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Development of Artificial Intelligence Based Chat bot for Project Assistance in Automotive Applications

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Abstract: *Improvements in Technology helps human to lead life easier when compared to ancient times. With new developments in software technology, apps and software tools are become part of life. Chatbots that are developing for many applications will find applications in our daily lives also for many personal usages. Even though Chabot concept is developing one, it is being rapidly adapted for many applications in various areas because this makes the work simpler and easier for the customer. Chatbots are artificial intelligence based tool that chat with one like a person replying from the other side. Project assistance Chatbot is an interactive tool that contains the knowledge base of a particular project or process. The Chatbot will be trained with the data of the particular project. The Chatbot will be able to identify the keywords given by the user, match it with the knowledge that has been fed to it. Finally, it will give the result to the user by logically connecting all the obtained results. Sequence to sequence model has been used to build this Chatbot, which uses encoder and decoder arrangement. The Chatbot model has been implemented with two sets of Recurrent Neural Networks (RNN) using the software Python TensorFlow. Sequence of symbols is encoded by one RNN into fixed-length vector representation and the vectors are decoded into sequence of symbols by the second RNN. The Chatbot has been trained with volume of data and it responds to the user queries.*

Key Word*: Artificial Intelligence, Chatbot, Chatterbot, Project Assistance, Answering System*

I. Introduction

I.1. Chatbot

Presently the computers attain the ability to learn the processes, procedures, jobs done by human and mimic many of the human activities because of the developments in artificial intelligence, machine learning and deep learning. One of the recent developments because of the advancements in software technology is Chatbots. "A Chatbot or chatterbot, is a software program based on artificial intelligence methods, which can carry out communication with people through sound or text". Hence, the Chatbots are software's agents used to make conversation in many different applications [1].

Virtual assistance such as responding to user requests, supporting, making decisions, etc. can be provided by chatbot, one of the most common technologies. Chatbots rely on Natural Language Processing (NLP) to analyze the knowledge based on the conversation context in order to give appropriate responses to users. NLP translates the knowledge into words by analyzing the grammar and semantics of the language being spoken [2].

I.2. Artificial Intelligence

Artificial Intelligence (AI) is the branch of science that highlights the creation of intelligent machines, which behave like humans. AI is the intelligence revealed by machines, which is contrast to the natural intelligence showed by humans and other animals. It gives machines the same intelligence that would be required by a human to perform the task. AI involves the following stages,

- Learning - acquisition of data and the rules to process the data
- Reasoning - using the rules to obtain the required results
- Self-correction – manipulation of its parameters till it reaches the required result.

I.3. Machine Learning

A computer program that has the ability to learn as humans/animals does from the experiences of a task, assessed by some performance measures/parameters. Performance is improving when the program is trained well with accurate dataset [3]. Machine learning is one the application of Artificial Intelligence for which the programs are written and executed in powerful computers. The concept of machine learning is based on the experiences that are gained by the application and produces the possible responses. Few important applications of machine learning are i) Recognizing the similar objects in different photos (Eg. Face recognition in Google photos), ii) Autonomous Vehicles, and iii) Web search based on suggestions etc [4].

II. Chatbot model

II.1 Chatbot Architecture

Figure 1 illustrates the basic architecture of Chatbots in terms of knowledge database and knowledge identification engine. It represents the main components of Chatbot. By using the different normalization techniques, the analyzer analyzes the statement input by the user to determine the word syntax and semantics of the sentence. It is not necessary that the Chatbot understands what the user is saying or retains all the details of the conversation to respond to user messages. A Chatbot should be smart enough to keep the conversation going [2].

It can either use machine learning models to craft responses from scratch or heuristics to select responses from a library of predefined responses. In the chatbot engine, the knowledge base communicates with the engine and uses a search algorithm to identify the appropriate response based on the input from the user. This is the brain of the chatbot system. Engine communicates with the knowledge base and generates the suitable response according to the user input by using some search algorithms to identify the correct response. Knowledge base is the brain of the chatbot system. Generator receives the response from the knowledge identification engine and presents the response to the user correctly. It uses script files, text files, dat files, XML files.

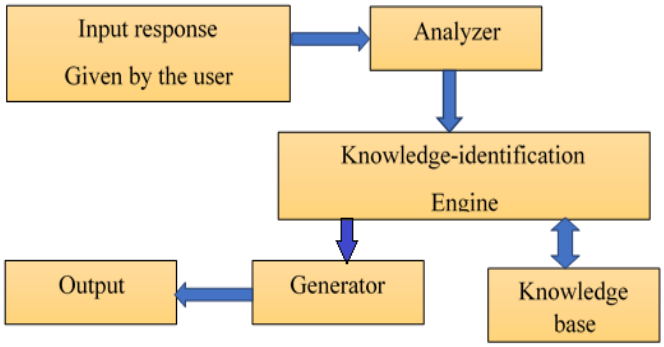


Figure no 1. Chatbot Architecture

II.2 Recurrent Neural Networks

Recurrent neural networks (RNNs) are powerful and robust neural networks that are one of the capable algorithms because of their internal memory [5]. With internal memory, it can more accurately predict what will happen next. This makes it a good algorithm for sequential data such as time series, voice, text, audio, video and weather. Gain a deeper understanding of sequences and their context compared to other algorithms [6]. Figure 2 depicts the recurrent neural network.

II.3 Long-Short Term Memory Networks

Long Short Term Memory (LSTM) networks are basically extensions of recurrent neural networks that have more memory. Since they have extended memory, they are very suitable for learning from experiences gained. The LSTM entities are used as building blocks for the RNN layer. With LSTMs, RNNs can memorize inputs over time. LSTMs can read, write, and delete information from memory. This is because LSTMs store information in memory that is very similar to computer information. The memory in LSTMs can be witnessed as a gated cell. Gated cell means deciding whether to save or delete information (for example, whether to open the gate or not) based on the significance that the cell gives to the information. The algorithm allocates weights to information by learning the importance that are given to the information. This implies that learning over longer period what information is important and which is not [6].

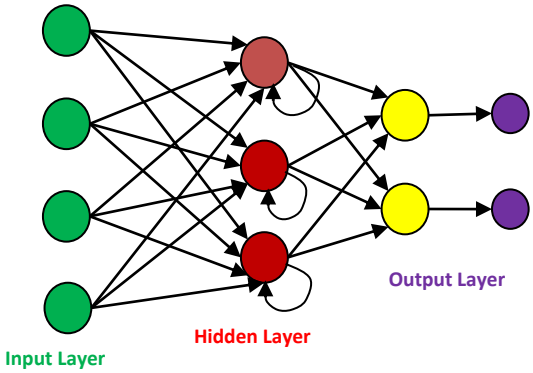


Figure no 2. Recurrent Neural Network

II.4 Sequence to Sequence Model

A sequence of words is taken as input by the Sequence to Sequence model and generates sequence of words as output [7]. Recurrent neural network (RNN) is used to perform this work. Figure 3 depicts the logic of the model used. The model consists of three parts: an encoder, an intermediate vector (encoder), and a decoder. An encoder and decoder are the two sub-models of the architecture. Raw text data is given as input for the RNN architecture. The output of the encoder is a neural expression. The output of the encoder becomes the input data of the decoder. The encoder produces a neural representation-encrypted output. The decoder has the ability to examine the output of the encoder and create completely different output data.

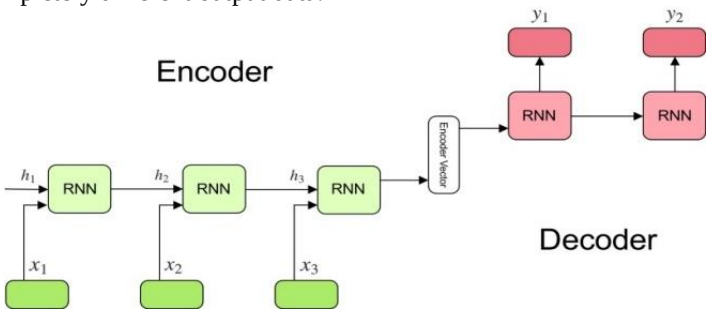


Figure no 3. Encoder-Decoder sequence to sequence model

II.5 Encoder

A stack of recurrent units (LSTM) accepts a single element of the input sequence and accumulates and propagates information for that element. The input sequence in a question-answering problem is a collection of all words from the query. Each word is represented by the symbol x_i, where i indicate the word's order. The formula shown in (1) is used to calculate the hidden states h_i:

$$h_t = f(W^{hh}h_{t-1} + W^{hx}x_t) \quad (1)$$

An ordinary recurrent neural network's output is represented by this simple formula. The prior hidden state h_{t-1} and the input vector x_t are given appropriate weights.

II.5.1 Encoder Vector

This is the model's final hidden state, generated by the encoder. The formula above is used to calculate it. This vector seeks to incorporate all input element information in order to aid the decoder in making correct predictions. It serves as the model's initial hidden state for the decoder.

II.5.2 Decoder

An output y_t can be predicted at any time step t using a group of RNN units. Each RNN unit generates an output and its own hidden state by accepting the hidden state from the preceding unit. The output sequence in a question-answer problem is a collection of words from the answer. y_i represents the words in the sequence, where i represents the order of the words. The hidden states are determined by (2)

$$h_t = f(W^{(hh)} h_{t-1}) \quad (2)$$

At any time step t, the output of the decoder is computed by

$$y_t = softmax\ (W^S h_t) \quad (3)$$

The outputs of each time step are determined by using the weights W^s associated with the unit and hidden state at that time step. The final output is determined with the help of the instruction *softmax,* which produces a probability vector. This model has the capability to map different length sequences.

III. System Description

III.1 Software Specification

The language Python 3.6 is used to develop the Chatbot. Python is an interpreting, interactive, high-level object-oriented computer language. It has high level built in data structures like the list, dictionary which makes it very much suitable for Rapid Application Development. Since Python has simple and easy syntax it has found wide popularity. Due to this reason it has also brought down the cost of program maintenance. Python has high modularity and code re usage. Python can be extended to other platforms easily. The Python interpreter and its vast library are available free for all major platforms [8].

In this paper, Anaconda is used which is a Python distributor. It is a common distributor of both Python and R data science package. The Anaconda is a very powerful tool for program developers as it reduces many of the problems that arise during development. It makes the process of debugging easier. It has more than 100 packages and installing them has been made easier with the pip module [9].

III.2 TensorFlow Module

TensorFlow is a library in Python language created by Google for fast numeric computing. . The TensorFlow is a open source library developed for executing machine learning algorithms in Python. Deep learning models can be developed easily in TensorFlow by using the wrapper libraries at the top of TensorFlow which makes the process simple. TensorFlow can be used for constructing machine learning and deep learning models. TensorFlow works on Python using a suitable front end API. TensorFlow can be used to build deep neural networks for applications such as image recognition, handwriting recognition, translation etc using Natural Language Processing (NLP), Seq-to-Seq Models, Recurrent Neural Networks, and Partial differential Equations. Tensorboard is another API enables the user to visualize the weight updation occurring inside the neural networks. The TensorFlow has the following features,

- It trains the models with small dataset/large dataset
- Improve generalization
- Training models are faster

IV. Design and Implementation

IV.1 Chatbot Implementation

The Chatbot is implemented in two stages namely training and testing stages. Chatbot is fed with labeled dataset in the training stage. RNN will train itself until it completes the epochs and converges the loss function to a minimal value [2]. The loss function is used to measure the accuracy of the Chatbot. The accuracy and loss function are inversely proportional. The blocks diagram in the Figure 4 depicting the basic functioning of the Chatbot.

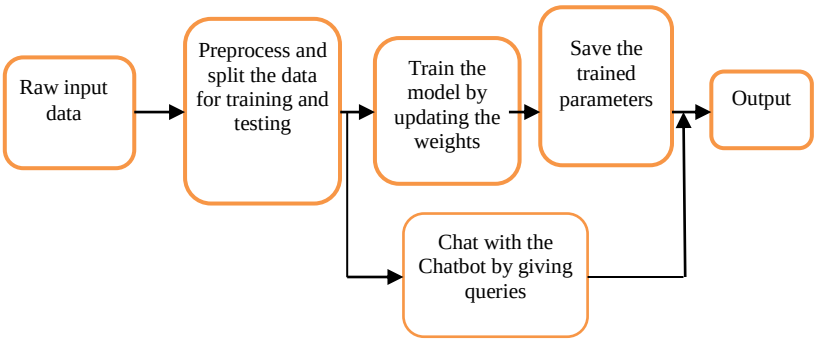
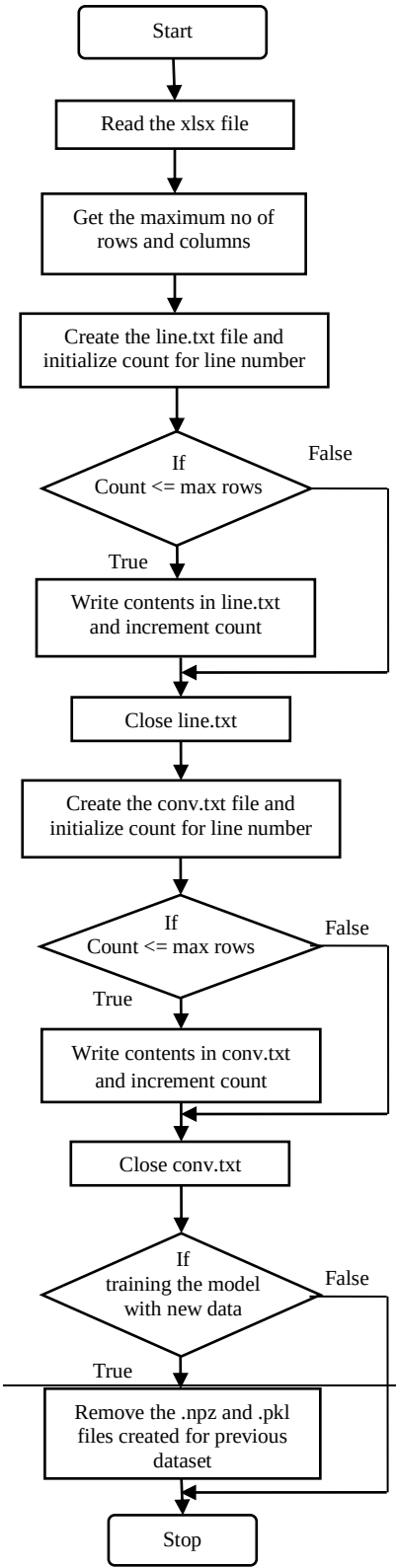


Figure no 4. Block diagram of Chatbot



The input data has to be converted into a form that can be processed by the model in Figure 4, hence it requires preprocessing. Then the data has to be split for training and testing, since the Chatbot is designed under supervised learning algorithm. Then based on the mode of operation the model will be taken into either chat mode or training mode. In training mode the input data will be given in batches and these batches will be passed with several epochs. The RNN will calculate the loss function after each batch and tries to converge it to a minimal value (below 0.1). After all the epochs are completed, the model will be saved with the trained parameters. In chatting mode the model will be loaded with the parameter that was saved and will be ready to chat. The learning rate is one important parameter that has to be initialized. For better results, the learning rate is always set low (0.01).

IV.2 Algorithm for Processing of Data

The raw input given to the model is in .xlsx format so it has to be converted to the .txt format. The algorithm has to create two .txt files one contains the question and answers and the other contains question and answer pair tags to proceed with the training. Hence the algorithm for the processing of data is shown in Figure 5.

The algorithm designed for the RNN model is shown in Figure 6. The input to the model is sequential which enables to use the Recurrent Neural Network along with the LSTM cell. The RNN is very efficient in learning sequential data as it will be able to recognize a pattern among the data provided. Once the input is given the RNN will start to allocate weights to the inputs. By comparing with the output, it will continuously change the weights of each node until the input is equal to the output. This method is called back propagation. The RNN has the ability to predict the future input based on the pattern. It will gain experience from the past output data. Hence RNN is a hybrid of supervised and unsupervised learning which makes it more efficient. Since the RNN store the past output it needs a memory [5].

Figure no 5. Flowchart for data processing

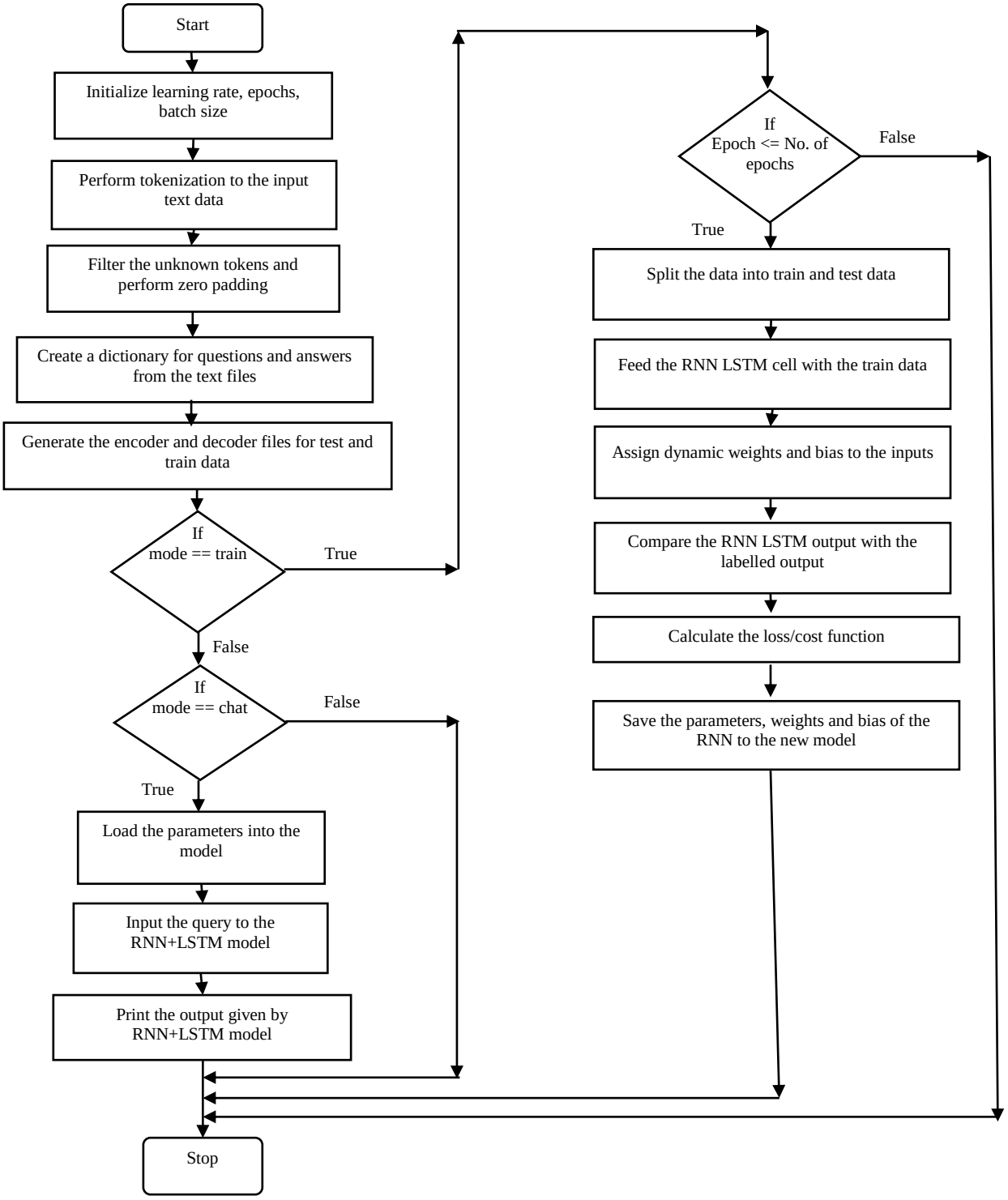


Figure no 6. Flowchart for the RNN model

Hence LSTM (Long Short Term Memory) cells are used. The LSTM will be able to classify data as useful and not useful. If found useful, it will add the data to the knowledge base otherwise it will be deleted. The model can be used in two modes training mode and Chat mode. In training mode the processed data will be fed to the RNN and the parameters will be manipulated. In chatting mode the saved parameters will be loaded and the model will be ready for chatting [6].

V. Results and Discussion

V.1 Dataset Creation

The raw input file given to the model is an .xlsx file. The Excel sheet will have two columns, the first column contains the queries and the second column contains their corresponding answers. The input to the model will be a huge amount of data, due to which processing it becomes difficult. Hence Excel sheets are used to organize the data in such a way that increases the readability of the data. Since the model has to be trained efficiently the designer will feed in the possible ways a query can be asked into the dataset. Doing so the model will get trained with many versions of input and hence the accuracy will increase. Figure 6 shows a sample how the data is being prepared.

As shown in the Figure 7, the queries are in column 1 and the answers are in column 2. The designer has included the different possible ways a query can be asked to increase the efficiency of the training.

	Queries	Answers
2	what is integer type?	simple type with distinguished values which are the positive and the negative whole numbers
3	Define integer type	simple type with distinguished values which are the positive and the negative whole numbers
4	Can I know about integer type?	simple type with distinguished values which are the positive and the negative whole numbers
5	I want to know about integer type?	simple type with distinguished values which are the positive and the negative whole numbers
6	what is integer type in vehicle diagnostics?	simple type with distinguished values which are the positive and the negative whole numbers
7	Integer type?	simple type with distinguished values which are the positive and the negative whole numbers
8	Integer type	simple type with distinguished values which are the positive and the negative whole numbers
9	what is record?	one or more diagnostic data elements that are referred to together by a single means of identification
10	Define record	one or more diagnostic data elements that are referred to together by a single means of identification
11	Can I know about record?	one or more diagnostic data elements that are referred to together by a single means of identification
12	I want to know about record?	one or more diagnostic data elements that are referred to together by a single means of identification
13	what is record in vehicle diagnostics?	one or more diagnostic data elements that are referred to together by a single means of identification
14	Record?	one or more diagnostic data elements that are referred to together by a single means of identification
15	Record	one or more diagnostic data elements that are referred to together by a single means of identification
16	Can you tell me about record?	one or more diagnostic data elements that are referred to together by a single means of identification
17	Haii	Hi! How are you?
18	Haiii	Hi! How are you?
19	heyy	Hi! How are you?
20	Hi how are you ?	Im fine. How are you?
21	Hello	Hello! How are you?
22	hello	Hello! How are you?
23	helo	Hello! How are you?
24	Helo	Hello! How are you?

Figure no 7. Sample of Dataset

```
L1 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ what is integer type?
L2 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ simple type with distinguished values which are the positive and the negative whole numbers
L3 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ Define integer type
L4 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ simple type with distinguished values which are the positive and the negative whole numbers
L5 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ Can I know about integer type?
L6 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ simple type with distinguished values which are the positive and the negative whole numbers
L7 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ I want to know about integer type?
L8 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ simple type with distinguished values which are the positive and the negative whole numbers
L9 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ what is integer type in vehicle diagnostics?
L10 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ simple type with distinguished values which are the positive and the negative whole numbers
L11 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ Integer type?
L12 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ simple type with distinguished values which are the positive and the negative whole numbers
L13 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ Integer type
L14 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ simple type with distinguished values which are the positive and the negative whole numbers
L15 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ Can you tell me about integer type?
L16 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ numerical common identifier for a fault condition identified by the on-board diagnostic system
L17 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ what is diagnostic trouble code?
L18 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ numerical common identifier for a fault condition identified by the on-board diagnostic system
L19 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ Define diagnstic trouble code
L20 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ numerical common identifier for a fault condition identified by the on-board diagnostic system
L21 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ Can I know about diagnostic trouble code?
L22 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ numerical common identifier for a fault condition identified by the on-board diagnostic system
L23 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ Tell me about diagnostic trouble code
L24 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ numerical common identifier for a fault condition identified by the on-board diagnostic system
L25 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ Diagnostic trouble code?
L26 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ numerical common identifier for a fault condition identified by the on-board diagnostic system
L27 +++$+++ u0 +++$+++ m0 +++$+++ you +++$+++ diagnostic trouble code?
L28 +++$+++ u0 +++$+++ m0 +++$+++ chatbot +++$+++ numerical common identifier for a fault condition identified by the on-board diagnostic system
```

Figure no 8. Sample of lines.txt file

V.2 Creation of input .txt Files

The model cannot directly input the Excel sheet hence it needs some tool to convert it into a readable form. Hence a separate tool has been developed which will convert the Excel data into two text files which are readable by the neural network model. The tool will give a tag for each query and answer, using these tags the tool will generate two .txt files. The first .txt file called line.txt will have the queries and answers arranged in order. To increase the readability the tool will add tokens to the input. These tokens will be removed during the training by the model. The Figure 8 shows the pattern in which the input is saved in lines.txt file.

As shown in the Figure 8, the 'u0', '+++$+++' and 'm0' are said to be tokens which are added. 'L1', 'L2'...etc. are said to be the line tags. The second generated file is called the conv.txt which will store the tags of the queries and answers in pairs. It creates a mapping of the queries to the answers. The Figure 9 shows a sample of the conv.txt file.

As shown in the Figure 9, the 'u0', 'u2', 'm0', '+++$+++' are all dummy tokens added to the data just to make the data processing easier for the model. '['L1','L2']' is the mapping of the query and answer tags where L1 is the tag for the query and L2 is the tag for the answer. This tagging is done for the supervised learning of the model as it needs labelled input and output.

The chatbot is designed with a Recurrent Neural Network hence the all the input in the data should be of equal size. Hence it will undergo zero padding which will add '<0>' to the data to make the size equal. Then the unknown tokens from the data will be removed to improve the training. Basically the chatbot has two modes training mode and chatting mode. The command used to bring the chatbot into training mode is shown in Figure 10. This command has to be given in the command prompt. The model will start training with the data until all the epochs are over. The process of training the model is shown in Figure 11. The model has completed one epoch and as soon as it is completed, it will select two queries, compare its output with its output, and calculate the loss function as depicted in Figure 11. This process will be repeated until all the epochs are over.

After the training is completed, the parameters will be pickled and saved as a new model. Now after completing the training the chat has to be put into chat mode. To bring the Chatbot into chat mode we use the command shown in Figure 12.

V.3 Results of Chatbot

After passing this command in the command prompt the Chatbot will be ready to chat with the user. The result of the Chatbot for basic greeting questions is shown in Figure 13. The Chatbot gives the answer, which closely matches with the given query. Thus, the Chatbot has to be trained with huge amount of data to get satisfactory output.

```
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L1', 'L2']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L3', 'L4']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L5', 'L6']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L7', 'L8']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L9', 'L10']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L11', 'L12']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L13', 'L14']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L15', 'L16']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L17', 'L18']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L19', 'L20']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L21', 'L22']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L23', 'L24']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L25', 'L26']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L27', 'L28']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L29', 'L30']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L31', 'L32']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L33', 'L34']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L35', 'L36']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L37', 'L38']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L39', 'L40']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L41', 'L42']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L43', 'L44']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L45', 'L46']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L47', 'L48']
u0 +++$+++ u2 +++$+++ m0 +++$+++ ['L49', 'L50']
```

Figure no 9. Sample of conv.txt file

```
In [1]: run main.py --train-mode
```

Figure no 10. Command for training mode

```
[TL] DynamicRNNLayer model/seq2seq/decode: n_hidden: 1024,
in_dim: 3 in_shape: (1, ?, 1024) cell_fn: LSTMCell dropout: None
n_layer: 3
[TL]        batch_size (concurrent processes): 1
[TL] DenseLayer  model/output: 245 No Activation
[TL] [*] Load model.npz SUCCESS!
Epoch [1/50]: loss 0.1145
Query > what is SI ?
 > application robby service identifier
 > im robby type
 > application layer service
 > im robby type
 > im address type
Query > hi
 > hi how are you
 > hi how are you
 > hi how are you
 > hi how are you
 > hi how are you
[TL] [*] Saving TL params into model.npz
[TL] [*] Saved
```

Figure no 11. Training of model

```
In [2]: run main.py --inference-mode
```

Figure no 12. Command for chat mode

```
Enter Query: hi
 > hi how are you

Enter Query: im fine
 > thats nice how can i help you

Enter Query: What is interger type?
>simple type with distinguished values which are the positive and
the negative whole numbers

Enter Query: good morning
 > good morning how are you

Enter Query: im good
 > thats nice to hear how can i help you

Enter Query: can you tell me about record
> one or more diagnostic data elements that are referred to
together by a single means of identification
```

Figure no 13. Output of Chabot

VI. Conclusion

The seq2seq model, which is used in this paper, incorporates the Recurrent Neural Network using Python's TensorFlow, to model prototype and executes Chabot. The prototype has been trained with different volumes of datasets and finally narrowed it down to the optimum working conditions. The greetings dataset and the organizational compound dataset both have been trained and combined together to obtain our resultant Chatbot. The response time of the Chatbot is about 500 milliseconds, which is negligible when compared to a manual search and

respond system. Hence, the developed chatbot model not only automates the process of project query enquiry in an organization but also optimally reduces the processing time of organizational queries.

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