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DEPRESSION DETECTION USING NATURAL LANGUAGE PROCESSING

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Abstract: Natural Language Processing is a field of Artificial Intelligence where-in the emphasis is given on words. NLP has also played a prominent role in healthcare industries by helping with records, recommending medicines by seeing the ailment, therapeutic chatbots etc. Aiming to help the mentally ill by making use of NLP based architectures combined with attention mechanism. We propose a chatbot build upon a hybrid model. Our proposed hybrid model mainly focuses on the key words from user input which the model can extract the most information from, then predicting an answer based on the key words. Several experiments are carried out and detailed results are recorded. Our paper focuses on helping the less able people in terms of money, time etc. to get mental help free of charge.

Index Terms - Depression, NLP, Attention, Chatbot, Deep Neural Network (DNN), Architecture.

I. INTRODUCTION

With the recent developments in the field of Natural Language Processing in Healthcare industries. Companies such as betterlyf, tata, wya and many other startups have acknowledged this and have started research toward this. With the advent of the Covid-19 virus it has made people difficult to seek out therapy this in-turn has made their mental health to worsen. The adoption of natural language processing in healthcare is rising because of its recognized potential to search, analyze and interpret mammoth amounts of patient datasets. Using advanced medical algorithms, machine learning in healthcare and NLP technology services have the potential to harness relevant insights and concepts from data that was previously considered buried in text form. NLP in healthcare media can accurately give voice to the unstructured data of the healthcare universe, giving incredible insight into understanding quality, improving methods, and better results for patients.

Companies like Winterlight Labs are making advancements to treat Alzheimer's disease by making use of machine learning approach to constantly check the cognitive impairment through speech. A similar approach has been followed by the Stanford University as they developed a chatbot which works as a therapist called Woebot, with the sole purpose of helping the mentally ill people Natural Language Processing has also been integrated with voice-driven interfaces like Siri, Alexa, etc.,

This gives the user the feel of talking to someone rather than just messaging with a machine. At present, there are many chatbots which have been created or implemented. For example, in [1] a chatbot has been developed with the use of Convolutional Neural Networks and Hierarchical Attention Network. The key focus is of the therapy element is to detect the level of depression in a particular individual [2].

In our paper we are going to take a deeper look into how Chatbots can be extremely helpful in tough situations. How Natural Language Processing is changing the medical field. How different Deep Learning architectures can provide different performance and how a bot can help users feel like talking to an actual human being [therapist]. The paper is segmented into 4 sections. A deeper look into the previously published papers in the Depression, Chatbots and Natural Language Processing in our literature review section. Next, our experimental setup which encompasses dataset used and several methodologies experimented to develop the final hybrid model.

Experimental Analysis talks about different types of architectures used and experimented to attain the best accuracy, A general block diagram of our hybrid model architecture. Lastly, the results section along with the conclusion in present in the last section of the paper.

II. LITERATURE REVIEW

Many researchers have had multiple ideas and have conducted experiments in the field of Natural Language Processing in Psychology. In paper [1] published in 2019, the authors have designed a chatbot that was to provide mental relief to students who undergo different levels of stress, they have used three popular deep learning classifiers namely, Convolutional Neural Network, Recurrent Neural Network and Hierarchical Attention Network. Paper [2] published in the year 2018, Bhuvan Sharma, Harshitha Puri, & Deepika Rawat focus on the therapy element which detects the level of depression in a particular individual. This study uses python as the base language which can be integrated with android to serve as a messaging platform so that it can target a larger audience. The authors of Paper [3] make use of self-attention in their deep learning model. It is stacked on Bi-LSTM network, which increases the depth of the model and captures the relationships between words. Checking for early depression detection using social media data through X-A-BiLSTM model [4]. The X-A-BiLSTM model consists of two essential components: the first one is XGBoost, which is used to reduce data imbalance; and the second one is an Attention-BiLSTM neural network, which enhances classification capacity. Abdul Hasib Uddin, Durjoy Bapery, Abu Shammim Mohammed Arif the authors of [5] deploy LSTM for depression analysis on Bangla social media data. Ziqiang hao, Meng Liu, Zhongyuan Wang, Weida Zhan the authors of [6] focus on retrieving key information in surveillance video and related features of human behavior by using attention mechanism. They have proposed a neural network architecture which corresponds of two parts. The first with CNN and the second with attention mechanism. The authors of the paper [7] gives us a combined multi-turn dialogue model and sentiment recognition model to develop a chatbot, that is designed for used in daily conversations rather than for specific tasks. A model based on multi-layer Bi-LSTM network [8] with attention module used in question-answering system. [9] comprehensive text features are obtained by using CNN and then attaching attention mechanism to extract features. The authors [10] facing a classification problem propose a multi-label sentiment classifier based on GRU and attention mechanism. They are faced with the problem of finding out the sentiment behind Japanese text/sentences. By using attention module, they convert Japanese to English word by word with sentence parsing, then the model classifies the text/sentence into 5 categories.

Based on literature survey and information gathered from different sources. Experiments have been carried out using a variety of different architectures on a dataset scrapped from www.counselchat.com. The train-test loss with respect to accuracy as well as the accuracy with respect to epochs have been calculated, recorded, compared. The experiments have been carried out in three phases. Phase III comprises of the experimental setup, IV contain the experimental analysis. V talks about the results and discussions, lastly VI contains the conclusion of our proposed methodology.

III. EXPERIMENTAL SETUP

A. Proposed Methodology:

After going through some research papers and looking at our data it is clear to go ahead with some commonly used NLP based Deep Learning architectures. By training and testing which model gives out the best accuracy, attention mechanism can be added to get the hybrid model. Further fine-tuning maybe required to get out the best accuracy.

B. Dataset:

The dataset is the most important part of the experimenting. It is very vital to training/testing architectures, getting the best accuracy, attaining the best model, ultimately the project. Our dataset was retrieved from a website called CounselChat. The site has licensed therapists responding to mental health-based questions posed by users, the users can like responses that they find the most helpful to them. There are around 31 topics which ranges between the likes of “depression” to “military issues”. The dataset is presented as a CSV with 10 columns. Most of the questions have a few responses with 75% of questions having two or less responses. However, many questions have a lot of therapist engagement. As this is a raw textual data, pre-processing and cleaning of data is necessary.

C. Architecture:

As the dataset comprises of only textual data, we started model building by going through few architectures. Firstly, the basic Recurrent Neural Network (RNN), it is a type of neural network where it remembers its input, due to an in-built memory, which makes it perfectly suited for sequential data. Then further onward in model building phase, better Neural Networks such as LSTM and Bi-LSTM were experimented upon. LSTM can be called as a modified version of the RNN, wherein it remembers the past data with its memory. LSTMs are well suited for classification and time-series predicting problems. A Unidirectional LSTM or LSTM will only preserve information from the past (one-direction). But Bidirectional LSTM or Bi-LSTM will preserve the information from both past and future.

1) Dataset Splitting: Each time before training our models, Dataset is split into training and testing sets. Usually the ratio is 80:20, and for our experiment the same is followed.

2) Hyper-parameters and Training: To get accurate results with the dataset, learning rate of our models is initialized to 0.0001. Low learning rate helps the model to avoid overfitting problem. Adam is initialized as the optimizer for both the models. In order to avoid overfitting, Dropouts and Early Stopping is used.

D. Attention mechanism:

Attention mechanism is a recent advancement in the field of NLP. It uses a sequence-to-sequence based model. As the experiments entail working with words. Attention mechanism focusses on certain areas to pay selective attention to. In our case certain words. This is very important when dealing with textual data as well as large datasets. This mechanism can suppress other useless information and shed a light to the more useful ones. The main idea of Attention mechanism is through the training phase, the model assigns different weights to different features, so that the model pays attention to only the important features.

IV. EXPERIMENTAL ANALYSIS

A. Training

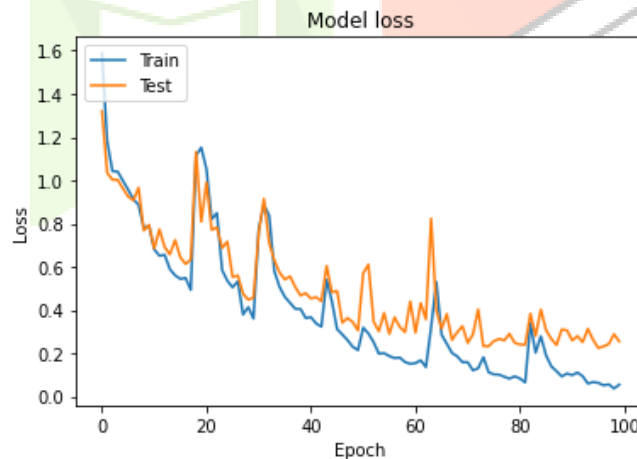
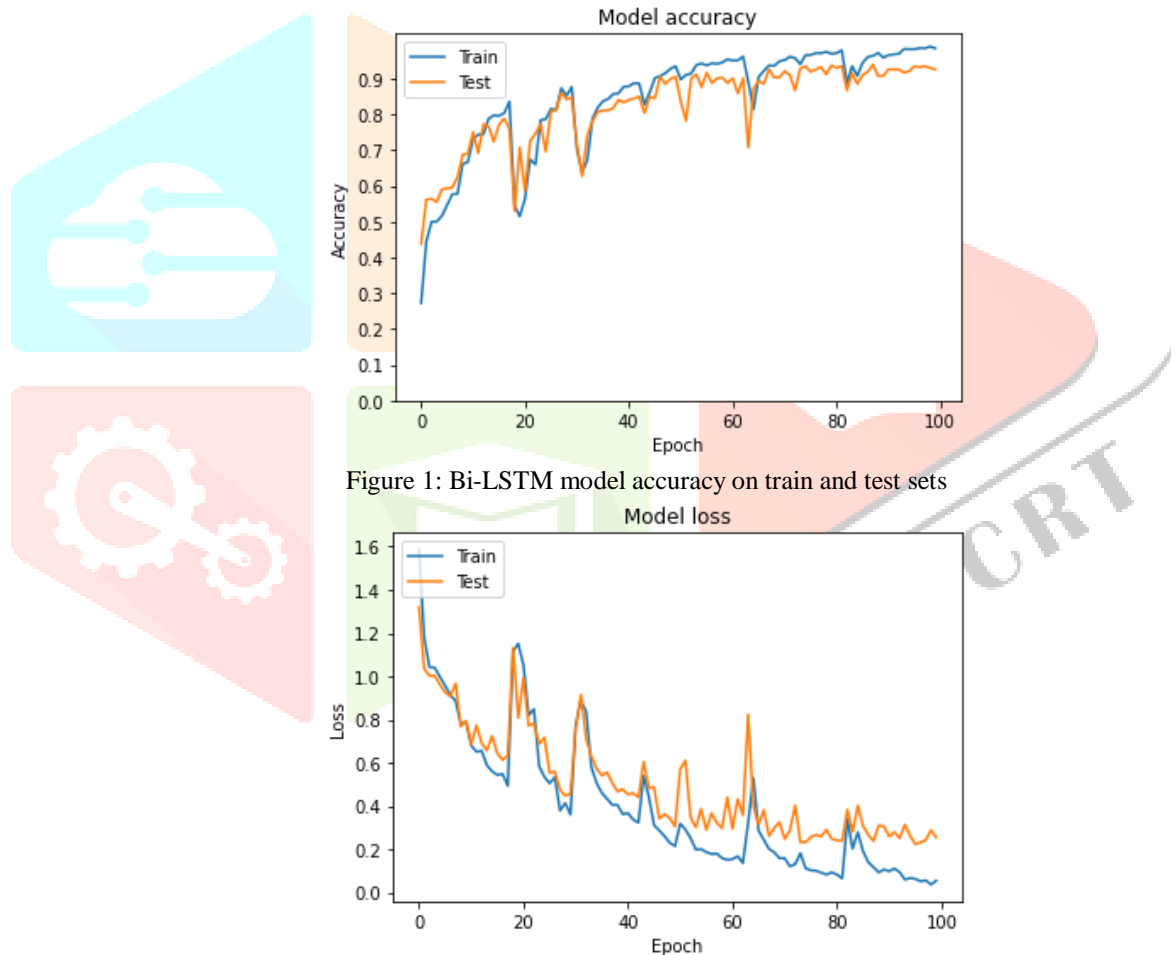
Our experiments were run on Jupyter Notebook as well as on Google colab running Python 3.0 with TensorFlow v2.2 and trained on a i7 processor machine with 8GB DDR4 RAM, with Nvidia Ge-Force GTX 1650 graphics card. Three architectures were experimented upon to build the hybrid model namely RNN, LSTM and Bi-LSTM to see which architecture gives out the best performance or accuracy.

All 3 architectures were trained for 100 epochs and their results are tabulated below.

Implementation	Architecture	Batch Size	Accuracy
1.	RNN	16	85.13%
2.		32	86.57%
3.	LSTM	16	91.21%
4.		32	90.64%
5.	Bi-LSTM	16	93.22%
6.		32	90.83%

Table 1: Results from tuning different Architectures

From the above table, Bi-LSTM architecture with 16 Batch Size gave us the best accuracy.



Based on this the above model was stacked with Attention mechanism and then trained this hybrid model. This hybrid model consists of 6 layers: The first layer had input layer, the second layer consisted of the word embedding layer, the third and fourth layers are both Bi-LSTM neural network layers, the fifth layer contains the self-attention mechanism layer with the last layer (sixth) as the output layer.

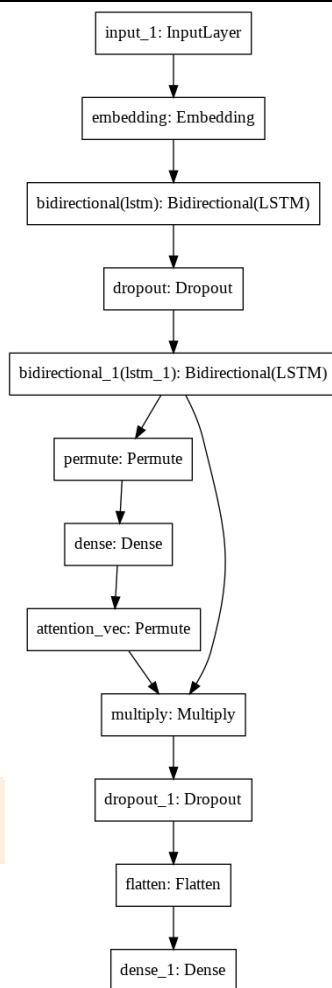


Figure 3: Hybrid model Architecture

The above model was trained for 100 iterations (epochs) and attained a good accuracy of 86.23%. After finetuning some of the hyperparameters the best accuracy of 93.03% was achieved.

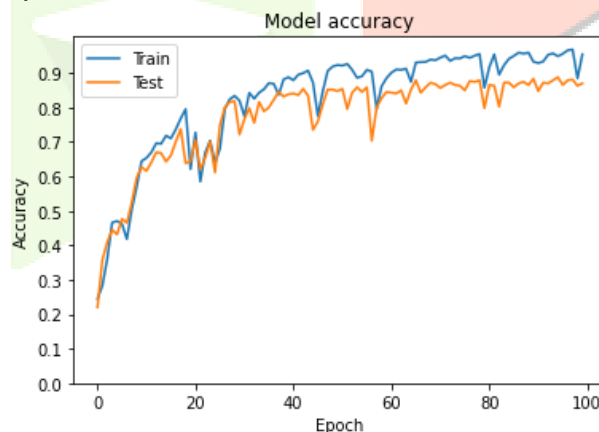


Figure 4: The hybrid model Accuracy on Train and Test sets

From the above graph it can be inferred that as the number of epochs increases the accuracy also increases, this is how the model learns. but after certain number of epochs the model stops learning.

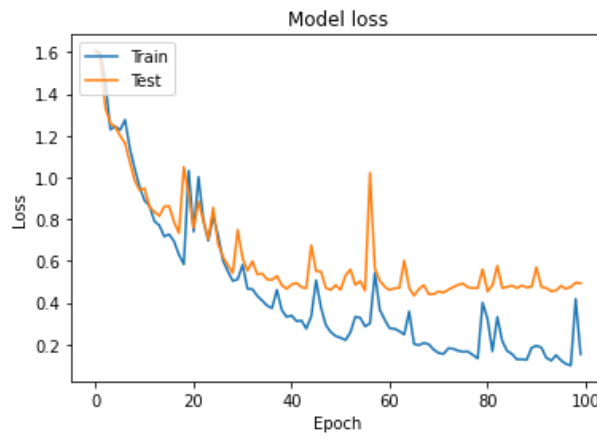


Figure 5: Loss with respect to training

From the above graph it can be inferred that as the number of epochs increases the model loss decreases. Working on textual data, each word and every word has some prominence. As the hybrid model uses attention mechanism, word prominence can be attained and visualized.

In order to check this, feature of attention mechanism a small function had to be created where it takes a text, divides it into sentences and sends it to the model which further checks which word has more prominence than the other in the whole sentence. each word is given a score and the top words with their scores are displayed in a bar graph.

Ex: “Anxiety and Depression have taken over my life”

We get 3 best scores {‘taken’: 0.00104914, ‘life’: 0.009940, ‘depression’: 0.493537}

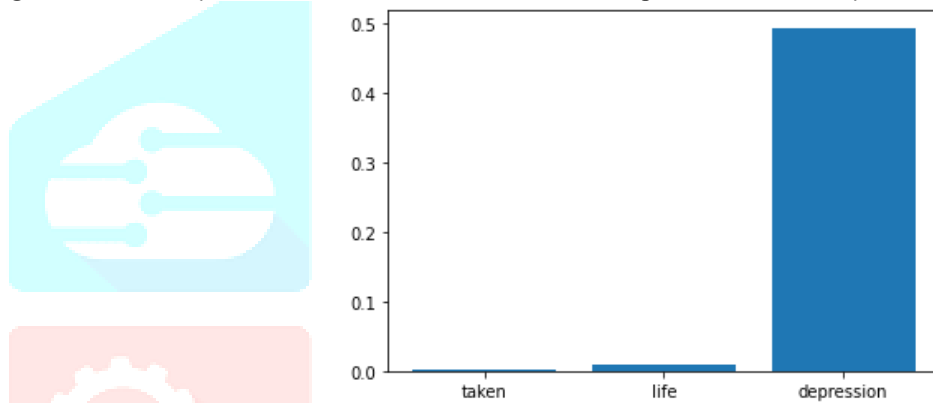


Figure 6: Top words with scores displayed in graph.

B. Chatbot

To develop the chatbot a basic function is created where it takes user inputs and sends it to the model to classify the input and then checks for the top words in the input. The model later predicts and gives an output which is presented as advice from the chatbot. Our chatbot is named jero. The bot initially greets the user then asks for any input. Upon registering input, the bot checks for the polarity of the query and then gives out the output. Few additional modules such as Speech-to-Text and Text-to-Speech are added to increase the functionalities of the chatbot. This adds to feel of talking to a human being. The user can talk to the bot and it will register the query and respond back in voice just like talking to a therapist.

V. RESULTS AND DISCUSSION

Testing was done both manually and by interacting with the chatbot. Both ways the hybrid model was able to predict with good accuracy and give out good advice to user queries.

i dont know if god is real or not

There are an infinite number of ways to look at this. Spirituality, religion, God, higher power, and many other parts of this discussion mean different things to different people. My question for you is what does "real" actually mean to you? Often, the concept of God has to do with what you believe in. If you ask 1000 different people, you'll probably get almost that many different answers. Consider talking with friends or family about this. I would suggest, though, that you have the discussion initially with people who you trust and who you feel are willing to listen to your questions and beliefs and perhaps offer an opinion without trying to make you believe as they do. You may also consider speaking with a pastor or another religious figure. The local Salvation Army may have a link to a religious or spiritual person that leads nondenominational church services. There may be able to help you to sort through this if your friends and family do not provide a comfortable environment for you related to this discussion. Just a word of caution. In my experience, ideas of religion and spirituality can be lead to very deep discussions with some people who are very strongly connected to what they believe. Some people do not easily separate their own beliefs from those of others. When initiating conversations about this, try first asking whether someone would be comfortable discussing religion or spirituality. A second question may be whether it is okay with this person you are talking to if you have different beliefs or opinions. As far as whether God is real or not, consider trusting yourself and what you learn, feel, and believe as you work through this process.

Fig 7: Model Predicting right and giving a reply.

My girlfriend and i have been quarelling a lot

You are newly married, you Have a hectic schedule, your wife is on anti anxiety medication. What if you take the focus (hint: p ressure) off of her orgasms and focus instead on connecting with one another. You know, like the gestures you each likely made while dating. It turns out that these little moments of connection throughout our days are actually foreplay. Spend a few week s making a real effort to focus on building up your little daily moments of connection, I wrote a post about this a while back, you can find it here: <http://connectfulness.com/little-moments/> And have fun with it!

Fig 8: Model Predicting wrong and giving a reply.

In Figure 7 the model has predicted that the users query is based upon spirituality and a reply was given based on spirituality whereas in Figure 8 the model has mis-classified the user query from relationship advice to marriage counselling and given a reply based on it.

V. CONCLUSION

In this proposed methodology many NLP based Deep learning architectures were initially experimented to build an effective hybrid model. Three architectures namely Vanilla RNN, LSTM, Bi-LSTM were used to get the best accuracy. Bi-LSTM gave the best accuracy, Attention mechanism was added to it and hybrid model was developed. The Hybrid model was trained for 100 iterations. fine-tuning was also done and ultimately 93.03% accuracy was achieved. A chatbot was developed which featured this hybrid model as its backend which would firstly classify then give an output to user queries as advice from an actual therapist. The results which were obtained are good but further work can be done to improve not only the model but also the chatbot.

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