

# ADiTi App: Leveraging Deep Learning and Generative AI for a Chatbot Application with Deep Belief Networks

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**Abstract:** A chatbot is an application that can chat with people by using AI. Nowadays, a lot of people have used the chatbot for conservation purposes because of time-saving and getting a fast reply. Sometimes Students or parents visited the university to collect information as the admission process, fee structure, and campus view, etc. This process is too time-consuming, so ADiTi App a generative AI based chatbot system is developed for MIT ADT University. In this paper, the concept of Natural Language Processing(NLP), Artificial Intelligence(AI), Machine Learning(ML), Dialogflow, and communicate tool has been used. This chatbot increased the performance and accuracy results in **96%** in answering the questions asked by the user either in the form of voice or text.

**Keyword:** Chatbot, GenerativeAI, NLP-Natural Language processing, KNN- k-Nearest Neighbors, DBN-Deep Belief Network.

## 1. Introduction

Chatbot's are computer programs that interact with users using natural languages. This technology started in the 1960's [17]. The chatbot is important for everyone because it's time-saving and fewer efforts. We can access the information of college easily because of Chatbot. We can access the information about the courses, fee structure, duration time, campus view, etc. there is no need to visit the university, colleges, or school. All the needed information has immediately available. Generally, in every Universities staff is used to handle requests of all queries asking from students. In the Covid19 pandemic, when the teaching becomes virtually, the same way its admission process, inquires and other tasks became virtually due to lockdown, hence it increases the problem of handling this duplicate inquiry from thousands of students to universities with few staff members. So to tackle this problem, Artificial Intelligence based Chatbot can play a very crucial role to handle such a high number of students request against

traditional methods like over-call discussion, by visiting universities. Today NLP is highly used to solve the problems between Chatbot and human language's also used for text and speech processing which, helps to better reduce, high categorization and classification of intents and entities to give more accurate results. DNN is a branch of artificial intelligence, where it uses a neural network to predict the best outcome over huge data by separately passing its neurons and through multiple hidden layers where it is extracted to the best possible outcome.

## 2. Literature Survey

Addi alt mlouk et al. [1] proposed a Kbot chatbot by using machine learning and natural language understanding. This chatbot handles different tasks as analytical queries, FAQ .etc NLU is used for speed recognition, and NER (Named entity recognition) used for extracting the query. This model used a support vector classifier for classification. The KE (Knowledge extraction) is used to recognize the main topic.

Bushra kidwai et al. [2] presented a system that work on healthcare application used machine learning, decision tree, and NLP algorithm. NLP is used to understand user intent. The decision tree is used for the accuracy of diagnosis. NLP language is good for chatbot. Accuracy based on the human doctor and bot responses. Response time depends on the number of symptoms.

Dr.S.priyadarsini et al. [3] proposed system that used a linear Regression algorithm with deep learning to make a smart chatbot. Jonam takes the user input from voice or text. They used by pyaudio module of python Lang for voice input or text input. DNN is used for building Neural Networks.

The voice recognition is using the Jonam voice assistant that is designed in such a way that users can get information

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from the internet through user voice command. User can give their own training data to train the Jonam so that can more reliable to the user.

Gkrishna Vamsi et al. [4] in their work developed a new method using a deep neural network for a chatbot. They use a dataset from the Kaggle website. NLP is used for tokenizing the pattern. In the future current advanced development in the neural network including Deep Brief Network, RNN, DeepCNN, etc. Accuracy of different optimizer algorithms as SGD, Adagrad, AdaDelta, RmsProp Adam. SGD is provided good accuracy.

Bhavyasri kadali et al. [5] developed a system by using IoT, NLP, and machine learning for home automation chatbots. In this chatbot they use text chatbot application and voice assistant. NLP module and speech recognition on the module is used in this system. Python NLTK library used for a chatbot. This system uses deep learning technology for a chatbot.

Neelkumar P. Patel et al. [6] presented a chatbot system that is developed for the university. This system uses artificial intelligence and machine learning technology for the university Chatbot. PHP, HTML, CSS, and jquery are used in development. Ajax is used to call and get responses from PHP files. The bot's name is UNIBOT. Easily collaborate and got the information fastly. This chatbot is not used the NLP language. Natural Language Processing (NLP) can also be integrated to enhance the chatbot in future work.

Hiroshi Honda et al. [7] proposed a model to build a question answering system by using deep learning, neural machine translation (NMT), and word2Vec training. Prolog-like system is used for symbolic processing they used google News-vector-negative 300 trained dataset. Word2Vec is good and handles unknown data. Symbolic processing to analyze large-scale data present on the web.

rupesh singh et al. [8] ,this system is used TensorFlow for developing the neural network model of the chatbot and used NLP technology. This chatbot is used for small businesses or industry etc. Accuracy is based on question and answer. Calculated probability through Intent.

Lucia Vaira et al. [9] developed a “mamabot” chatbot by using machine learning and NLP to support pregnant women mothers and emergency services. Increases the number of intent for more efficient results. To improve the number of intents for testing and training purposes.

Rashmi Dharwadkar et al. [10] proposed a chatbot in NLP technology for medical purposes. This chatbot used the features of google API, voice text, and text-voice conversion. This chatbot is a developed web-based platform is analyzing customers' sentiments. SVM algorithm is used to predict the disease. In the future, it will be used as voice

and face recognition to interacting with the patient at deeper levels.

Minghui Qiu et al.[11] proposed Alime chat model is developed for industrial application. This system uses three models as the IR model, generation-based model, and reranks model. This chatbot provided online services that support not only chatting but also customer services(e.g. sales, shopping guide, book, etc.) Mean probability, cross-entropy and harmonic mean these are used to check the performances of response for each testing question.

Anbang xu et al.[12] developed the chatbot by using deep learning for customer services on social media. Deep learning techniques used to mapping from sequences to sequences. LSTM is that it can be stored sequential information. chatbot affect the relationship between users and brands in a long term. Appropriateness, Empathy, Helpfulness are to check the quality response performances.

Bhavika R. Ranoliya et al.[13] proposes a chatbot for university-related FAQ(frequency asked question) by using the AIML query (artificial intelligence markup language). The AIML consists of three types as atomic categories, default, recursive categories. There is no need to visit the University personally. All the queries and information are available on the chatbot.

Mengting Yan et al.[14] proposes a serverless chatbot in this some levels are present as audio i/o converter, the text I/o, abilities. Security is the issue in this serverless chatbot. open whisk is an open-source serverless platform. this system is implemented six abilities as News, jokes, date, weather, music tutor, alarm service to improve the extensibility of chatbot.

Bayan abushawar et al.[15] presented a study for the overview of the ALICE chatbot by using AIML(artificial intelligence markup language) techniques based on the corpus approach. ALICE chatbot in terms of the knowledge base and its pattern matching technique. pattern matching technique is based on finding the best, Longest, pattern match. A chatbot could be used to visualize a corpus, to learn/practice English, Arabic, Afrikaans, or other

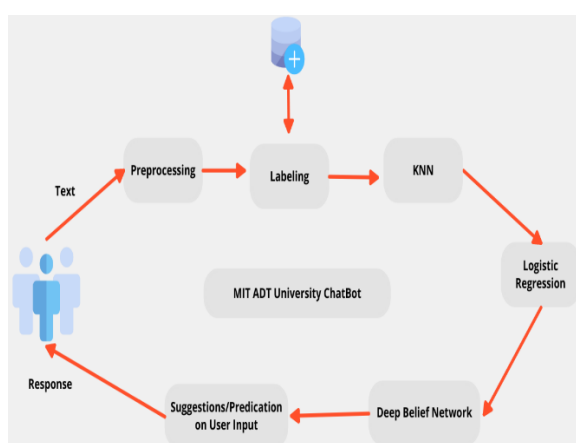
Jiyou jia et al.[16 ,17] works on an English learning chatbot by using NLML(natural language markup language) for input text transformation. NLML is obtained from the user text into NLOMJ(natural language object model in java ), NLDB, GTE these techniques are used. This system provided English learners with a virtual partner. It generates communicative response according to the user input, calculates the performance of Dialogue duration.

Abid Haleem, et al [18], in their research work presents the study of ChatGPT as a very significant NLP support tool for the the large language model to generate and summarize text.

The literature review shows that KNN, Naive Bayes, decision tree and SVM are the best classifiers for a chatbot. The study of different work-related to chatbot shows that RNN, LSTM, DBN (Deep Belief Network) and CNN are good algorithms for training of chatbot. In many research work python library is used for speech recognition. And CNN technique for images processing. RNN and LSTM algorithms are best for time series data analysis. In this proposed system the DBN algorithm is used as it reduces the training complexity and makes deep learning more feasible.

### 3. System Architecture

In this system, Chatbot will be integrated into the University website where Chatbot UI will take user inputs and passes them to the backend. It extracts the intents and searches them in the knowledge base for all possible responses against user input based on tags in intents.



**Fig 1:** Hybrid System Architecture

Once the system got the intents with the possible responses, then it pass them to categories and classify them as per domain needs, to ensure to get only response that is relevant and can give more accurate results from the whole list of the response. It also uses as an abstraction layer here. To predict the best possible output it will use DBN algorithms to get the response which is having a high prediction score and provide that response back to Chatbot UI.

### 4. Dataset

This chatbot provided the courses, fee structure, admission process, placement information, etc to the end user so these types of tags, patterns, and responses are created in the dataset.

To create the dataset all information is taken from the college website in which 16 labels of data and around 324 message records are maintained. Model is trained and tested on this custom made dataset using python libraries.

The Message, label, synonyms of labels, intents, TF-IDF score, semantic similarity, user rating, human handover rate are attributed and used in the dataset.

### 5. Proposed Algorithm

To implement a chatbot system many components are required to transform unstructured data into a structured classified dataset, and to resolve the confusion rate in between responses generated and data provided also a mechanism is required for ranking of the score. In case of supervised machine learning algorithm it required labeled dataset in structure format, for feature selection principal components analysis (PCA) algorithm is used. Many times auto encoders are used for restructuring of the missing values in the dataset, as improper data can lead to false responses to users query . Data mining classification and categories algorithm can be used to make it relevant to user responses by as per their labels.

This chatbot used three algorithms are as follows:

1. KNN algorithm
2. Logistic Regression algorithm
3. Deep belief Network algorithm

#### Preprocessing:

In the preprocessing of some NLP commonly used terms are tokenization, pos-tagging, stop word, stemming and entity extraction, etc.

#### Tokenization:

Tokenization means to separate a piece of text into smaller units. Example of admission for computer engineering as an intent so it provides the token as "admission", "computer", and "engineering".

#### Pos-Tagging:

In the pos(Part of speech) tagging converting to in the form as Noun, adjective, verb, adverb, etc.

For example in the query for admission in computer engineering, the sentences contains "admission" -Noun "computer" - Noun and "engineering" - Adjective.

#### Stop Word:

Stop words means set of commonly used in english word as "a", "an", "the", "for", "when" etc. In our example "for" is a stop word. The stop word is performing the specific task as to remove all words which are required to filter out in intent.

#### Stemming and Entity Extraction:

Stemming is very important in any NLP based system.

It is provided to remove the suffix from a word and reduce it to its root word.

**Table1:** Sample Question Answering Table

Tag	Patterns	Responses
Address	"what is address of University", "where is MIT-ADT University", "Is it in Pune", "what is address of University"	"MIT Art, Design Technology University, Pune, INDIA Rajbaug, Loni Kalbhor, Pune - 412 201, India."
Fee	"what is fee for Undergraduate every year", "what is fee for Post-Graduate every year", "what is fee for Doctoral degrees every year"	"Fee for students are 1 lac per every for a duration courses".
list of courses	"List down courses", "tell me which courses are available at?"	"we are providing Undergraduate, Post-Graduate and Doctoral degrees in Art, Design, and Technology"
awards	"which awards are recived to MIT-ADT University"	"Awarded as 'Best University Campus' by ASSOCHAM of India, NITI AYOJ, IIT BOMBAY"

In the example of admission for computer engineering query the words "admission"- admit,

"Computer"- computer, and "engineering" -engineer as a like process of steaming then entity extraction.

**KNN algorithm:**

KNN algorithm follows the supervised learning approach for fast classification and prediction. Hence in this system KNN classifier is used to find the nearest distances between two intent and many more by using Euclidean distances.

$$Euclidean\ Distance(x, xi) = \sqrt{\sum (xj - xij)^2}$$

The KNN algorithm has the responsibility of assigning labels to user queries at the start of the chatbot system. Once labels are assigned to user queries so need to find the best possible response from similar responses. Let's say "admission in Computer engineering" for this user query, FastKNN algorithm assigned label as "courses". Here chatbot system is confused about how to respond to a user query when it's having multiple responses for the same query like "Admission in diploma for computer engineering",

"Admission in BE for computer engineering", "Admission in diploma", "Admission in BE", "Admission in ME", "Admission in Ph.D." and many more.

**LR-Logistic Regression:**

Logistic regression used as a supervised learning algorithm and work with continuous data as well as discrete data. It fit the line as maximum likelihood of data. It is simply trying to convert the independent variable into an expression of probability that ranges between 0 and 1 with respect to the dependent variable. Logistics regression is used for classification as well as regression on categorical data.

In this system, the logistic regression algorithm takes its part to assign labels with their weights based on similarity score [19].

$$p(x) = \sigma(t) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x)}}$$

It also classifies the query responses with the Tf-IDF algorithm based on a knowledge base where all user conversation histories are stored which is helpful to identify user conversation flow where human intervention rules are set for user responses.

**Deep Belief Network (DBN):**

RBN algorithm is a classifier as well used for prediction in many systems. It is restricted in terms of the connection between the visible and hidden units. RBN has some limitations as they are not as familiar with the backpropagation algorithm and training is more difficult hence DBN is used in the proposed system.

DBN is a deep learning algorithm it is divided into two major parts first one is multiple layers of restricted Boltzmann machine to pre-train our network and the second one is a feed-forward back propagation network that refines the result from the RBN stack.

In this system, it has added many features for query responses, like TF-IDF score, similarity score, logistic algorithm weights, Semantic similarity.

The total energy of the joint configuration of the visible and hidden units (v, a) is given by

$$E_{va} = -\sum_p \rho, qvpaqWpq - \sum_p vpdp - \sum_q aqgq$$

Where,  $p$  represents the indices of the visible layer,  $a$  represents layer of binary hidden units,  $q$  represents indices of the hidden layer, and  $wp, q$  denotes the weight connection between the  $p$ th visible and  $q$ th hidden unit. Further,  $vp$  and  $aq$  denotes the state of the  $p$ th visible and  $q$ th hidden unit, respectively,  $dp$  and  $gq$  represent the biases of the visible and hidden layers.

The first term,  $\sum_p \rho, qvpaqWpq$  represents the energy between the hidden and visible units with their associated

weights. The second,  $\Sigma v p d p$  represents the energy in the visible layer, while the third term represents the energy in the hidden layer.

At every hidden layer, it checks for the best possible response from a set of responses. During calculation, it takes above score while calculation of sigmoid activations weights. During calculation, it takes above score while calculation of sigmoid activations weights and take similarity score of responses against user query then pick the output and provided the prediction.

### Data Flow Diagram

In this system first, the user asks the question in form of text or voice then the query is passed to the backend after that preprocessing starts. In the preprocessing some NLU terms are used as tokenization, pos-tagging, stop word, steaming, etc. All these processes come in preprocessing then next the intent pass to the k-nearest neighbors algorithm.

In the KNN algorithm first do get the synonyms of labels or categories then if it is found in synonyms then assign the label to it and do fast labeling of training dataset and pass to logistics regression.

In logistics, regression gets the training and testing dataset from KNN After that get the similarity score between patterns and assign the similarity score to the dataset for each unique pattern. Then correct labeling and pass it to the DBN algorithm. DBN algorithm took the trained dataset by logistics regression and then predict the accuracy and response time of intent after that response passes to the user input and see that response.

### 6. Result and Discussion

This chatbot is used for the University purpose, as per the figure shown in fig 2a and 2b using Dialogflow and Kommunicate for gives clear and explicit control over a conversation.

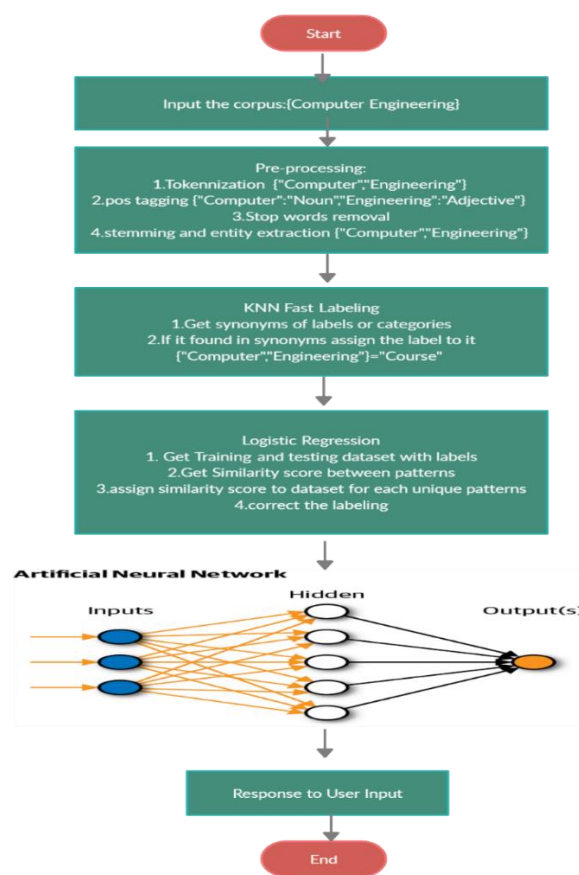


Fig 2a: Data Flow Diagram

Kommunicate powered chat plugin to add to a website that integrates well with Dialogflow.

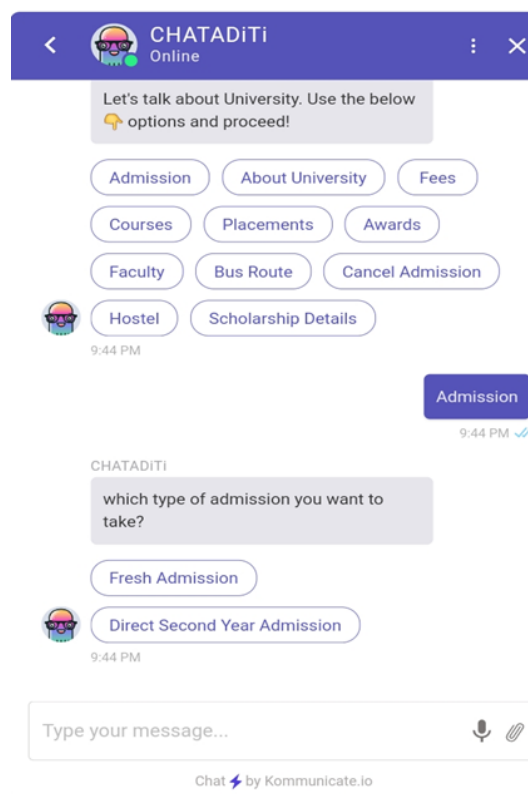


Fig 2b. Chatboat Interface

This chatbot is used for the university purpose and for voice google speech recognition API are used. It takes input from the microphone in the .wav file then sends it to the google API client and then it transforms those waves into speech and returns them back to us to use at the backend server to perform the DBN algorithm on it. When type or voice the message on the UI chatbot that message goes to Dialogflow. In the fulfillment of Dialogflow, we are connected to the webhook by using the ngrok URL. After the webhook configuration, this message request pass to the base server with their query then finds the response of that query by using the google session client library. After that Algorithm is performed on that responses and returns the response on UI Chatbot.

### Accuracy of analysis:

In calculation of the accuracy of the SGD and proposed hybrid model various parameters are used such as Similarity score, Semematic Score, TF-IDF Score these. In the analysis graph shown in figure 3 the accuracy of Hybrid Model algorithms is better than SGD.

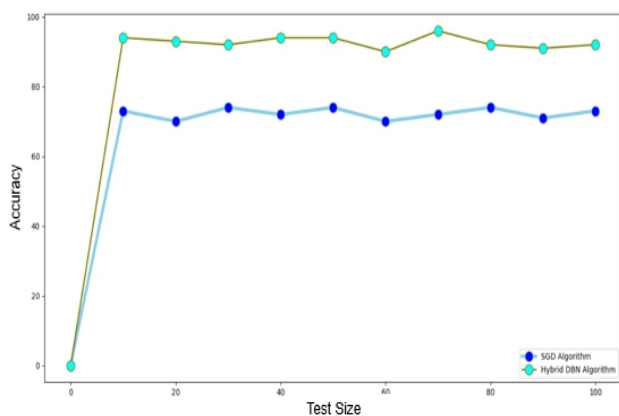


Fig 3: Accuracy of Algorithm

In figure 3 the y-axis represent the accuracy and on the x-axis test size is taken. 33% samples of dataset are recommended for testing data remaining are for training. The result shows that the Hybrid algorithm provided good accuracy on this dataset. The missclassification of chatbots in very few cases is also taken care, the fallback rate information is captured and then accuracy against train dataset confusion rate, reset rate human takeover rate is recalculated.

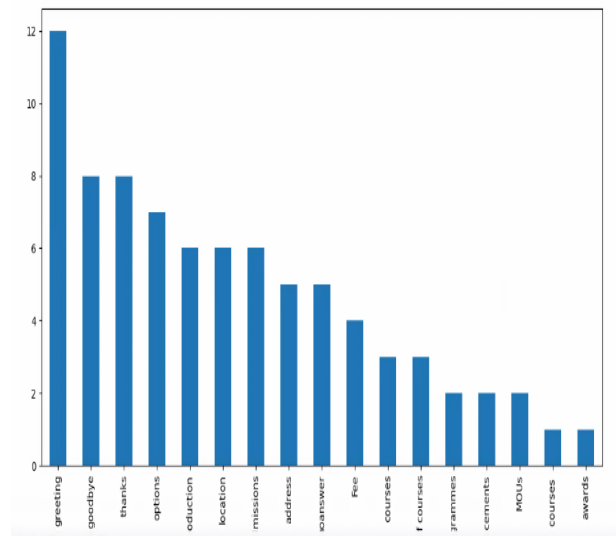


Fig 4: Label of Categories

In this figure see the label categories to find out for university chatbot, here trained the dataset with these labels.

### Performances Analysis:

The performance analysis of different algorithms is given in table 2. This table is shown train time, test time, total Duration time and Accuracy,.

Table 2: Performances of algorithm

Algorithm/ Parameters	SGD	Hybrid Algorithm
<b>Train Time</b>	0.008s	0.501s
<b>Test Time</b>	0.006s	0.002s
<b>Total Duration Time</b>	0.014s	0.503s
<b>Accuracy</b>	73	96

For computing the training and testing time of SGD and Hybrid model following formulas are used. The train and test time always depend on system configuration.

$$\text{Total Train time} = \text{start of training dataset} - \text{End of training dataset}$$

$$\text{Total Test time} = \text{start of testing dataset} - \text{End of testing dataset}$$

$$\text{Accuracy} = \frac{\text{Total no. of correct prediction}}{\text{Total no. of prediction made for a dataset}}$$

$$\text{Total Duration Time} = \text{Train Time} + \text{Test time}$$



The SGD technique do not performed well on the given dataset as compared to the Hybrid Model , its total duration time is 0.503s and accuracy is 98 % which is far better. The experimental study shows the Hybrid Model provided good accuracy.

The proposed algorithms is trained and tested on the same dataset. The performance measures viz precision, recall, F1-score, and support are calculated and given in table 3. In this system the scikit-learn function is used to calculate these performance metrics.

$$\text{Precision} = \text{True Positive} / (\text{True Positive} + \text{False Positive})$$

$$\text{Recall} = \text{True Positive} / (\text{True Positive} + \text{False Negative})$$

$$\text{F1-score} = (2 * \text{Precision} * \text{Recall}) / (\text{Precision} + \text{Recall})$$

**Table 3:** Classification Analysis of proposed System

Labels	Precision	Recall	F1-score	Support
introduction	0.80	0.88	0.84	10
greeting	0.93	1.00	0.96	9
good bye	0.83	0.85	0.84	9
thanks	0.82	0.85	0.83	8
No answer	0.88	0.87	0.87	9
option	0.89	0.90	0.89	8
admission	0.95	0.93	0.94	9
location	0.88	0.99	0.93	7
address	1.0	0.97	0.98	10
courses	0.98	0.88	0.93	8
fee	0.94	0.86	0.90	9
list of course	0.93	0.90	0.91	8
undergraduate program	1.00	0.88	0.94	9
placement	0.94	0.90	0.92	8
MOUS	0.93	0.89	0.91	9
awards	0.97	0.88	0.92	8

Precision is to predict the number of correct positive predictions. Precision is calculated for the minority class. The recall is to predict the number of correct positive predictions out of all positive predictions. Recall provides the indication of missed positive prediction. F-Measure is provided a way to combine both precisions and recall into a single measure. Support shows that the actual occurrences of the class in the dataset

## 7. Conclusion

Chatbots are effective tools and easy-to-use time-saving applications. The proposed chatbot system will help to get the information easily about the university or related admission process . In this system various Machine learning, NLP, and generative AI approaches were used, including SGD, hybrid Model as KNN-classifier, logistics regression, and DBN among them, the experimental analysis shows that the hybrid model outperforms with 96% of accuracy.

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