Compassion Driven Conversational Chatbot Aimed for better Mental Health

Sunath Khadikar[1], Pawan Sharma[2], Priyanka Paygude[3]

[1]Dept. of Information Tech., Bharati Vidyapeeth College of Engineering, Pune

[2]Dept. of Information Tech., Bharati Vidyapeeth College of Engineering, Pune

[3]Dept. of Information Tech., Bharati Vidyapeeth College of Engineering, Pune

1

Abstract: *A study reported in WHO, conducted for NCMH states that at least 6.5 per cent of India's population suffers from some form of the serious mental disorder, also around 450 million people currently suffer from mental health conditions, placing mental disorders among the leading causes of ill-health and disability worldwide. The bottom line is that though effective measures and treatments are in place, there is an extreme shortage of mental health workers like psychologists, psychiatrists, and doctors. With lack of doctors and not many resources for people how do you take care of this problem. We hereby develop a compassion-driven AI chatbot named as "Buddy" which works as your 3 AM friend. Buddy is an artificial intelligence based mobile chatbot app for initiating positive conversations, building mental resilience and focuses on improving mental well-being using a text-based conversational interface of the user. The chatbot responds to users emotions over textual conversations and encourages to manage anxiety, depression, loss, focus etc. The chatbot uses Recurrent Neural Network for learning and Natural Language processing for understanding and generating response for user.*

Keywords: **Chatbot, Machine Learning, Mental Health, Natural Language Processing, Neural Networks**

1. INTRODUCTION

In 2017, there were 197·3 million people with mental disorders in India, comprising 14·3% of the total population of the country. Mental disorders contributed 4·7% of the total DALYs in India in 2017, compared with 2·5% in 1990 [1]. Mental illnesses are health conditions that involve change in thinking through one's behavior and emotion. These illnesses are associated with stress and/or problems due to ongoing work, financial, society or family activities. As reported latest in 2014, the number of mental health professionals in India was as low as "one in 100,000 people". The average suicide rate in India is 10.9 for every lakh people and the majority of people who commit suicide are below 44 years of age. Mental illness, also called mental health disorders, refers to a wide range of mental health conditions — disorders that affect your mood, thinking and behavior. Mental illness is treatable and the stigma around needs to be stopped. Many people suffering from mental illness do not wish to talk about it due to fear of being judged and treated differently. But mental illness is nothing to be ashamed of. Mental health problems include anxiety, depression, OCD, Panic attacks, bipolar disorder, DAD, loneliness, paranoia, PTSD, PMDD etc. and the list goes on. Bottomline is that a large number of population is getting affected due to mental health issues and this needs to be curbed right now and with lack of doctors and not many resources for people how do you take care of this problem.

In this regard there have been applications like Wysa chatbot[2] which is one of a kind chatbot which learns every user's experience and builds reports accordingly. Also the Pacifica app [3] also designed to target anxiety, stress through Cognitive Behavioural Therapy and mindfulness. In this paper we have discussed the stigma around mental

health and how our chatbot is designed to combat situations like these. The design and methodology has been discussed for how the chatbot will be implemented and what differentiates it from previously used chatbots in healthcare. Henceforth, the paper also discusses the architecture for the same and how the user responses are understood and then accordingly attended by the bot.

2. LITERATURE REVIEW

Lately, there has been a huge surge in developing chatbots for applications as it easy to deploy and maintain and saves the company a lot on support. Chatbots find many uses ranging from healthcare to education, industries to agriculture. From education based chatbots in [4], [5] to agriculture in [6], chatbots provide range of functionalities.
Also in the field of healthcare, there have been significant changes and improvements due to different chatbots for patients, doctors, medicine purchase like in [7]. Also small businesses have improved customer service like in [8] with use of retrieval-based chatbot. Drawing inspirations from these chatbots and how they have been implemented, we in this paper provide a solution for the above discussed problem in the upcoming sections.

3. DESIGN AND METHODOLOGY

To come up with a solution for this problem we introduce a Chatbot that takes care of you as your friend and talks to you when you feel like having a conversation.

3.1 Buddy : The 3AM Friend

The chatbot “Buddy” is a compassion-driven AI chatbot that works as your 3AM friend. It is an artificial intelligence based mobile chatbot app for initiating positive conversations, building mental resilience and focuses on improving mental well-being using a text based interface of its own. It has the ability of holding conversations just like any of your friend would and therefore helps in times when people often feel isolated.
Instead of rule based or retrieval based , this chatbot is designed by generative based learning that there is no set of questions or rules that the chatbot will definitely ask , it learns from the older conversations and is capable of answering the conversations which it encounters very first time. This application drives the conversation towards a positive scope and tries to understand and assist the user in handling the situations of stress better. The application also helps them develop self-expression. The main benefit of the application is that it entirely free and available to you 24x7 so you always have someone to share your problems with.
The application is capable of responding to emotions that any user writes on the text based interface, in its conversation, uses self-help practices such as CBT, motivational interviewing and analysis, positive behaviour support, behavioural reinforcement and guided actions and methods to encourage the user to build emotional resilience skills. It helps the user to manage their stress, anxiety, overthinking, energy, helps in focus, promotes meditation and encourages the same, and other situations[2].
To begin with implementation of chatbots, there are certain types of chatbots based on what purpose they fulfill. For some purpose you only need some pattern and template for the limited number of responses and questions that could be asked, such bots are rule based and are quite easy to implement[9]. But our kind of chatbot requires to answer queries that are unique to people and very varying and therefore rule based approach fails to provide the functionality.
The approach we picked for this chatbot uses Deep Learning and Natural Language processing for generating and understanding responses , i.e generative approach.

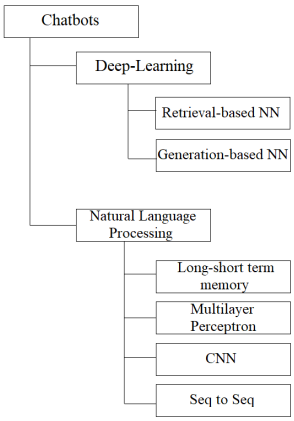

Fig1. Different techniques used to implement chatbots

The chatbot needs to understand the user's intent , determine how and what should be the response for the same, follow lexical rules and grammatical rules and then generate a befitting response[10].

3.2 Using Natural Language Understanding and Natural Language Generation

The very first task in hand is to understand the intent of the user for which the famous natural language understanding concept has been utilized. The job of NLU unit is to transform the user utterance to some semantic format that can be easily understood by the system which includes two very important tasks : Slot filling and Intent detection.
The job of filling the slots and detecting the intent of user is seen as a sequence tagging problem. Just for this reason, we have used the LSTM based recurrent neural network for the implementation of NLU unit[11].
Natural Language Generation is the process of generating text from a meaning representation. For tasks like machine translation, text summarization and dialog systems, NLG systems provide a much critical role. Chatbots that use the rule-based NLG , the outputs are predefined template statements for a given frame thus have limited response without adding anything of its own. We went ahead with NLG based on semantically controlled LSTM Recurrent network which gives it the ability to learn from unaligned data[11].

The basic steps involved in the development of the chatbot are :

- Studying and analyzing the data.
- Preprocess the data to make it compatible with the format required for model
- Split it into train, test, valid datasets
- Create a Model
- Feed the training data
- Let it overfit, and then reduce the depth/width of model
- Train again and further evaluate results for overfitting/underfitting
- Run model for test data.

3.3 Generative Based Approach

The generative approach used here doesn't use any predefined templates or sentences rather uses deep learning. Therefore unlike the usual retrieval based where we translate from one language to another, here we translate from an input to an output.
Seq2Seq model framework most suited for this type of chatbot eliminates the dialog problem faced in rule-based or retrieval-based approaches. With the aid of deep-learning, generative based has yielded great results.

The Sequence-to-Sequence model architecture has two RNNs with different sets of arguments or parameters. This particular approach consists of 2 RNNs, the first one is used to encode the input sequence , what we call as the encoder, and the second one is used to decode the encoded input sequence into the output or target sequence, known as the decoder[11]. This idea has provided great results for text summarization and conversation based on questions and answers where the sequence of words matter and the system needs to remember the significance of ordering.

Encoder

The task of encoder is taking in the input or source vector, training on that data, presenting all the input states of a sentence as a single state. That state acts as the initial state encoder to first recurrent layer of the decoder. The encoder simply makes changes to hidden states by taking in sequence of tokens. At the very end, a final state is achieved that has the context of the output and is further used to generate output.

Decoder

The task of decoder is to deal with last state of encoder's recurrent layer which becomes the initial state to decoder's first layer, the input of the decoder is the sequences that we want to get. The main aim here is to take context representation from the encoder and response generation according to the context. A softmax layer has been maintained for this purpose in decoder RNN. At each time step, we obtain a probability distribution as output over the entire vocabulary by taking the decoder hidden state.

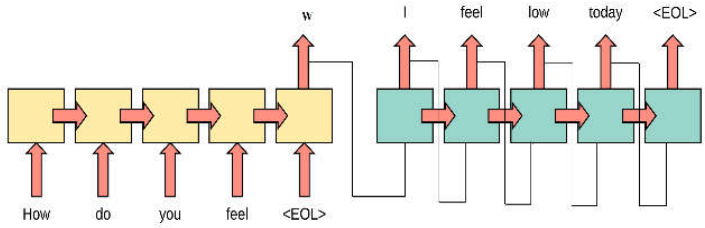

Fig.2 Encoder-decoder LSTM cells

Long-Short Term Memory

An LSTM network is a recurrent neural network that has LSTM cell blocks in place of our standard neural network layers[10]. Each cell in LSTM has several components known as the input, output and the forget gate. Recurrent neural networks are exceptionally good on sequential data or where the order of inputs matter. But whenever the context is too far away, they tend to create a ruckus. Long Short-Term Memory or LSTM's are explicitly designed to avoid the long-term dependency problem. LSTMs also provide solution to Vanishing/Exploding Gradient problem [12]. LSTM have the ability to remember information for longer periods and are known for this. Usually RNN models

have repetitive modules for a network for eg. in standard RNNs tanh layer is used. Here we have stacked arrangement of LSTM cells.

Specific to our chatbot, below are the detailed steps that enable us to build the chatbot using deep learning and natural language processing :

1) The data pre-processing is a key part of the entire process because making the data ready for modeling plays important role on how efficient the system will turn out to be. Reading the words, converting to index of each word, word to index dictionaries, filter too long and too short sequences, bag of words, array dealt with it, tokenizing with "End of sentence" and "Start of sentence" to make sentences more clear are all done in pre-processing phase.

2) The data pre-processing has changed it from raw lines of conversations to zero-padded numpy arrays of indices, and further required dictionaries of word2index and unit index2word to keep counts. It is important to note here that the LSTM takes only batches of inputs and not a single input at a time.

3) With a few helper functions, we gather random examples from dataset, in batches and feed to model. The most important class Seq2Seq that does all the training, evaluation, graph building, saving model takes several parameters as input like batch_size, num_layers, emb_dim, learning rate, epochs etc.

4) The LSTM cell that is the most important part of the entire model has a keep_prob placeholder which is used to control dropout rate and prevent overfitting[12]. The basic LSTM cell used is wrapped with a Dropout Wrapper. The LSTM cells here are stacked LSTM architecture.

5) Next we used a function *embedded rnn seq2seq* from seq2seq module, to create a seq2seq model, which does word embedding internally. For testing also, we use the same model that has almost the same parameters as training but with the *feed_previous* switch enabled. Thereby the decoder has to use the output of previous step as input to its present timestep, while during training, the input to decoder is taken from real output sequence.

6) The function sequence loss has been used to get the expression for loss. The next step is training with a dropout selected as 0.5. The data was split into training, testing and validation and further the results were analyzed.

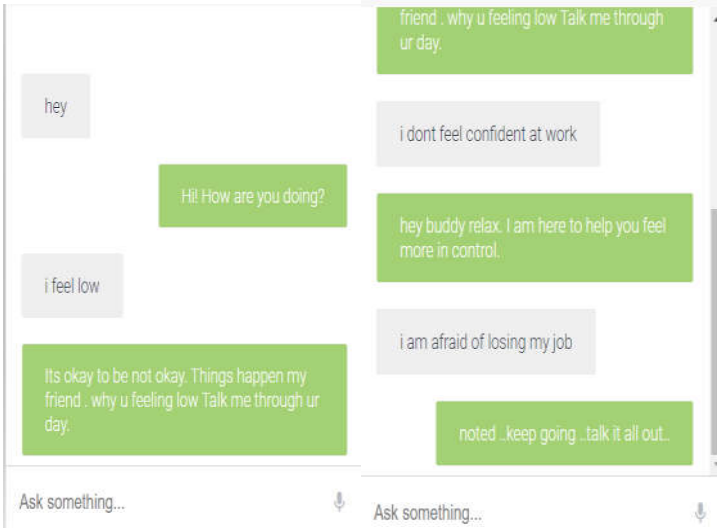

Fig.3. Sample images of how chatbot "Buddy" holds up conversation and interacts.

4. CONCLUSION

The main aim of this chatbot is to act like a friend and hold friendly conversations to improve mental resilience of the user which it is capable of. The bot is holds conversation with the trained data and continuous learning that helps it improve further. The bot also suggests meditation techniques, promotes yoga practices, and other suggestive links to relieve stress and improve mental state of user. The interface is user-friendly and currently text-based with further scope of speech-based conversations.

This is a unique way of interacting with the user and its implementation and usage is quite different from other chatbots. This is developed is an application which will be available 24x7 for the users and is entirely free. In this paper we have presented the idea and the implementation of the chatbot, the algorithms that run behind the curtain.

Acknowledgments

We would like to thank our project guide Ms. Priyanka Paygude for her constant guidance and support. Also we would like to thank the Information Technology Department of our college Bharati Vidyapeeth College of Engineering, HOD Dr. Sandeep Vanjale for their encouragement and assistance for developing this project.

REFERENCES

[1] Sagar, R., Dandona, R., Gururaj, G., Dhaliwal, R. S., Singh, A., Ferrari, A., ... & Kumar, G. A. (2020). The burden of mental disorders across the states of India: the Global Burden of Disease Study 1990–2017. The Lancet Psychiatry, 7(2), 148-161.

[2] Inkster, B., Sarda, S., & Subramanian, V. (2018). An empathy-driven, conversational artificial intelligence agent (Wysa) for digital mental well-being: real-world data evaluation mixed-methods study. JMIR mHealth and uHealth, 6(11), e12106.

[3] Poon, S. K. (2016). Pacifica: stressed or worried? An app to help yourself (Mobile App User Guide). British journal of sports medicine, 50(3), 191-192.

[4] Patel, N. P., Parikh, D. R., Patel, D. A., & Patel, R. R. (2019, June). AI and Web-Based Human-Like Interactive University Chatbot (UNIBOT). In 2019 3rd International

conference on Electronics, Communication and Aerospace Technology (ICECA) (pp. 148-150). IEEE.
[5] Sharma, R. M. Chatbot based College Information System.
[6] Gunawan, R., Taufik, I., Mulyana, E., Kurahman, O. T., & Ramdhani, M. A. (2019, July). Chatbot Application on Internet Of Things (IoT) to Support Smart Urban Agriculture. In 2019 IEEE 5th International Conference on Wireless and Telematics (ICWT) (pp. 1-6). IEEE.
[7] Kowatsch, T., Nißen, M., Shih, C. H. I., Rüegger, D., Volland, D., Filler, A., ... & Heldt, K. (2017). Text-based healthcare chatbots supporting patient and health professional teams: preliminary results of a randomized controlled trial on childhood obesity.
[8] Singh, R., Shinde, N., Patel, H., & Mishra, N. (2018, April). Chatbot using TensorFlow for small Businesses. In 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT) (pp. 1614-1619). IEEE.
[9] Serban, I. V., Sankar, C., Germain, M., Zhang, S., Lin, Z., Subramanian, S., ... & Rajeshwar, S. (2017). A deep reinforcement learning chatbot. arXiv preprint arXiv:1709.02349.
[10] Csaky, R. (2019). Deep learning based chatbot models. arXiv preprint arXiv:1908.08835
[11] Bhashkar K., "Conversational-ai-chatbot-using-deep-learning-how-bi-directional-lstm-machine-reading":Medium
[12] Yin, Z., Chang, K. H., & Zhang, R. (2017, August). Deepprobe: Information directed sequence understanding and chatbot design via recurrent neural networks. In Proceedings of the 23rd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (pp. 2131-2139).
[13] Lokman, A. S., & Ameedeen, M. A. (2018, November). Modern chatbot systems: A technical review. In Proceedings of the future technologies conference (pp. 1012-1023). Springer, Cham.
[14] Nguyen, H., Morales, D., & Chin, T. (2017). A neural chatbot with personality.
[15] Palasundram, K., Sharef, N. M., Nasharuddin, N., Kasmiran, K., & Azman, A. (2019). Sequence to sequence model performance for education chatbot. International Journal of Emerging Technologies in Learning (iJET), 14(24), 56-68.
[16] Prassanna, J., Khadar Nawas, K., Jackson, C., Prabakaran, R., & Ramanath, S. Towards Building A Neural Conversation Chatbot Through Seq2Seq Model.
[17] Abdullahi, S. S., Yiming, S., Abdullahi, A., & Aliyu, U. (2019, December). Open Domain Chatbot Based on Attentive End-to-End Seq2Seq Mechanism. In Proceedings of the 2019 2nd International Conference on Algorithms, Computing and Artificial Intelligence (pp. 339-344).
[18] Bavishi, U. K. (2019). Implementing a college enquiry chatbot.
[19] Dnyaneshwar, M. G. G., Somnath, M. H. P., Rajendrakumar, P. R., & Dadasaheb, P. K. Web Based College Enquiry Chatbot with Results.
[20] Dandona, L. (2019, December 23). The burden of mental disorders across the state of India disorders across the states of India:. Lancet Psychiatry 2020; p