

Bengali Conversation with Artificial Intelligence: An Empathic Chatbot Companion

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Abstract:In the era of machine intelligence, a chatbot has become popular and several intelligent chatbots are designed which replaced the traditional chatbots. A Chatbot is artificial intelligence (AI) software that uses key pre-calculated user phrases and auditory or text-based signals to simulate interactive human conversation. Chatbots rise as a key area for Human-Computer Interaction (HCI) community. Empathy is the ability to understand human emotions. Empathy in a chatbot is a new topic for the chatbot interface. With the help of Empathy, a chatbot can detect the human emotion or state of condition and talk accordingly with the user. Recent efforts are also aimed at creating more responsive chatbots for deeper and emotional talks. This can also help enhance chatbot use by making users feel better. Few chatbots are available in the Bangla language but none are available that can detect human empathy and act according. The empathetic chatbot can have a conversation with the user and can extract the feelings from the text using some method. The generation of empathic responses will detect and convey appropriate emotional responses more dynamically. This paper aims to discuss ways and methods of using empathy to introduce a Bangla Chatbot.

Keywords: Feed Forward Neural Network, Natural Language Processing (NLP), Word Embedding, Word Stemming, Seq2Seq Model.

1. Introduction

In modern days, the interaction of humans with digital devices has become common which led to the development of a chatbot. Machines started to impersonate many human behaviour patterns, with the flow of artificial intelligence. Artificial Intelligence conversational method, which is also known, as Chatbots are an excellent example of such an intelligent machine. Golpo, a chatbot was implemented by TD Orin in 2017. She designed a data-driven close domain chatbot in Bengali using a knowledge-based talk interface and learning from the user. Golpo cannot detect empathy. Our chatbot can detect empathy, which will act as a companion [1]. Every year in Bangladesh, suicide kills around ten thousand people [2]. In most cases, the reason is depression and loneliness. But our chatbot will act as a companion for lonely people and it will help to remove loneliness and depression. A chatbot can be developed in many ways using Deep Learning which requires Neural Networks to learn the input sequence. But it is a huge task to add Empathy to a chatbot. Adding empathy will make the chatbot behave more humanly and will make the user feel like having a conversation with a person.

Most people appreciate a chatbot that offers sympathetic or empathetic responses.

1.1. Natural Language Processing (NLP)

Natural Language Processing is a computer science and artificial intelligence subfield that deals with machine-to-human language interactions. The Deep Learning approach provides multiple layers of modeling and a state-

of-the-art output for data representation. In the context of natural language processing, a variety of models and methods is present [3].

1.2. Feed Forward Neural Network (FNN):

A FNN is an AI component where a loop is not created by the relation between the nodes. It is the Neural Network's first and easiest. The current input and hidden state are used by a feed-forward network layer to produce the new vector. The vector is transformed to create a new context vector via Softmax.

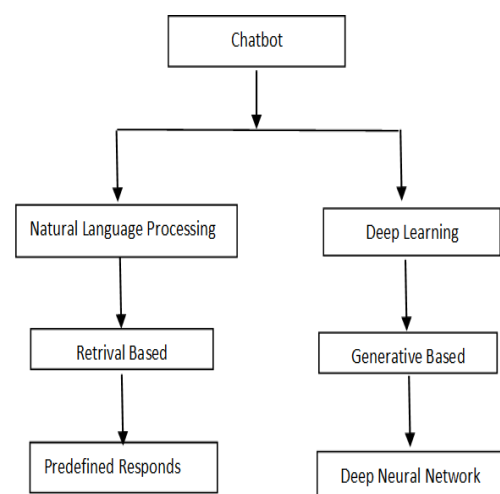


Fig.1. Flow chart of Chatbot.

1.3. Seq2Seq Model

Seq2seq model uses deep learning to revolutionize the process of grammar and sentence structure. It works with the current word while translating and also with its neighbouring words. It has mainly two components, Encoder, and Decoder. It is also known as the Encoder-Decoder Network. The encoder requires the deep neural network layers to convert the hidden vectors that represent the existing terms in the context. And decoder is akin to the encoder. The input here is the hidden vector, its own hidden status, and the current word to finally predict the next word. Other than the two components, there are Attention, Beam Search, and Bucketing in the Seq2seq Model.

2. Chatbots in Context of Bangladesh

2.1 Use of Chatbots in Bangladesh

Chatbots are rising as an increasingly important field for interaction among people and computers. Chatbots are not just useful for automating marketing, sales, and customer service operations at global enterprises. They have also been used successfully to fight social injustice, and raise awareness among the people. It can also act as a friendly human companion. In the context of Bangladesh, Chatbot can play a very important role.

- A. Avoid Suicidal Tendency: Empathic Chatbot is like having a companion. Talking sometimes makes the mind clear of all the confusion. Nowadays the young generation often feels depressed and lonely for various reasons. They then try to commit suicide. Our Empathic Chatbot can help them get out of their depression. Crisis Text Line provides an AI solution to detect the risk of suicide. It uses deep neural networks and natural language processing (NLP) for detection.
- B. Bots for Identifying Anxiety and Depression: Nowadays depression is quite a familiar thing with the young generation. They get depressed and anxious for various reasons, such as studies, family problems, etc. Chatbots can help people to get out of this depression. They can share their feelings and get something to talk about.
- C. Bots can act as a friendly companion: The old people of our country usually spend their time alone. They have no one to talk to. Our Empathic Chatbot can help them avoid loneliness.

3. Architectural Model of Chatbot

3.1 Classification of Chatbot

Based on their purpose of designing and the information that is expected to provide, there are two classes of chatbot [8]. They are:

- A. *Conversational chatbots*: A conversational chatbot is designed for fun purposes or to complete a task. A conversational chatbot can be either a Chatterbot or a task-oriented bot. Our chatbot can be categorized as Conversational Bot as it is for normal chat and can detect Emotions.
- B. *Domain-based chatbots*: The classification of a chatbot based on domains is of two types. Open Domain and Closed Domain bots. In open-domain

dialog system aims to create long-term user relationships through satisfying the human need for interaction, affection, and social association.

A chatbot can be designed in two ways: Response to a user can be generated using machine learning models or a relevant answer from predefined responses. A chatbot can be of either a Generative model or Retrieval based model.

- A. *Generative models*: This model is designed to have human-style conversations. These types of chatbot require a huge amount of data. These data are to be trained accordingly. Microsoft Tay and Zo are notable examples [11].
- B. *Retrieval-based models*: Retrieval model is very simple for implementation and has predictable results. APIs are available for developing retrieval-based models. They are easy to build when compared to generative models. A Retrieval Based Model uses a collection of predefined responses and a model to generate user input responses. Information Retrieval is the activity of obtaining the system resources that are relevant to the answer.

The designed chatbot is classified as both conversational and generative. A chatbot can also be defined as an intelligent friend that consists of three components. The components are a model that process message based on problems, a model that select appropriate support strategies, and a model that generate responses based on the first two models.

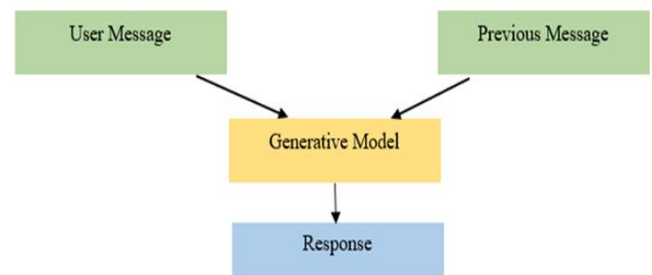


Fig.2. Generative Based Model

3.2 Other Popular Chatbots

The first developed chatbot was Eliza by a German Computer Scientist in 1996. It used NLP program at MIT Artificial Intelligence Lab [4].

ALICE (Artificial Linguistic Internet Computer Entity) is a natural language, open-source chat robot, which uses AIML (Artificial Intelligence Mark-Up Language). They, therefore, introduced an architectural chatbot with appropriate modules to recognize and maintain social practices in conversations [4]. Microsoft Xiaoice is available in China and is an empathic chatbot. It has a sense of humor and listening skill. Xiaoice can tell jokes, recite poetry, share ghost stories, and relay song lyrics [5]. Xiaoice published the first fully AI Chinese poem book [10].

In 2017, T.D. Orin designed a chatbot titled Golpo in Bangla, which is a basic text conversation. She collected a Bengali Corpus for building the knowledge of the system. The format was used in JSON. Best Match Adapter was used for the output. It used Jaccard Similarity function [1]. In 2018, Japan anchored a new robot named Erica. It is a highly human android model by Hiroshi Ishiguro to resemble a woman who is 23 years old. It is capable of reciting scripted news and has a conversation with humans. But they haven't added empathy to their robot. Adding empathy would have made the robot more humanly [6]. In 2019, a group of students from UIU developed a Virtual Assistant application for Bangla Language. They covered a wide variety of frequent commands with an accuracy rate of 94.065%. They generated a dataset consisting of keywords and their similar actions. But if commands are given outside the dataset, they search Google for the command and present the result. Though they have reached their goal still they have some limitations [7].

Xu et al. in 2017 developed a chatbot using Long Short-Term Memory which can process human emotions and information. They surveyed about 1M Twitter conversations and between user and agent. Emotional Requests express emotions and attitudes whereas Informational Requests intent to gather information about a problem [8].

4. Methodology

The input of our chatbot is text-based. After taking the input as text, it breaks down the text into Token. Then the tokenized words are checked from word-to-word for Word Stemming. Stemming breaks down a word to its core meaning. Then the process goes to Word Embedding. Here the input text is given a binary value based on the importance of text in the input. It is a numerical representation done in Binary Form. There are two ways of value representation. These are 1D Array and 1 Hot Vector. We used the 1D Array representations. The binary value is sent to the seq2seq model with the help of an activation function which is called Softmax.

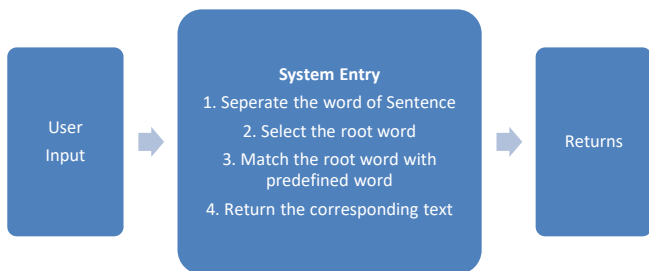


Fig.3. Flowchart of the Proposed System.

Softmax Units: The activation function of the output nodes is implemented by the Softmax Function. The softmax units are used for the multitude output distribution. It is also known as the normalized exponential function. By applying Softmax, each component gets between the interval of (0, 1). It is used for a probability discrete variable with n values. It can also be used for Sigmoid Function which is a distribution of binary variables. The formula that defines the standard softmax function is $R_k \rightarrow R_k$ where for $i = 1, \dots, K$ and $z = (z_1, \dots, z_k) \in R^k$. We apply the exponential

function element z_i of the input vector and normalize the value by dividing the sum. Data plays a crucial role in the design of any application. Chatbots are to be trained with sentence and question, response pairs. There are many datasets available for the design of chatbots. But in Kaggle, there is no Dataset present for Bangla Language and none found for Empathy. So, we created our very own dataset in JSON format. Initially, we fitted a simple dataset for our model.

To design any application, the first thing we need is data, which should be pre-processed to obtain a particular format of a machine. The data processing of our chatbot goes through a certain amount of processing before generating output.

- A. *Word Embedding*: Word embedding is the numerical representation of a text. Mapping a word of a vector is done with 1 and 0. Let us consider an example sentence="আমারআজকেঅনেকপড়তেহবে". The vector representation of "পড়তে" for the above sentence is [0, 0, 0, 1, 0].
- B. *Word Stemming*: In linguistic morphology, stemming is a process to reduce inflected words in the basic root. The algorithm of stemming is being studied in Computer Science since the 1960s. The stem word is not identical to the base word but it is the root of the word. For example: Let us consider the word "কষ্টদায়ক". The word stem of the word is "কষ্ট".

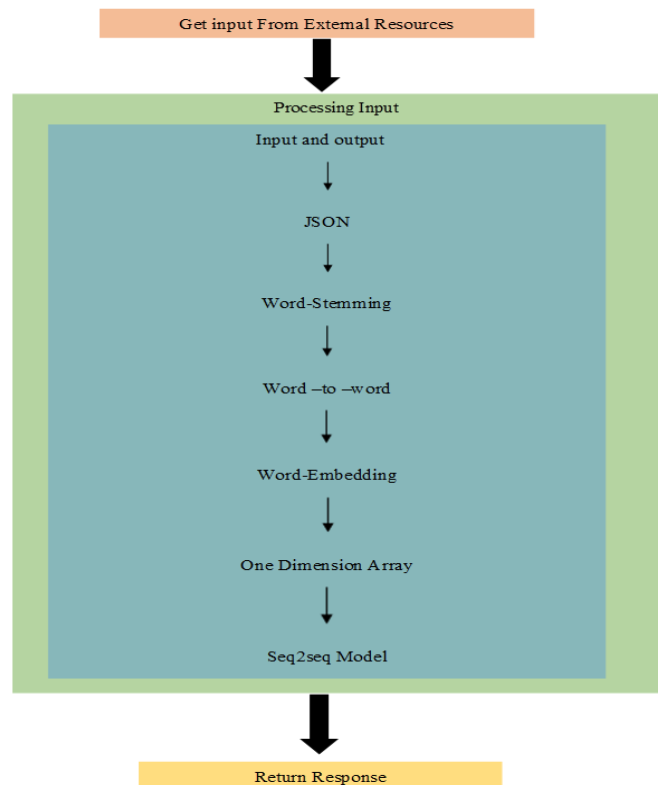


Fig.4. Process Flow Diagram.

4.1 Preparing the Seq1Seq Model

The model has three arrays. Encoder Input, Decoder Input, and Decoder Output. The function of encoder input is

tokenizing the question while the function of a decoder is to tokenize the answers.

The model also has embedding and layers. The 2 input layers are one for encoder input and the other for decoder input. Words in a user’s request cannot be directly used as inputs. Each word needs to be converted to a feature vector. Word embedding is the numerical representation of a text. Mapping a word of a vector is done with 1 and 0. Word Embedding improves the ability of the network to learn from the given input data. The model is trained for 150 epochs using the RMSprop optimizer. We used the Softmax function as it can predict a single output from an answer.

5. Results

We split our whole dataset into two-part. One is Train Dataset and the other is Test Dataset. 80% of the whole is Train Data and the rest 20% is Test Data. The accuracy percentage of the train data and test data is 0.95% and 0.934% respectively. In 2017, a student of BRAC University developed a Bangla chatbot named Golpo. She developed a chatbot that can have some normal conversation [1]. But it lacks the technique to detect empathy. On the other hand, our chatbot can detect human emotion and reply accordingly. We used seq2seq to develop the chatbot. When asked our chatbot can answer questions and show some empathy. It can both answer emotional and informational questions. It can give an appropriate answer to the user.

Table 1: Comparison between the Golpo and Pihu

User	Golpo	Pihu	Comment
What is a computer ?	কম্পিউটারএকটি ইলেক্ট্রনিকডিভাইসযা ডিজিটালআকারেতথ্য নেয়এবংপূর্বনিরধারিতনির্দেশনাবলিরউপর ভিত্তিকরেকিছুআউটপুটদিখেথাকে।	কম্পিউটারএকটিই লেক্ট্রনিকডিভাইস , যাডিজিটালআকারেতথ্যনেয়এবংবিভিন্নপ্রক্রিয়ারমাধ্যমেতাবিশ্লেষণওউপস্থাপনকরে।	The query asked to both chatbots is informational. They give us a similar type of response.
What is your number?	নেই	আমারকোনোফোন নাম্বারনাই	As an empathic chatbot, Pihu can give a witty answer where Golpo is not able to give an empathic answer.
আপনার _ফোন নাম্বারকত			
What are your interests?	আমিসবধরনেরজিনিষেআগ্রহি। আমারপ্রিয় বিষয়রোবটএবংকম্পিউটার,প্রাকৃতিকভাষাপ্রক্রিয়াকরণ।	আমিসবকিছুজানতেআগ্রহী।	Here Golpo gave a specific answer which is better than Pihu.
তোমারআগ্রহগুলোকি?			

6. Discussion

The name of the chatbot is Pihu. Before working with the Bangla chatbot we implemented an English Chatbot to get familiar with the working environment. We set up the environment and successfully implemented the English chatbot. But our real difficulty was with the Bangla chatbot and adding empathy to it. Normal Bangla chatbot is easy to design as it does not need to identify the users’ feelings. But when it comes to adding Empathy, we needed to think about other techniques to make the chatbot feel the users’ emotions. Adding empathy in the chatbot for Bengali language is a unique feature and a new methodology was used to implement it which reflects the novelty of the work. The input of our chatbot is text-based. We used Seq2seq model and our JSON dataset that fits in order to develop the chatbot. The chatbot can answer the questions that are asked to it and can show some empathy. It can give a good response to the user. The answers were accurate and the response time was also good.

7. Conclusion

Basically, users want a chatbot that can put value into their lifestyle while being a friend and a companion. They also provide insightful suggestions on topics that they usually bring up. A Chatbot can automate a natural language conversation (or chat) with a user across messaging applications, websites, or mobile applications. The Chatbot shows Empathy and can understand the mood of the user in the current state. It was a challenge to collect the dataset and fit it into the model. As no dataset is found, we had to prepare our very own dataset and it is updating accordingly. Comparing with the previous in Golpo, we were able to deliver some empathetic replies from our chatbot. Whereas Golpo gave straight answers, Pihu showed some empathy. We intend to work more with Pihu and will try to improve it. In the future, the aim is to add some predictable features so that Pihu can predict the mood based on chats with the user. Also, LSTM will be included as it can give access to the memory cell and can store previous conversations.

The paper discussed the approach for designing a chatbot with empathy. In addition to this, a comparison is highlighted between several chatbots so far developed. From the survey, it can be concluded that the chatbot we developed is a state-of-art till now for Bangla Language and will be able to detect Empathy which is not yet done.

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