identify the

illness. Word Embedding methods like word2vec, glove, and bert were used in this endeavor to find contextual information and generate vector representations of the data's words. The model was prepared utilizing over 0.1 million discourse records from the dementia bank dataset. The information gathered by the dementia bank involves both the expressions of the teacher and the patient. Stopwords, numerals, tags, and other special characters have been removed from the patient's speech, which has only been extracted. POSStagging, Stepping, and Lemmatization were then applied to the dataset. This information is tokenized utilizing the word2vec, glove, and bert models from now on. The procedure has been divided into two parts at this point: one employing transformer models and the other models based on neural networks. The information records have been arranged as per the necessary configuration for different classifier strategies prior to being passed to the classifiers for order.

**Advantages:**

1. Accelerated Progress: The proposed system's transformer models have been tweaked to perfection. The model's lower layers are trained first because they are pre-trained models. As a result, training them on the dataset takes very little time. The used profound brain network models utilize word implanting procedures, which help in finding relevant data from text faster and furthermore help in arranging the model all the more rapidly. As a result, the proposed system's methods speed up development.

2. Little Dataset: This project makes use of customized models; As a result, this method's pre-trained weights make it possible to fine-tune the required task on a much smaller dataset than when starting from scratch with a model. The prerequisite for a significant preparation dataset is the essential disadvantage of creating NLP models all along. since it requires a ton of investment and work to accomplish sensible accuracy. It would be simpler to train a model on a smaller dataset and achieve a satisfactory outcome by utilizing these finely tuned models.

3. Better Outcomes: For the purpose of fine-tuning models in the proposed system, it was sufficient to add a completely connected layer on top of the initial models. The few modifications made to the fine-tuned model would result in superior results when compared to the other neural networks used to analyze speech patterns to identify Alzheimer's disease. Utilizing these optimized models over custom models is preferable if you want to achieve acceptable outcomes.

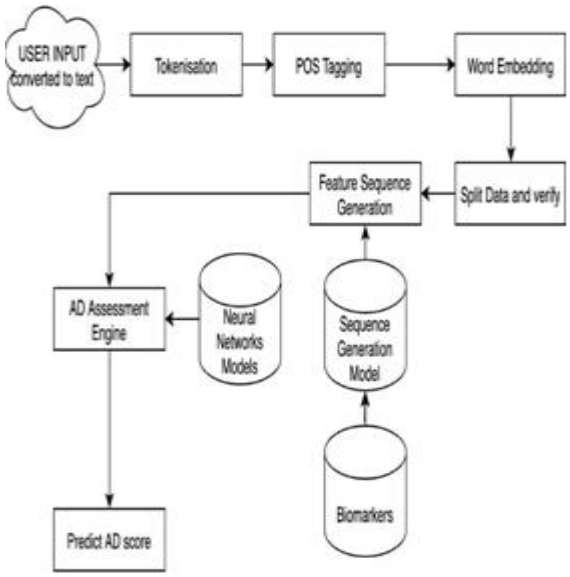


Fig.2: System architecture

## 4. IMPLEMENTATION

The execution of the proposed application incorporates different brain network models and a transformer model using libraries, for example, nltk,transformers,torch,sklearn and a GPU-based computational stage CUDA. This part portrays the different models used in the task's turn of events. The models are carried out in the Python programming language and work on Dementia Information Bank records.

Data Collection and Preprocessing :

Data collection:

Our exploratory study form use of the Dementia Bank dataset [10], a far-reaching group of candidly approachable audio files accompanying textbook transcripts. These audio files comprise audio records of interviews accompanying healthful controls and feasible AD sufferers. While the interviewees act tasks like tale recall, wafer stealing writing, discussion eloquence, and sentence building, the interviews are written. The passage transcripts of these interviews have happened assembled and included into our study.

Data Preprocessing:

The facts from the senility bank is pre-controlled by separating the patient discourse from the.cha documents and following changeful over it to.csv documents accompanying referring to a specifically known amount of extra portions, containing stops, age, introduction, news records, and so forth. All identifiers, singular integrities, numerals, emphasis stamps, and block conversation are threw away from the news records.

Working on Dataset:

In the wake of forgiving, facts records were give up responsibility CSV documents and referring to a specifically known amount of records accompanying no value in the categorization division were removed; referring to a specifically known amount of portions were similarly transformed. A new column named "AD" is increased the dataset and replaces the eight apparent identifiers in the Category column that show various stages of Alzheimer's disease.

BERT Implementation (Tokenization and Classification):

Bidirectional Encoder Portrayals from Transformers is a method for pre-fitting sound portrayals namely exploited to produce models that are before civilized for unambiguous NLP undertakings. The holding close-face BERTF or Sequential Classification model has existed cultured in this place endeavor. A single entirely joined coating is raised top of the first BERT model to perfect it.

Implementation of Deep Neural Network approach:

In this trial, three definite neural network arrangement models were applyied to select if a patient has Alzheimer's. The differing models secondhand in this place project are in this manner: CNN Convolutional neural networks are a type of deep learning that is to say usually secondhand for calculating dream. However, it has currently existed secondhand accompanying judicious results for NLP tasks. In our foundation, each sentence yield apiece

discussion-implanting tier is arranged handling a 2-D convolution neural network model.

LSTM(Long Short Term Memory):

Long-Short Term Memory is a subtype of the recurrent neural network RNN 9 that can study dossier reliances long distances cause it has thought containers secret in allure coatings. We thus investigated accompanying the LSTM model cause bureaucracy makes necessary the maintenance of worldwide enumerations.

BiLSTM(Bidirectional Long Short Term Memory):

In our foundation, we have surveyed various streets concerning Bi-LSTM, the bi-directional long-short term memory model, because it jam dossier from two together ancient times and the future, therefore improving background care.

We have devised an exercise architecture for the purpose of dawdling the projected whole into operation. This design authorizes us to judge differing potential approaches. The following is the exercise design for our project:

- The initial phase of the implementation procedure is data collection. We gathered the informational index from Dementia bank, the biggest openly accessible corpus of interview records from Alzheimer's patients.
- The next step is to clean up the data and keep the useful information after collecting the necessary data.
- After the data have been cleaned up, we look at the data to see if any more data needs to be cut out without hurting the corpus' value.
- By reducing the length of each word to its root, we used stemming and lemmatization to reduce the size of the data and increase its value.
- We assigned the data the available POS identifiers.
- When the data that has been POS-tagged is available, our implementation process is broken down into two categories.
- In the primary stage, we utilize a BERT-based classifier
- Second, equal stream in which we carry out classifiers in view of profound brain networks subsequent to advancing the information with word embeddings.
- For word embedding, glove, word 2 vec, and deep learning CNN, LSTM, and Bi-LSTM are utilized, and neural networks are utilized for classification.
- Whether a patient has AD or is a control is determined by the binary outcomes of the two parallel implementation phases.

## 5. EXPERIMENTAL RESULTS

```
0.916030534351145
[[25  2]
 [ 9 95]]
              precision    recall  f1-score   support

           0       0.74      0.93      0.82        27
           1       0.98      0.91      0.95       104

    accuracy                           0.92       131
   macro avg       0.86      0.92      0.88       131
weighted avg       0.93      0.92      0.92       131
```

Fig.3: BERT for sequential classifier

```
[[ 13   9]
 [  5 103]]
              precision    recall  f1-score   support

           0       0.72      0.59      0.65        22
           1       0.92      0.95      0.94       108

    accuracy                           0.89       130
   macro avg       0.82      0.77      0.79       130
weighted avg       0.89      0.89      0.89       130
```

Fig.4: LSTM based classification

```
[[ 14   8]
 [  7 101]]
              precision    recall  f1-score   support

           0       0.67      0.64      0.65        22
           1       0.93      0.94      0.93       108

    accuracy                           0.88       130
   macro avg       0.80      0.79      0.79       130
weighted avg       0.88      0.88      0.88       130
```

Fig.5: CNN classification

```
[[ 13   9]
 [  5 103]]
              precision    recall  f1-score   support

           0       0.72      0.59      0.65        22
           1       0.92      0.95      0.94       108

    accuracy                           0.89       130
   macro avg       0.82      0.77      0.79       130
weighted avg       0.89      0.89      0.89       130
```

Fig.6: BILSTM based model classification

## 6. CONCLUSION

Three models were used to classify Alzheimer's disease in this experiment, and the BERT model set a new classification accuracy benchmark. Word implanting strategies to catch novel semantic attributes worked with by context oriented consciousness of the present in Alzheimer's sickness patients are represented. The most recent BERT classifier can be used in our endeavor to classify probable patients, control patients, and even stages. Another standard has been laid out for how precisely the BERT classifier can foresee a singular's probability of fostering Alzheimer's disease. Compared to prior research that did not take into account contextual embedding, word embedding has enabled more precise outcomes. When given inputs of fixed length, other neural networks, such as CNN, Bi-LSTM, and LSTM, have produced results that are comparable to one another.

## 7. FUTURE SCOPE

- The project could be made even better by using multi-class classification and creating multi-class labels to predict the stage of dementia and whether the disease is present.

- The potential for future work incorporates expanding arrangement accuracy.

- The relationship between speech pauses and dementia stage can be determined with the help of advanced deep learning methods.

- Conceivable to make a portable application populates results while getting discourse input from the client. Functional mobile applications are easier to use and more visible.

## REFERENCES

[1] Becker, J. T., Boller, F., Lopez, O. L., Saxton, J., & McGonigle, K. L. (1994). The natural history of Alzheimer's disease: description of study cohort and accuracy of diagnosis. *Archives of Neurology, 51*(6), 585-594.

[2] Malika Aubakirova and Mohit Bansal. (2016). Interpret- ing neural networks to improve politeness compre- hension. In *Proceedings of EMNLP*.

[3] Ronan Collobert, Jason Weston, Le´on Bottou, Michael Karlen, Koray Kavukcuoglu, and Pavel Kuksa. 2011. Natural language processing (almost) from scratch. *Journal of Machine Learning Research*, 12(Aug):2493–2537.

[4] Yarin Gal and Zoubin Ghahramani. 2016. A theoret- ically grounded application of dropout in recurrent neural networks. In *Advances in neural information processing systems*, pages 1019–1027.

[5] Ross Girshick, Jeff Donahue, Trevor Darrell, and Ji- tendra Malik. 2014. Rich feature hierarchies for ac- curate object detection and semantic segmentation. In *Proceedings of the IEEE conference on computer vision and pattern recognition*, pages 580–587.

[6] Alex Graves. 2013. Generating sequences with *arXiv preprint* recurrent neural networks.*arXiv:1308.0850*.

[7] Akos Ka´da´r, Grzegorz Chrupała, and Afra Alishahi. 2017. Representation of linguistic form and func- tion in recurrent neural networks. *Computational Linguistics*, 43(4):761–780.

[8] Diederik Kingma and Jimmy Ba. 2014. Adam: A method for stochastic optimization. *arXiv preprint arXiv:1412.6980*.