



**REVA**  
UNIVERSITY

Bengaluru, India

**A Project Report on**  
**An Intelligent Conversational Agent with**  
**Text Classifiers**

**Submitted in Partial Fulfilment for Award of Degree of**  
**Master of Technology**  
**In Artificial Intelligence**

**Submitted By**  
**Vinaya James**  
R20MTA11

**Under the Guidance of**  
**Dr. Jay Bharateesh Simha**  
Chief Mentor, RACE & CTO ABIBA systems

REVA Academy for Corporate Excellence - RACE  
**REVA** University  
Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru - 560 064  
race.reva.edu.in

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## Candidate's Declaration

I, **Vinaya James** hereby declare that I have completed the project work towards the **Master of Technology in Artificial Intelligence** at, REVA University on the topic entitled **An Intelligent Conversational Agent with Text Classifiers** under the supervision of **Dr. Jay Bharateesh Simha**, Chief Mentor, Artificial Intelligence, RACE, REVA University. This report embodies the original work done by me in partial fulfilment of the requirements for the award of a degree for the academic year **2022**.

Place: Bengaluru

Vinaya James

Date: 22-10-2022



## Certificate

This is to Certify that the project work entitled **An Intelligent Conversational Agent with Text Classifiers** carried out by **Vinaya James** with **SRN R20MTA11**, is a Bona fide student of REVA University, is submitting the project report in fulfilment for the award of Master of Technology in Artificial Intelligence during the academic year 2022. The Project report has been tested for plagiarism and has passed the plagiarism test with a similarity score less than 15%. The project report has been approved as it satisfies the academic requirements in respect of the project work prescribed for the said degree.

Dr. Jay Bharateesh Simha

Dr. Shinu Abhi

External Viva Panelists

Names of the Examiners

1. Rajib Bhattacharya, Director – Data & Analytics, Cargill
2. Akshay Kulkarni, Manager, Publicis Sapient

Place: Bengaluru

Date: 22-10-2022



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Director, Corporate Training

Place: Bengaluru

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## List of Abbreviations

Sl. No	Abbreviation	Long Form
1	NLP	Natural Language Processing
2	AI	Artificial Intelligence
3	NLTK	Natural Language Tool Kit
4	ALICE	Artificial Linguistic Internet Computing Entity
5	AIML	Artificial Insight Mark-Up Language
6	SVM	Support Vector Machine
7	ML	Machine Learning
8	NB	Naïve Bayes
9	KNN	K Nearest Neighbors
10	DT	Decision Tree
11	LSA	Latent Semantic Analysis
12	gTTS	Google Text to Speech
13	API	Application Programming Interface
14	BOW	Bag Of Words
15	QA	Question-Answering
16	CNN	Convolutional Neural Network
17	DL	Deep Learning
18	WSGI	Web Server Gateway Interface
19	URL	Uniform Resource Locator
20	HTML	HyperText Markup Language
21	PC	Personal computer
22	RDBMS	Relational Database Management System
23	TF-IDF	Term Frequency-Inverse Document Frequency
24	NLG	Natural Language Generation
25	MAD	Michigan Algorithm Decoder
26	IDE	Integrated Development Environment

27	GUI	Graphical User Interface
28	FBR	Fall Back Rate
29	GCR	Goal Completion Rate
30	LR	Logistic Regression
32	MP3	MPEG-1 Audio Layer 3
33	DINA	Dinus Intelligent Assistance

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## **Abstract**

Machines work similarly to humans due to advanced technological hypotheses. The best example is a conversational agent that depends on advanced models in computer science. conversational agents serve as a channel for communication between man and machine. There are many conversational agents and designs available on the market which is working on different functions and can be applied in areas like business, medicine, agriculture etc. The technology used for conversational agent development is Natural Language Processing (NLP). It advances the concepts of Artificial Intelligence (AI), precision and perfection have significantly improved, and conversational agents have become the optimal choice for many organizations. conversational agents available in travel and tourism areas, that gather user searches and it offers suitable search outcomes. Research still occurs in the conversational agent's area to improve customer satisfaction.

The project is an application that allows users to converse with humans using artificial intelligence principles. As a reference implementation, the receptionist role of a university is chosen to demonstrate the proposed solution. The typical questions encountered by the receptionist are collected with the relevant answers. Subsequently, this data is used to model a Question-Answering (QA) System to learn and answer the questions posed by the human communicator.

Among the following classifiers Multinomial Naïve Bayes (NB), Multinomial Logistic Regression (LR), Support Vector Machine (SVM), K Nearest Neighbours (KNN), and Decision Tree (DT), are used to find the best classifier for the conversational agent. With the help of this classifier built a better model to help the students and parents with all the academic clarifications.

Various machine learning algorithms are used to test the suitability of the proposed system, and it has been found that multinomial Naïve Bayes is giving the best results with an accuracy 84%. Subsequently, a conversational agent is developed to demonstrate the utility of the proposed solution with 83% accuracy. The results achieved are encouraging and future directions are to



investigate the ability of the system to work under uncertainty and incompleteness.

***Keywords: QA Systems, Natural language processing (NLP), Naive Bayes Algorithm***

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## Chapter 1: Introduction

A bot is a software system that achieves computerized, robotic tasks which automates the works. It is intended to be the ultimate virtual assistant for entertainment purposes, assisting with things such as answering queries, obtaining driving directions, adjusting the thermostat in a smart home, and playing one's favourite music, among others. Nowadays, conversational agents are used in several sectors. Some of the common industries are, educational, business, games and are also become competitors for several cabin reservation organizations. There are more , medical/health and more conversational agents that can answer by voice, because of technologies like AI, Machine Learning (ML) etc [1].

Conversational agent provides an artificial service, with which it can provide difficult user inquiries of people. That is, conversational agents that communicate via voice are equipped with advanced features respond to people. NLP technology can recognize all kinds of user requirements, and it expands the use of the conversational agent. conversational agents are not time limited and therefore can serve user at any time. Conversational agents provide effective customer service, and due to this, it will highly benefit businesses and societies [2]. Organizations can gain money, as they do not have to pay staff if they use conversational agents instead of employees. That is, conversational agents improve efficiency. A conversational agent is a computer program that performs an online communication using text or text-to-speech technology.

An Intelligent conversational agent with Text Classifiers is an application that converts with people using artificial intelligence. "Eliza", "Cleverbot" and other comparable web applications have been created in the past. This system is an application that responds to a student question. A student's question is usually a conversation. Chat can be done in any format; no format is set to chat with the bot. For this, NLP is used in this project. The system allows users to access information about events associated with the university. To solve questions, the system uses AI and ML. User can inquire about university related activities like

anniversary day date and time, sports day and more cultural events. This saves time for students, teachers and other staff. In addition, the work of employees will be reduced. It is about effective communication between faculty and students.

The university's conversational agent concept is based on Google Assistant, which will respond to students' queries through a web application. User can get answers to their questions by clicking on the link. Conversational agent uses a standard algorithm for extracting data and displaying conversations between a human user and a robot. In majority, the system finds intents or keywords. Apple Siri, Amazon Alexa, Facebook Messenger, WeChat are illustrations of famous conversational agents.

## **Chapter 2: Literature Review**

A review of the relevant literature, also known as a background review, was carried out with the purpose of researching and learning from the results of earlier surveys and studies.

Oh et al. [3] analyses on emotion recognition and classification using AI techniques. In this paper, emotions classification models are trained from numerous labelled data based on Recurrent Neural Network (RNN), Deep Learning (DL), Convolutional Neural Network (CNN). In NLP counselling Linguistic interaction is important and Natural Language Generation (NLG) is used to understand the user dialogues. Multimodal approach is used to recognize emotions. Corpus is collected to study the semantic information of words and characterize it as a vector using the word vector. Thus, the program gathered a synonym lexical intelligence.

Preez et al. [4] paper is on development of a voice recognition chat-bot. If the bot did not recognise the questions from the customer, it will be processed with the help of a third-party expert-system. A text-based web bots are created which is an entertainer for the clients. Here they aimed to build an enhanced system, which is trained not only on text-based but also for voice-based. Setiaji et al. [5] study was related to the conversation between man and machine. Bigram is used to identify the similarity score for input sentences. A database named Relational Database Management System (RDBMS) is used to store the learning of conversational agent. N-gram techniques are used for word extraction from sentences. For comparison and subtraction, input data using Moro phonemes and phonemes like decisive parameters are used. Nearest the match is made with the help of probability analysis. The final statements are sent to an expert system.

Menal's et al. [6] conversational agent developed for healthcare purpose app for Android. Google Application Programming Interface (API) is used to send the messages like text or voice, the customer will only get respective response from

the conversational agent. The classification algorithm used is SVM. To eliminate unwanted words suffixes or prefixes -used the Porter algorithm.

Shinde et al. [7] analysed the dataset by tagging the dataset with an n-gram low dimension demonstration the document content is verified on the site. Term Frequency-Inverse Document Frequency (TF-IDF) matrix  $t$  generates  $S$ ,  $U$ , and  $V$  and finally considered the multiplication of three cosine matrices similarity counts. The conversational agent is created for public health service. The programme used N-gram, TF-IDF and Cosine similarity. Knowledge base is designed to store customer related question and answers. Then the program extracts the keyword from the question using unigram, bigram and trigram to help quickly answer the queries. Dharwadkar's et al. [8] module explains how it converts text to speech, which helps to receive a verbal response. Consequently, it is referred to as a verbal dialogue. There are many text-to-speech APIs in Python. The often known one is Google Text to Speech API (gTTS API). It is a simple program which converts typed text into sound then it will be stored as mp3 file. It supports by a number of languages like English, Hindi, Tamil, French, German.

Suta et al. [9] research results suggest that conversational agents work in three ways steps: understanding natural language input; generation of an automatic, relevant response; and building realistically and fluent natural language responses. The current hurdle in designing artificially intelligent conversational agents lies in the lack of natural language processing in this industry's abilities. Without the ability to properly understand it the content and context of user input the conversational agent cannot generate a relevant response.

In order to provide better business service and outcomes, Nabid et al. [10] presented an AI-based Smart Reception that can authenticate users and communicate with humans in Bangla by replying to university-domain-related inquiries. Automatic Speech Recognition (ASR), Interactive Agent, and Text-to-Speech (TTS) Synthesis are the three components that make up the Interaction Recognition system. The created AI-based system might be a

flexible answer for any domain-specific reception system in charge of providing organised and effective customer support both offline and online. To address the academic needs of the visitors, Ranoliya et al. [11] created a chatbot that uses AIML and Latent Semantic Analysis to quickly and accurately respond to any question based on the dataset of FAQs (LSA).

Dinus Intelligent Assistance (DINA) Chatbot was created by Agus et al. [12] for University Admission Services, a mobile application system called Alpha that makes use of chatbots as intelligent teaching assistants. The system comprises of a cloud-based database (Google Firestore), speech recognition, online services, and an artificially intelligent (smart) chatbot (Dialogflow framework). One drawback was that the chatbot semi-automatically uploaded the course information. The below are some existing conversational agents:

## **2.1 Eliza**

The ELIZA programme was created in 1966 by German Personal Computer (PC) researcher Joseph Weizenbaum and gives users the impression that they are speaking with a real person. It is one of the most well-known chatterbots in computing's annals. Experts reevaluate the client's statements and initiate further investigation by providing a springboard for further discussion. This is a typical idiom utilised by PCs programmes developed between 1964 and 1966 at the Massachusetts Institute of Technology Artificial Intelligence Laboratory. Eliza reinvented herself as a conversation by utilising a technique of substitution called "exemplary coordination," which provided clients with a dream. The original "content" was written in the Michigan Algorithm Decoder (MAD)-Slip, which gave orders for the most experienced way to work together. This let ELIZA process client inputs and take part in a talk based on policies and content headings. The most well-known piece of content, DOCTOR, modelled himself after Rogerian psychotherapist and followed directions to reply to client inputs with non-directional questions. Among the few major efforts, it managed to ace the Turing test [13].

## **2.2 ALICE**

Artificial Linguistic Internet Computing Entity (ALICE) is an award-winning, open-source dialect-specific fake insight visit bot that uses Artificial Insight Mark-Up Language (AIML) to formulate responses to questions. ELIZA provides the power It is powered by ELIZA. It is an open-source conversational agent created by Dr.Wallace that relies on comprehending common dialects and coordinating examples. It was awarded the Loebner Prize three times. Utilizing coordination principles, it responds to the customer's question [14].

## **2.3 Parry**

Parry is a common dialect computer program that re-renders the thinking of a neurotic person. This consideration includes consistent error of second thought procedures - others must be preparing something evil, not risk intentions. In the investigation, specific sectors must be avoided - Parry achieves using a confusing array of assumptions, attribution and “enthusiastic reactions”. Activated moving masses divided into verbal sources of information. Parry was the first to pass the Turing test - it was in the mid-1970s. When human interviewers worked with program using the remote console, they were unable to recognize Parry from a real neurotic person [15].

## **2.4 Dr Siri**

In 2010, Apple created Siri for iOS. It is a savvy person who acts as a tutor and who employs the usual interface for a spoken language to aid in learning. Using Messages, Apple users could consult Siri with any questions or concerns and brainstorm potential solutions. Now Siri improves its compatibility with audio, video, and image files. It can react to information provided by clients in the form of content, voice, photos, and videos [16].

The generic conversational assistants can give information about everything generic to the world, but it cannot help with answers regarding the closed domains like a specific university, hospital, or organizations.



## **Chapter 3: Problem Statement**

The project is an application that allows users to converse with humans using artificial intelligence principles. As a reference implementation, the receptionist role of a university is chosen to demonstrate the proposed solution. The typical questions encountered by the receptionist are collected with the relevant answers. Subsequently, this data is used to model a QA System to learn and answer the questions posed by the human communicator. The project uses a number of algorithms that evaluate questions and respective responses for users. This system answers the student's question. Customers can verbalize in any way they like; no need to follow any format.

The main problems are:

1. The generic conversational assistants do not have knowledge about very specific domain and specific problems.
2. Multiple students cannot be handled by single a receptionist. There will be a delay for getting answers. Receptionist would not be knowing all the answers for the student question, so they have to refer and get the answers from authorities.
3. Provide 24/7 support: Around the clock support would not be available from the university front desk. Otherwise, the university has to employ more than a single person to attend students round the clock.

## **Chapter 4: Objectives of the Study**

The project is to form intelligent conversational agent that can allow a person-to-bot interaction to have an ongoing, interesting, and enriching conversations containing searched information from dataset. Thus, the project created a conversational agent, that may contain a standard database of sentences, simple but relevant answers while chatting. It successfully analyses human input and find mainly relevant keywords with some understanding the context. Digital assistants work with human agents to create user support.

The three objectives of this study are.

1. To develop the corpus for a QA system for a university receptionist.
2. Find the best classifier for conversational agent among algorithms like Multinomial NB, SVM, KNN, Decision Tree and Multinomial LR.
3. Develop a conversational agent using the ML models.

## Chapter 5: Project Methodology

The project is an application that allows users to converse with humans using artificial intelligence principles. Find the best method to build a university question-answering system.

Here use the following methodologies:

### 5.1 Natural Language Processing

NLP is a part of computer world – specifically the division of AI –relating to the capability of computers to recognise text and the voiced phrases likewise as humans. The process of teaching computers to interpret natural language is well known as natural language processing. Computers can interpret structured data such as spreadsheets and database tables, but unstructured data, such as human languages, words and voices, are difficult for computers to understand, requiring use natural language processing.

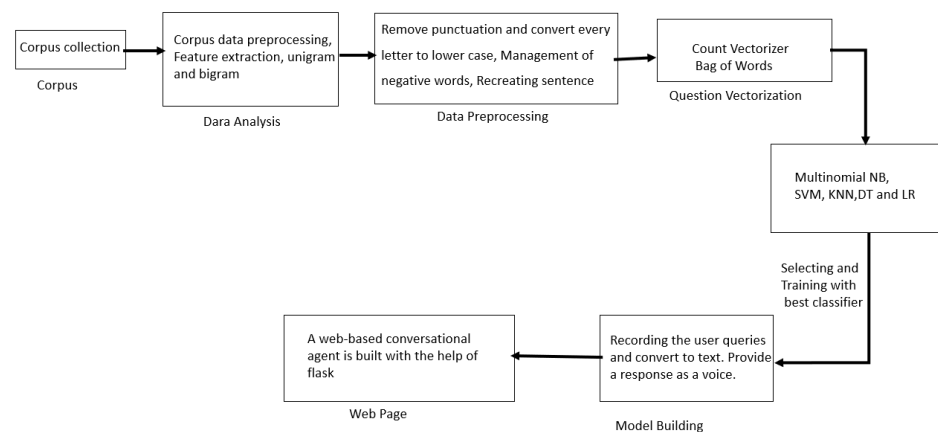


Figure No. 5: The Proposed Solution

Question and answer data are gathered initially and subjected to data analysis, as shown in Figure No. 5. All of the questions have undergone data pre-processing. From the questions, bag-of-words are derived and fitted with Count Vectorizer to the classification model. The classifier model considered are Multinomial NB, Multinomial LR, SVM, Decision Tree and KNN. This leads to the identification of the conversational text agent's best-fit algorithm. Built the conversational agent as a ML based question answer system. The user voice

queries are converted to text and the conversational agent will find the appropriate answer for the respective question. The answers are predicted with the help of respective mapping between index and answers in the dataset. Then the answer is converted to voice response. conversational agent web page is built with the help of Flask.

## 5.2 Naïve Bayes

Conversational agents can be constructed using a Naive Bayes method, in which the training questions is assigned a equivalent answers and label number. The classifier predicts the label of the user response. This label number is the index of the corresponding answer in data frame. Naïve Bayes algorithm is used to create naive Bayes classifiers, which is a set of classification methods. It is a group of algorithms that share similar idea, such as each pair of classified features is independent of the others. Multinomial NB is used in this project.

The Bayes classification method assumes predictor independence. It assumes the existence of one feature in a class which is irrelevant to the existence of any other feature. For example, if the fruit colour is green, round-shaped and about four inches in diameter, it is considered an apple. Though these properties are dependent on each other or on the existence of other properties, each of them donates to the probability that the particular fruit is an apple. That is why it is knows as "naive". Naive Bayes models are easy to build and is particularly suitable for large sets of data. Due to its simplicity, Naive Bayes outperforms even the most advanced classification systems. When it comes to predict the class of the particular dataset, the algorithm is faster. The classifier needs less dataset for training. Naïve Bayes Equation (1)[17]:

$$P(c|x) = \frac{P(x|c)P(c)}{P(x)} \dots\dots\dots (1)$$

Here,

- $P(c / x)$ : Posterior probability of class (c, target) given predictor (x, attributes).
- $P(c)$ : is the prior probability of class.

- $P(x / c)$ : is the likelihood which is the probability of predictor-given class.
- $P(x)$ : is the prior probability of predictor.

### 5.3 Logistic Regression

ML models widely utilizes Logistic Regression. It used vector variables which evaluates the coefficients of each input variable and predict respective word vector. The number of dependent variables in multinomial logistic regression is greater than two, compared to binary logistic regression's two dependent variables. It operates in a manner that is similar to binary logistic regression. The study compares each pair of the result variables in turn [18].

### 5.4 SVM

SVM is an example of a supervised learning algorithm. It is associated with data that may be separated linearly. The "hyper plane" used by the SVM classifier provides a broad space in which to divide data. The classification process is staged to identify the hyper-plane that divides the two classes. The classifier has a Kernel at its disposal. Measurements that transform low-dimensional information space to a higher-dimensional space. This classifier makes it simple to categorise issues that do not have a clear path [19].

### 5.5 KNN

KNN is a supervised learning algorithm. The algorithm is placing a training data, known as feature vectors, in a multidimensional feature space. It calculates the distance (Euclidean distance) between the question and answers. Nearest neighbour is identified for the label [20].

### 5.6 Decision Tree (DT)

A DT is the graphical representation of best possible solution for the provided problem like a tree, its branches and leaves. DT conversational agents are 'rule based'. It uses pre-defined rules to drive the student conversation providing a condition at each step. It studies the historical conversations and comes up with proper answers for the queries [21].

### **5.7 Bag of words with Count Vectorizer**

A data processing method called Bag of Words (BOW) is utilised for text modelling. It lists each word in a text after extracting the words from it. Only the words in that single sentence will be counted, not its sequence or structure. This indicates that it builds a vocabulary from the terms found in the text. The BOW is built using Python *Sklearn*, and the words are fitted into the classification model using *CountVectorizer* [22].

## Chapter 6: Resource Requirement Specification

As part of the project below are the libraries or packages used.

### 6.1 Libraries

#### Data extraction

Pandas are used to get the data from the provided excel sheet with question answers collected as part of data collection.

#### Joblib

*Joblib* is a collection of Python pipelining tools that offers simple pipelining. more specifically. *Joblib* provides particular optimizations for *numpy* arrays and is designed to be quick and reliable with large data in particular.

1. Lazy re-evaluation and transparent disc caching of functions (memoize pattern)
2. Simplified parallel computing

#### Pytsx3

A Python text-to-speech conversion library is called *pytsx3* [23]. It is compatible with Python 2 and 3 and works offline, unlike other competing libraries.

#### Speech\_recognition

A machine's capacity to listen spoken words and recognize them is known as speech recognition. Python uses speech recognition to translate spoken words into text, ask a question, or respond. Speech recognition software library that supports a number of engines and APIs both online and offline.

#### Microphone usage

*PyAudio* is a Python wrapper for *PortAudio*, a cross-platform audio I/O module [23].

The *PyAudio* package is required in order to operate with user voice and speech recognition.

## **Flask**

The Web Server Gateway Interface (WSGI) web application framework *Flask* is compact. With the capacity to scale up to complicated applications, it is made to be quick and simple to get started with. It started out as a straightforward wrapper for *Werkzeug* and *Jinja* but has since grown to be one of the most well-liked Python web application frameworks. The primary object is the flask object, which implements a WSGI application. The application's module or package name is supplied to it. Once constructed, it will serve as a central repository for the view operation, template settings, Uniform Resource Locator (URL) guidelines, and many other things [24].

### **Rendering Templates**

All different types of text files can be created using templates. The main output for online apps will be HyperText Markup Language (HTML) pages, while markdown, plain text for emails, and other outputs are also possible. The `render_template()` method is available for rendering templates.

### **Request**

Based on the environment it obtained from the WSGI server while handling a request, the *Flask* application constructs a *Request* object. Due to the fact that a worker (which can be a thread, process, or coroutine depending on the server) only handles one request at a time, the request data can be regarded as global to that worker for that request.

### **Redirect**

Redirecting users to a specific URL and assigning a specific status code is possible with the help of the *Flask redirect* utility, or function. A response object is returned when this function is invoked, and the destination location with the specified status code is redirected.



## 6.2 Software/Hardware requirements

Table No. 6 provide the minimum software/hardware requirement for a conversational agent.

Software/Hardware requirements	
OS	windows 7+
Memory	512MB
Storage	50MB
Soundcard	Microphone/Headset required for capturing voice commands
CPU	Intel Core2 Duo E8300 @ 2.83GHz or AMD A10 PRO-7800B APU
Graphics card	NVIDIA GeForce 510 or AMD Radeon R5 235

Table No. 6: Software/Hardware requirements

## Chapter 7: Software Design

The suggested model required the below inputs:

1. Questions
2. Answers
3. Serial Number (Label)

After the data pre-processing, multiple classifiers are used to train the model. Text vectorization techniques are used which will convert the text into finite length vectors. With the help of this mechanisms map the questions, answers and labels for the conversational agent. In order to map the replies, user speech requests are recorded and converted to text. The appropriate response are provided as voice response once the model has identified the questions. Software design is presented in Figure No. 7.

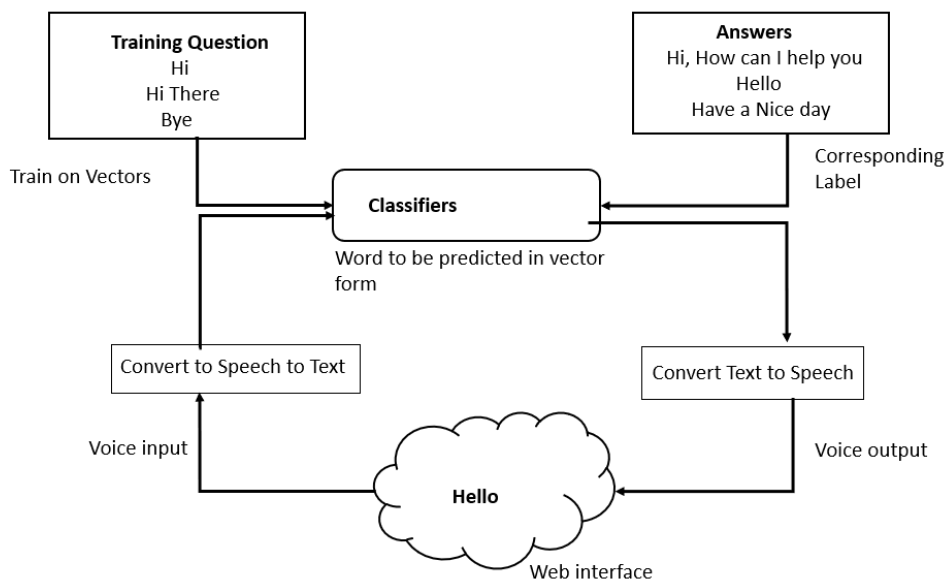


Figure No.7: Software Design

## Chapter 8: Implementation

The implementation of conversational agent is discussed in this session.

### 8.1 Dataset

Data is collected with the help of university authorities and students. Initially collected around 300 general questions which regularly comes to the university receptionists and authorities. Then the questions are categorized as Admission, HR, Hostel, ERP support, Academics, Examination, UG courses, Certificate/Diploma/PG Diploma, Ph.D. and RACE. Collected the answers with the help of professors and developed a corpus with appropriate answer for each question.

N-grams are prevalent in natural language processing. Text-suggestive functions in messengers or search engines are commonplace now. Below are the procedures used for the data analysis:

1. Dataset exploration: Data visualisation and statistical methods as the first stage in data analysis to define dataset characterizations, such as size and composition.
2. Extracting features: Frequency of each word and the most common words in the dataset and Question will be converted to a bag of words with the *CountVectorizer*. Split data into training and testing set
3. Initial data processing steps: Remove Punctuations and change all words to lower case. Anti-spam and anti-hate speech detectors improve the social media experience. In order to acquire their well-deserved reputation for dependability, all of these qualities depend on n-grams. When  $n=1$  it is a Unigram, and when  $n=2$  it is a Bigram.

### 8.2 Determine the optimal classifier

With the help of multiple classifiers built a ML based text conversational agent that can help the students and parents with the general academic inquiries. After developing conversational database and data pre-processing, created bag of

words with the help of count vectorizer. The classifiers are trained with vectorized questions and answers.

Here used Multinomial NB, SVM, Multinomial LR, KNN, and Decision tree to compare and find the best model for text conversational agent. The following is the algorithm for this function:

*Step 1:* Input the corpus:

*Step 2:* Check for Null values in the corpus

*Step 3:* Build the following functions to pre-process the question in the corpus.

3.a: Remove punctuation and convert every letter to lowercase

3.b: Management of negative words

3.c: Recreate the sentence

*Step 4:* Finally assign the newly constructed questions to list, to train the model, along with respective labels and answers.

*Step 5:* Create a function that will call all the functions created in *Step 3*.

*Step 6:* Convert questions using *CountVectrozer* to BOW format.

*Step 7:* Train the vectors using any of the following classifiers: DT, SVM, LR, NB, and KNN.

*Step 8:* Create a chat utility that interacts with the user until the user presses "quit."

8.a: The bot initiates the chat

8.b: By invoking each of the functions in *step 5*, the user queries will go through pre-processing.

8.c: The chosen classifier in *Step 7* then begins predicting outcomes by giving each response a label.

*Step 9:* Start the conversational helper program.

### 8.3 Development of conversational agent.

*Countvectorizer* and model will be saved as a pipeline with the aid of *joblib*, once the optimal model has been determined. With the use of speech recognition, each user query received via the microphone will be logged and identified. The following is the algorithm for this function:

*Step 1:* The Voice bot greets the user and introduces herself.

*Step 2:* A bot prompts the user to speak and a listen function is enabled

*Step 3:* The bot is able to understand the user's commands since it listens to them [using the listen function provided earlier].

*Step 4:* The Listen function transforms the voice of the user to text.

*Step 5:* Text-based predictions are made with the help of a Multinomial NB classifier.

*Step 6:* Bot then verbalizes the forecast [using the speak function built above].

*Step 7:* The Bot will ask the user to repeat themselves if they are unable to speak or are not fully audible. This loop repeats until Bot is able to comprehend the user's words.

*Step 8:* Bot terminates the communication when a user requests to 'Exit' or 'Quit' the conversation.

#### 8.3.1 Conversation Module

The classifier and *bow\_vectorizer* *joblib* models are loaded and passed to the class named *ChatBot*. Here the user speech is recorded and converted as text with the help of *speech\_recognition* and *pytsx3*. *PyAudio* is used to play and capture audio from the user. For the voice synthesis engine, the *pytsx3 init* function is utilized. The answer of conversational agent is saved as MPEG-1 Audio Layer 3 (MP3) file. The engine's *Say* method passes the spoken input text. The voice commands are processed using the *run-and-wait* mechanism. When only a certain portion of the audio from the audio data is desired, such as the first five seconds, the duration parameter must be set to 0.5.

Microphone instances are created. It's challenging to consistently obtain data devoid of noise. All audio recordings have some level of noise from the beginning, and this unmanaged noise will have an impact on how accurately the speech recognition system works. The *adjust\_for\_ambient\_noise* function of the Recognizer class offers a solution to this issue. To capture input, use *listen()* method in conjunction with the context manager (microphone).

The user question will be saved as a Waveform Audio File Format i.e. *.wav* file using *get\_wave\_data()*. Recognizing user voice from an audio source requires the Google Web Speech API *recognize\_google()*. An *UnknownValueError* exception is raised by the API when audio cannot be converted to text. Always use try and except blocks to enclose API calls so that this exception can be handled. The respective answers will be mapped, and the responses are converted as voice and delivered as output.

### **8.2.1 Web\_browser Module**

Now, using the *Flask* web-based framework, write a new file called "*script.py*" to receive the user's inquiry and forecast their response. It should be noted that directories named static, templates, and script.py files must be created before creating a Flask application.

1. A subfolder named *css*, *js* and *images* are seen in the static folder. *.css* files with the name *style* can be found in the *css* folder.
2. HTML page with the name *sucess.html* under the templates folder.
3. A *script.py* file to run the flask application through an Integrated Development Environment (IDE).

The default entry point for the application is located at *@app.route('/')*. The trained model is loaded, and a Graphical User Interface (GUI) is then used to forecast the conversational agent's answer. Figure No. 8 depicts a conversational agent interface.



BOT

Figure No. 8: Conversational agent interface

## Chapter 9: Testing and validation

As part of testing, the application undergone hundreds of questions from university data set and manually cross verified the answers provided by conversational agents. Our initial dataset consists of 638 questions, to which the application provides extremely precise responses. From the initial dataset, derived around 3000 augmented questions. The application is validated with the augmented questions and manually cross verified respective answers Figure No. 9.1.

Model is trained with the initial dataset that is 638 questions. The effectiveness of conversational agents is validated using a human evaluation method. The human review has obvious benefits since people can judge whether or not conversational agent responses are reasonable and realistic. However, many autonomous metrics have been presented as an alternative to costly human review techniques. The grammatical complexity of natural languages and the diversity of possible answers make automatic systems inadequate for achieving meaningful and reliable evaluations. The validation is performed with 305 augmented questions. The accuracy and analysis report are in chapter10.

---

```
Hi, I'm a bot,How can i help you?
hi
Hi there
how are you
Good, tell me..
I'm not able to connect to the admission department.
You can write to admissions@reva.edu.in. One of our admission counsellor will contact you at your registered mobile number
What are the courses that are offered?
Computer Applications, Arts and Humanity, Law, Architecture, Management, Certification program
Computer Applications courses are offered in the university.
Bachelor of Computer Applications (BCA)
The arts and humanity courses are offered in the school.
1. BA in Political Science, Economics and Journalism
2. BA in Journalism, English and Psychology
3. BA in Tourism, Journalism and History
4. BA in Journalism and Mass Communication
5. BA in Performing Arts, English, and Psychology
Law courses are offered in the University of Georgia.
1. Bachelor of Arts and Bachelor of Laws (B.A., LL. B. Honours)
2. Bachelor of Business Administration and Bachelor of Law (BBA., LL. B. Honours)
The courses in architecture are offered in the university.
Student will have to select one open elective subject in a semester from any stream.
The architecture courses are offered in the University.
Bachelor of Architecture (B. Arch.)
```

Figure No. 9.1: QA system

Better classifier is identified on the text classifier function, based on it a conversation agent is built. Human review is performed on speech to text functionality to identify the performance of the conversational agent. The



conversational agent is validated by 10 engineers and manually cross verified with respective answers. The same is depicted in Figure No. 9.2.

```
127.0.0.1 - - [13/Oct/2022 16:38:59] "POST /chatbot HTTP/1.1" 200 -
user response recording started...
finished recording
user: is the university from airport
BOT: 20 km
user response recording started...
finished recording hh
user: is the application timeline for admission
BOT: The application have varied timelines. For details www.reva.edu.in
user response recording started...
finished recording hh
user: what is a criteria for engineering G
BOT: Passing in PUC / 10+2 examination with Physics and Mathematics as compulsory subjects along with one of the Chemistry / Biotechnology / Biology / Computer Science / Electronics / Technical, Vocational subjects and obtaining at least 45 % marks (40% in case of candidate belongs to SC/ST category) in the above subjects taken together, of any Board recognized by State Governments / Central Government / Union Territories or any other qualification recognized as equivalent there to. Getting a high score in REVA University Common Entrance Test (REVA CET) or K-CET / COMED-K or any other equivalent examination conducted by recognized Institute / Agency.
user response recording started...
finished recording hh
user: how is the security arrangement in campus
BOT: The University has installed CCTV cameras. Digital screening is mandatory for all visitors who visit the campus. There is 24 hours security provided for all students in campus.
user response recording started...
finished recording hh
user: is there a food court in campus
BOT: There is a modern multi cuisine food Court with comfortable seating capacity and is located in the heart of the campus. The multi cuisine food comprises of a veg south Indian food, Andhra non veg cuisine, Nonveg grill, Veg and Non veg Pizzas, Pan Asian food, Tea, coffee, cold drinks, healthy juices, Pastas, veg and non veg sandwiches, top of the line bakery, mouthwatering chats and Ice-creams.
user response recording started...
finished recording hh
user: what is the minimum score in GRE
BOT: No, admissions from JEE Mains percentile score is not considered.
user response recording started...
finished recording hh
user: pick you test that come to prepare University
BOT:
    Deloitte
    Dell EMC
    IBM
    Philips
    TCS
    Berger
    Infosys
    Amazon
    Juspay
    Karvy
    KPMG
    HP
```

Figure No. 9.2: Conversational agent system

## Chapter 10: Analysis and Results

The data analysis of corpus is conducted with the help in N-gram method. The frequency of a word in a unigram depends on all the other terms in the dataset. The probability of a word occurring is independent of the words that precede it. Figure No. 10.1 depicts unigram representation of RACE-related questions.

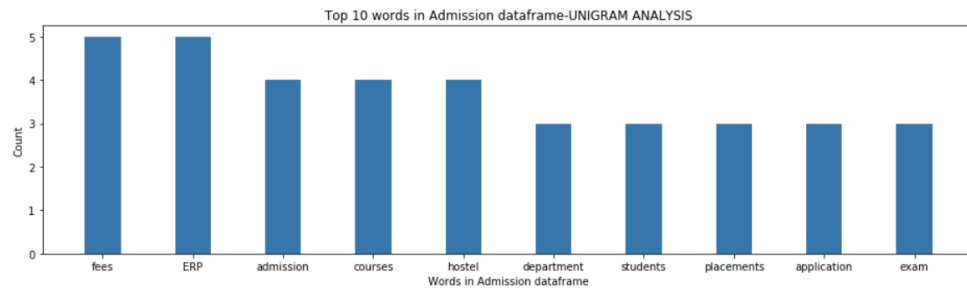


Figure No. 10.1: Unigram representation

In Bigram, each occurrence of a word is assumed to depend only on its preceding occurrence. This means that we are counting these two words as one gram. Figure No. 10.2 depicts bigram representation of RACE-related questions.

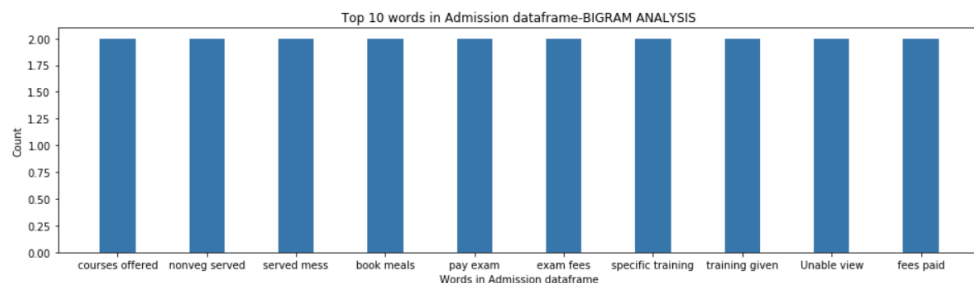


Figure No. 10.2: Bigram representation

Data sparsity is a problem for higher order n-grams [25]. This can make them less useful because so many are not seen. Without more data, it is hard to figure out how the real data is spread out. The N-gram analysis aids in the discovery of relevant keywords. The results can be used in content strategy development and improvement.

Keeping the smoothing amount low will yield better performance. This is because the lower ones make it easier to comprehend the data. The counts are

indicative of the actual data, but the smoothing is similar to a "prior belief". Over smoothing is the equivalent of discarding the data entirely! As a result, the likelihood of every given unigram is maximized.

The conversational agent is implemented to help the academic needs of students and parents. The conversational agent is based on Multinomial NB, this will help the students to fetch the information's like Admission, Fees, Accommodation, Program, and other academic activities of university [26]. The project has cross checked each classifier and its accuracy of answers to find the best classifier for the conversational agent.

When a conversational agent does not know the correct response to a message, it uses fallback responses. Monitoring their rate of recurrence, i.e. Fall Back Rate (FBR) [27] , and the user messages that elicit them might assist to identify the incorrect placement of the conversational agent (non-relevant user expectations) and/or problems in the NLP engine.

True Negative Rate [28]: In conversational AI, accuracy is measured by the proportion of times that the conversational agent responds correctly. On the other hand, out-of-scope accuracy detects when the conversational agent knows which topics it is not trained on and follows the proper behaviour (i.e., escalation to a human agent or diverting to another channel) rather than speculating a response. Table 10.1 depicts the accuracy and FBR for all the classifiers.

<b>Classifiers</b>	<b>DT</b>	<b>SVM</b>	<b>NB</b>	<b>LR</b>	<b>KNN</b>
Correct Answers	127	253	255	203	68
Wrong Answers	178	52	50	102	237
Total	305	305	305	305	305
FBR	58%	17%	16%	33%	78%
Accuracy	42%	83%	84%	67%	22%

Table No. 10.1: FBR and Accuracy of classifier models

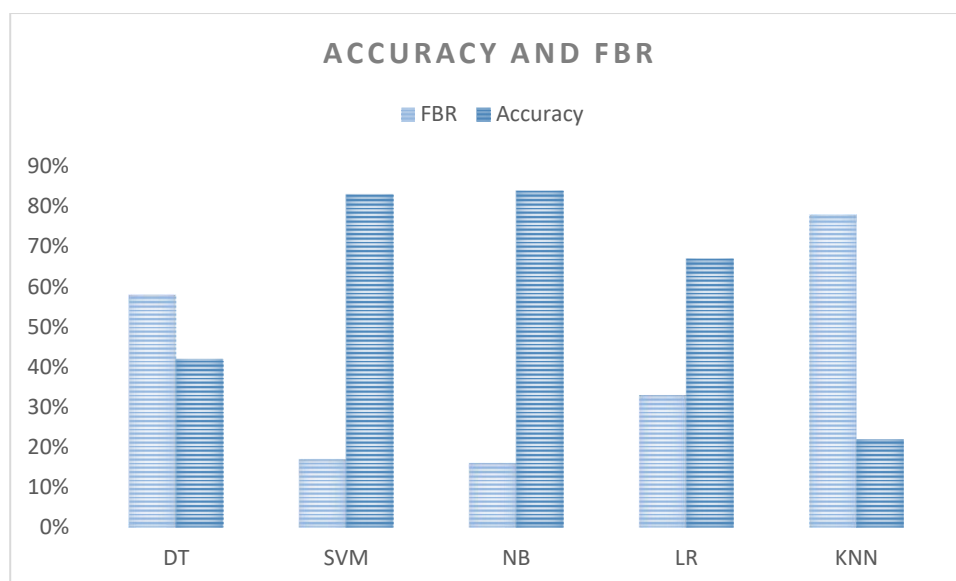


Figure No. 10.3: FBR and Accuracy of classifier models

The FBR increases if the conversational agent is put incorrectly, or there may be a problem with the NLP engine if the conversational agent does not comprehend the user's intent. From the Figure No.10.3, Multinomial NB classifier provides the best accuracy 84 % value and low FBR 16% value than rest of all classifiers. Thus, Multinomial NB works in favour of data analysis and gives better results for the conversational agent.

The conversational agent speech-to-text conversion is validated, and the results are provided in Table 10.2.

Test Engineers	Engg . 1	Engg . 2	Engg . 3	Engg . 4	Engg . 5	Engg . 6	Engg . 7	Engg . 8	Engg . 9	Engg . 10
Correct Answers	272	308	288	304	300	296	306	284	303	301
Wrong answers	53	17	37	21	25	51	19	41	22	24
Total	325	325	325	325	325	325	325	325	325	325
Accuracy	84%	95%	89%	94%	92%	84%	94%	87%	93%	93%
<b>Average accuracy</b>	<b>83%</b>									

Table No. 10.2: Conversational agent accuracy

The conversational agent provided an average accuracy of 83%. The accuracy of the proposed solution is significantly impacted by the accents and pronunciations of the individuals.

## **Chapter 11: Conclusions and Future Scope**

Artificial Intelligence conversational agents are widespread for web related services for systems like research, showbiz, business organizations, and academic world. It provides real human-computer communication, which will take place by asking queries by the user to respond with suitable answers. This project is to develop an interactive conversational agent for university environment using multiple classifiers. Though the system performed well in the test, but it is not too efficient when it comes to other classifiers.

In future work, conversational agents can mix with ML and LSA. With the help of LSA customers can interact with the conversational agent in real-world human conversation. The dialogue can be improved by adding and altering patterns and templates for general student inquiries using ML and correct replies are given utilizing LSA.

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## Appendix

### Plagiarism Report<sup>1</sup>

An Intelligent Conversation Agent with Multiple Text Classifiers

#### ORIGINALITY REPORT

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## GitHub Repository

<https://github.com/vinayasandhiav/Conversational-Agent>