Agriculture Assistant Chatbot Using Artificial Neural Network

Neelam Chandolikar
Department of IT and MCA
Vishwakarma Institute of Technology
Pune, India
neelam.chandolikar@vit.edu

Chirag Dale
Department of IT and MCA
Vishwakarma Institute of Technology
Pune, India
chirag.dale19@vit.edu

Tejas Koli
Department of IT and MCA
Vishwakarma Institute of Technology
Pune, India
tejas.koli19@vit.edu

Mayank Singh
Department of IT and MCA
Vishwakarma Institute of Technology
Pune, India
mayank.singh19@vit.edu

Tarussh Narkhede
Department of IT and MCA
Vishwakarma Institute of Technology
Pune,India
tarussh.narkhede19@vit.edu

2022 International Conference on Advanced Computing Technologies and Applications (ICACTA) | 978-1-6654-9515-8/22/$31.00 ©2022 IEEE | DOI: 10.1109/ICACTA54488.2022.9753433

***Abstract* — As India has an agro-based economy, 58% of its population relies on agriculture as its primary method of livelihood. In spite of this, the economic survey for 2019-2020 indicates that agriculture growth in India has stagnated around 2.9% annually for the past 6 years. Considering the number of people in India still relying on it, it is a real concern. One of the prevailing issues is lack of right information. This problem can be solved by providing farmers with expert advice and relevant information (e.g. determine when to irrigate, how to sow seeds, and which pesticides to use effectively to increase the yields). In this paper, the proposed chatbot called AgroBot is a multi-user chat application. AgroBot can overcome this problem by allowing farmers to obtain the information they need to succeed in an ever-changing market and to enlarge with new technology and market demand in an easy-to-use manner. Farmers can communicate easily with the chatbot since the system uses NLP (Natural Language Processing) to identify and parse farmer inquiries, identify the main key words and their questions, identify the main keywords and compare them to the Knowledge Base, and provide the best possible results. The development of such a system would benefit farmers by allowing them to gain better information about agricultural practices and, as a result, increase agricultural productivity.**

Keywords– Chatbot; deep learning; artificial neural network; agriculture; natural language processing; forward neural network

I. INTRODUCTION

IBEF Research [1] shows that 58% of the Indian population still depends upon agriculture as their primary source of income. But growth in the agriculture sector is stagnant at 2.9% annually. Despite this, the agricultural sector's growth is stagnating at 2.9% per annum. It is due to the lack of information and expert advice farmers require to make decisions in an urgent manner in order to succeed. The study also shows that villages adjacent to urban centers in India have a high proportion of people with semi-literacy and technical skills due to the fact that their children have moved to those cities, and with such displacement, they have brought back some of their knowledge. As such villages grow, their technical expertise can be utilized to fill in this information gap. However, the majority of farmers do not have access to correct information about best farming practices and trends.

This system overcomes these disadvantages by providing a user-friendly interface, where users or farmers can interact with AgroBot to obtain the relevant information. With the help of "AgroBot" users can get their questions answered easily and quickly. Upon receiving user input, the textual query undergoes pre-processing steps for recognizing which category of queries it belongs to and provides a response. Utilizing interactive querying methods as part of the system, the system will provide new age farmers with agriculture information. Moreover, it can be used to predict the future agricultural product costs, which is of great benefit to farmers in planning their future activities.

II. PRELIMINARY CONCEPTS

A. Deep Learning

An underlying principle of deep learning, alias for deep structured learning, is basically a multilayered neural network consisting of three or more layers. They are designed to mimic the behavior of the human brain. Through continuous analysis of data with a given logical structure, deep learning algorithms attempt to produce conclusions indistinguishable to those of humans. As a result, deep learning uses a multilayered structure of algorithms called neural networks.[2]

B. Artificial Neural Network

As a machine learning and pattern recognition system, artificial neural networks (ANNs) are computational or mathematical models based on the human nervous system (in particular the brain). Unlike humans, animals have a more complex nervous system, so a system configured like this will be able to solve more complex problems. According to artificial neural networks, they function as systems of highly interconnected "neurons" that are capable of calculating values from inputs.[3][4]. Figure 1 shows the structure of the Artificial neural network.

978-1-6654-9515-8/$31.00©2022IEEE

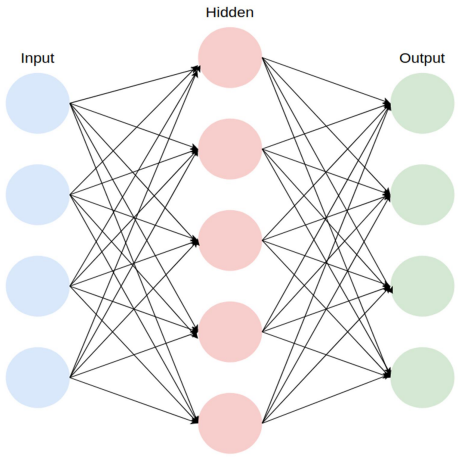

Fig. 1. Artificial neural network structure

As an example, a neural network isn't just one or a few interconnected neurons; it can have millions of them connected. An animal's or human's body is the best example of Parallel Processing in the body. The interconnected neurons support parallel processing in the body. As of today, artificial neural networks are basically clusters of primitive artificial neurons. Several layers are then connected to form the clustering. In order to solve the complex problems of the real world, individuals must understand how these layers are connected. In other words, neural networks are capable of detecting trends and extracting patterns that are too complex for computer techniques or humans to notice.

III. Related Work

Tsung-Hsien et.al proposed a method for network based training of task oriented dialogue systems using neural networks reducing manual configuration and handcrafting models to work in different scenarios [5]. Ilya et.al proposed a method to efficiently convert rare words using alignment algorithms in Neural Machine Translation with the help of a dictionary [6].

Iluian et.al proposed a method for making conversation between dialogue system and user realistic by using Generative Hierarchical Neural Network Models [7]. Yoon Kim et.al proposed a method for creating a character aware neural model. This model relies on character-level inputs and makes predictions on character level only [8].

Abigail See et.al proposed a method for compressing the size of the neural model by pruning and avoiding over parameterization in the model [9].Jie Zhoui et.al proposed a method to improve performance of Neural Machine Translation. The performance gains were achieved by linear connection, named fast-forward connections, based on deep Long Short-term Memory [9].

Wenhu Chen et.al proposed a method to effectively recognize context with help of metadata using sequence to sequence neural machine translation. The guided alignment training approach helps in translation of unrecognized words overcoming the problem of unknown words [10].

Ilya Sutuskever et.al proposed a method for using deep neural networks along with sequence to sequence structure with help of Long Short-Term Memory[11]. Yoon Kim et.al proposed a method for word level prediction 10x faster compared to traditional methods[12].Peter Norvig et.al proposed a method for correcting spelling in text conversation in chatbot[13].

As a result of the above defined problem, the Government launched a central knowledge bank that provides access to various agriculture-related IT services. Below are analysis some of the most prominent services:

Farmer's Portal makes knowledge readily accessible via the Internet. The content on this website relates to farming but is primarily presented in English and Hindi. It is important to note that this service is hampered by the fact that many farmers are not literate enough to operate computers well. Times of India [15] reported that only 6% of rural households had a computer and 18% of the rural youth could operate one. According to this survey due to shortage of computer skills among farmers, a website is not a feasible option for spreading agriculture related information [16].

With a rating of 4.3 out of 5 ,AgriApp is one of the most popular apps amongst farmers on Google Play Store[17]. Through this mobile app, farmers can receive information about farming resources and government services. The disadvantage of AgriApp is that it is a knowledge bank in which the user has to search for information manually and, if they opt to chat with the application operator, they are required to wait for a considerable amount of time to receive a response.

KCC provides farmers with an over-the-phone helpline for clarifying their inquiries. As this service facilitates telephonic conversations, it is able to meet the needs of each farmer individually, since the information is provided to them in their native language. However, the KCC is only open from 6 AM to 10 PM, and a skilled laborer who knows agricultural practices is needed for the KCC to function. These call centers are experiencing an increasing number of questions, and it might not be possible to efficiently handle them all on time, plus many of the questions are redundant [18].

IV. Proposed Methodology

A chatbot automates interactions between a company and its customers via conversational interaction. With the help of machine learning techniques, artificial intelligence-powered chatbots are able to understand natural language and respond in a personalized manner to users. At the beginning, chat bots were mostly used by retailers, travel agencies, media companies, insurance companies, and other companies. Using this emerging technology, agriculture could also provide advice and recommendations to farmers on farming related problems and assist them in finding answers to their questions.

Using Natural Language Processing techniques, the conversational assistant understands user queries in their English language. Even grammatically incorrect sentences will be recognized as input queries by the

system. A user query undergoes pre-processing, where words are tokenized from the query, stop words will be removed so that they won't interfere with the likelihood of classifying the query based on its class, and finally it will go through a stemming process to convert those words to their root words. As soon as the words have been transformed into a bag of words, they are transformed into a vector f Once the training dataset has been developed, the algorithm is trained on it.

Using the Gaussian Naive Bayes algorithm, a neural network is built using the training set data and error is optimized. Datasets for the test are preprocessed, classified, and neural networks are constructed in the same way. As a result, the class with the most probability is iterated.

A. System Architecture

The figure 1 shows an architectural diagram of the Chatbot application. A user enters a text query into the user interface. After receiving the user queries, the user interface sends them to the Chatbot application. An initial stage of pre-processing is performed on a textual query in the Chatbot application. This preprocessing step involves tokenizing the query into an array of words, removing the unnecessary stop words, and stemming the words to their root words. To retrieve relevant responses for a classification query, the query would be classified using the Naives Bayes classifier.

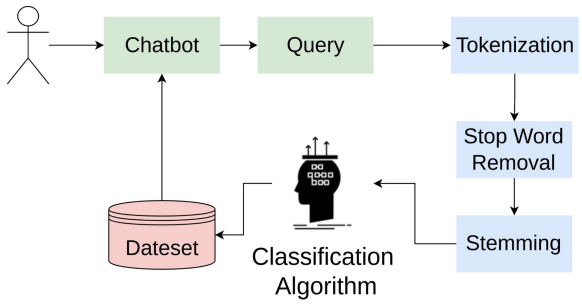

Fig. 2. Architecture Diagram

B. Query Preprocessing

In order to tokenize the user queries, the bag of words technique is applied, and the words (such as is, the, a , an) are taken off with the help of Natural Language Toolkit.

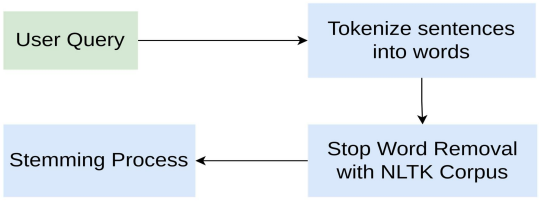

Fig. 3. Query Preprocessing Diagram

The stemming process produces root words from the original words. The words reverse, reversed, reversing all makeup reverse, which is their root.

C. Training and ChatBot Development

A dataset with thousands of farming inquiries and their related solutions was imported. This dataset is then transformed into a vector template. Using a neural network, the Bot is trained, and the inaccurate values are enhanced. A data structure is created to store the trained data.

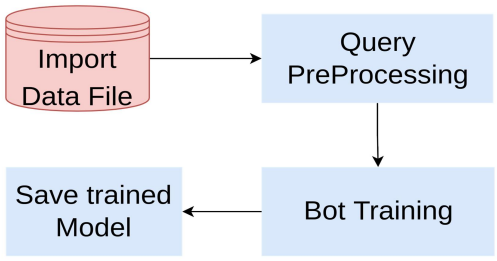

Fig. 4. Chatbot development and training diagram

D. Deep Learning-based Response Retrieval

Using the training dataset, a neural network classification model is constructed. A probability distribution is derived for the test dataset based on the model. Using the threshold value, the least probable values are filtered out and sorted in ascending order. A response is then generated by looping through the values with the highest probability.

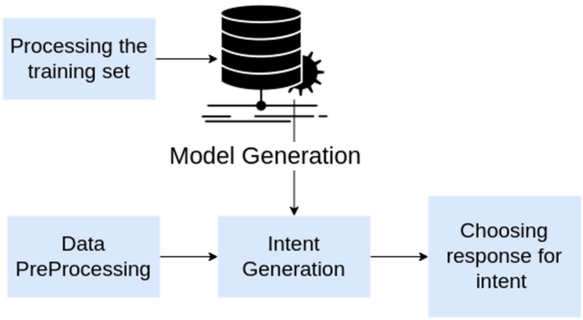

Fig. 5. Response retrieval diagram

E. Tokenization

Tokenization process consists of separating a piece of text into smaller units called tokens. A token can be a word ,sub word or even characters.

F. Stemming

The stemming process involves deriving a word's meaning from its root by attaching suffixes and prefixes to it. With stemming derived words are reconstructed to originating words

G. Bag of Words

While modeling text using machine learning algorithms, a bag-of-words model is used to represent the text data. In this chatbot we used a bag of word models for feature extraction.

H. Intent Generation

The token generated from the query is fed into a neural network that identifies the intent for the query and returns the intent.

I. Artificial Neural Network

For creating model's sequential API from keras are used. Sequential API enabled us to create models' layer by layer. The sequential model is a linear stack of layers.

Models using artificial neural networks take advantage of artificial intelligence due to which they are data driven and they can memorize and learn a data structure, then simulate it. A multidimensional information domain allows them to learn key information patterns [3]. In a sense, artificial neural networks mimic the learning procedure of a human as such, they dont require characteristic information relating to the system. However, they learn which incoming parameters are associated with which output variables by analyzing previous data. The artificial neural network is thus ideal for designing complex systems with noisy, dynamic, nonlinear data [4]. Additionally, artificial neural networks are suitable for tasks involving imperfect data sets [5]. Fig.5 Here is an illustration of a neural network, consisting of a hidden layer and an input layer.

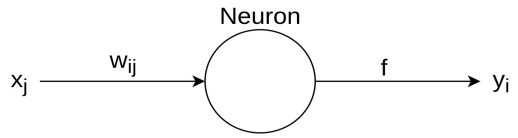

Fig. 6. Neuron structure in Neural Network

The input x_j is conveyed via a connection that increases the power by the weight w_{ij} to produce the output $x_j w_{ij}$. As a result of applying this product to a transfer function f, a result known as y_i is produced as follows:

$$y_i = f\left(\sum_{j=1}^{n} x_j w_{ij}\right)$$

In this example, i constitutes a neuron in the hidden layer, while j constitutes an input in the neural network.

V. Results and Finding

The Chatbot will be able to produce replies for user queries without any human assistance. The Chatbot provides answers to the farmer queries. Any query sent by the farmer; the bot replies to those queries in the form of chat. The interface of the Chatbot can be displayed as a Web Application or Mobile application. Agriculture related queries like rainfall required for crops, soil condition, weather condition, seeds, climate, fertilizers etc. can be easily answered by the chatbot and provide response in text and also helps in analyzing the future price of crops, so that they can plan their activities. Multilingual support is the future enhancement that will be of great use.

A. Example

Client: which condition is suitable for rice crop?

Tokenization:

['which', 'condition', 'is', 'suitable', 'for', 'rice', 'crop']

{'SW': 'for', '.': 'suitable', 'CROP': 'rice}

Intent: riceCondition

AgroBot: Rice crop needs a hot and humid climate.

Our study also showed that most of the queries related to regional information, such as weather and market prices, were redundant. Answers to most queries are delivered automatically by the Question-Answer system without human assistance. By avoiding unnecessary costs associated with setting up new call centers, better utilization of human resources will be achieved. In addition to handling all redundant queries, our system can also update new queries on the fly.

VI. Conclusion

A large and open problem in an economy such as India that is dominated by agriculture is to build scalable, reliable, real-time, 24/7 responsive applications. An application called AgroBot proposed in this paper, which combines NLP and machine learning, provides natural-language answers to farming-related questions in a multi-user chat environment.

Utilizing natural language technology, our chatbot can impact uneducated people by offering information related to agriculture and horticulture. By using the messaging app, farmers will have access to agricultural information and localized information such as market prices and weather forecasts for their area. With our AI-enabled system, farmers will have access to a wide variety of questions, anytime, which will promote the spread of modern farming more rapidly and to a larger number of farmers.

In particular, we think the system helps to analyze Indian farmers' mindsets and the structure of the agriculture industry. As well as providing a secure means for communication with the farmer, the system also assists policy makers in gaining a better understanding of what farmers need. Data analysis also enabled to determine which sectors and seasons need attention. Therefore, all available resources were used to build a decision system that addresses the problem of the lack of awareness and information in the agriculture sector in India.

References

[1] IBEF, http://www.ibef.org
[2] Senthilkumar, M., and Chiranji Lal Chowdhary. "An AI-Based Chatbot Using Deep Learning." In Intelligent Systems, pp. 231-242. Apple Academic Press, 2019.
[3] Grossi, Enzo, and Massimo Buscema. "Introduction to artificial neural networks." European journal of gastroenterology & hepatology 19, no. 12 (2007): 1046-1054.
[4] Manickam, MRM Veera, M. Mohanapriya, Sandip A. Kale, Mithapalli Uday, Prashant Kulkarni, Yuvraj Khandagale, and Suraj P. Patil. "Research study on applications of artificial neural networks and E-learning personalization." International Journal of Civil Engineering and Technology 8, no. 8 (2017): 1422-1432.
[5] Wen, Tsung-Hsien, David Vandyke, Nikola Mrksic, Milica Gasic, Lina M. Rojas-Barahona, Pei-Hao Su, Stefan Ultes, and Steve

Young. "A network-based end-to-end trainable task-oriented dialogue system." arXiv preprint arXiv:1604.04562 (2016).
[6] Luong, Minh-Thang, Ilya Sutskever, Quoc V. Le, Oriol Vinyals, and Wojciech Zaremba. "Addressing the rare word problem in neural machine translation." arXiv preprint arXiv:1410.8206 (2014).
[7] Serban, Iulian, Alessandro Sordoni, Yoshua Bengio, Aaron Courville, and Joelle Pineau. "Building end-to-end dialogue systems using generative hierarchical neural network models." In Proceedings of the AAAI Conference on Artificial Intelligence, vol. 30, no. 1. 2016.
[8] Kim, Yoon, and Alexander M. Rush. "Sequence-level knowledge distillation." arXiv preprint arXiv:1606.07947 (2016).
[9] See, Abigail, Minh-Thang Luong, and Christopher D. Manning. "Compression of neural machine translation models via pruning." arXiv preprint arXiv:1606.09274 (2016).
[10] Zhou, Jie, Ying Cao, Xuguang Wang, Peng Li, and Wei Xu. "Deep recurrent models with fast-forward connections for neural machine translation." Transactions of the Association for Computational Linguistics 4 (2016): 371-383.
[11] Chen, Wenhu, Evgeny Matusov, Shahram Khadivi, and Jan-Thorsten Peter. "Guided alignment training for topic-aware neural machine translation." arXiv preprint arXiv:1607.01628 (2016).
[12] Sutskever, Ilya, Oriol Vinyals, and Quoc V. Le. "Sequence to sequence learning with neural networks." In Advances in neural information processing systems, pp. 3104-3112. 2014.
[13] Kim, Yoon, Yacine Jernite, David Sontag, and Alexander M. Rush. "Character-aware neural language models." In Thirtieth AAAI conference on artificial intelligence. 2016.
[14] Norvig, Peter. "How to write a spelling corrector." De: http://norvig. com/spell-correct. html (2007).
[15] Mahendra K Singh, India computer use, Times of India (2016)
[16] Gov India https://www.farmer.gov.in
[17] Agri App https://play.google.com/store/apps/details?id=com.criyagen&hl=en_IN&gl=US
[18] Kisan call center manage.gov.in 1800-180-1551
[19] Yan, Mengting, Paul Castro, Perry Cheng, and Vatche Ishakian. "Building a chatbot with serverless computing." In Proceedings of the 1st International Workshop on Mashups of Things and APIs, pp. 1-4. 2016.
[20] Arora, Sanjeev, Yingyu Liang, and Tengyu Ma. "A simple but tough-to-beat baseline for sentence embeddings." In International conference on learning representations. 2017.
[21] Salvi, Sanket, V. Geetha, and S. Sowmya Kamath. "Jamura: A Conversational Smart Home Assistant Built on Telegram and Google Dialogflow." In TENCON 2019-2019 IEEE Region 10 Conference (TENCON), pp. 1564-1571. IEEE, 2019. R. Lokeshkumar, E. Maruthavani, and A. Bharathi , A new perspective for decision makers to improve efficiency in social business intelligence systems for sustainable development, International Journal of Environment and Sustainable Development 2018 17:4, 404-416.
[22] S. Balakrishnan, V. K. and M. S. S. Hameed, "An Embarking User Friendly Palmprint Biometric Recognition System with Topnotch Security," 2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS), 2021, pp. 1028-1032, doi: 10.1109/ICICCS51141.2021.9432230.
[23] V. Arulkumar A Survey on Multimedia Analytics in Security Systems of Cyber Physical Systems and IoT, 2021 2nd International Conference on Smart Electronics and Communication (ICOSEC) pp 1556-1561, Nov 2021. 10.1109/ICOSEC51865.2021.9591754
[24] Ravi Kumar Poluru & Lokesh Kumar R (2021) An Improved Fruit Fly Optimization (IFFOA) based Cluster Head Selection Algorithm for Internet of Things, International Journal of Computers and Applications, 43:7, 623-631, DOI: 10.1080/1206212X.2019.1600831
[25] Selvan.C, S.R.Balasundaram, (2020), Data Analysis in Context Based Statistical Modeling in Predictive Analytics, IGI Global, Handbook of Research on Engineering, Business, and Healthcare Applications of Data Science and Analytics, pages 98-114.
[26] V. Arulkumar An Intelligent Face Detection by Corner Detection using Special Morphological Masking System and Fast Algorithm, 2021 2nd International Conference on Smart Electronics and Communication (ICOSEC) pp 1556-1561, Nov 2021.
[27] Jain, Mohit, Pratyush Kumar, Ishita Bhansali, Q. Vera Liao, Khai Truong, and Shwetak Patel. "FarmChat: a conversational agent to answer farmer queries." Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies 2, no. 4 (2018): 1-22.
[28] Shen, Xiaoxue, Adele Lu Jia, Siqi Shen, and Yong Dou. "Helping the Ineloquent Farmers: Finding Experts for Questions With Limited Text in Agricultural Q&A Communities." IEEE Access 8 (2020): 62238-62247.
[29] Chen, Yi, Wei Wang, and Ziyang Liu. "Keyword-based search and exploration on databases." In 2011 IEEE 27th International Conference on Data Engineering, pp. 1380-1383. IEEE, 2011.
[30] Farmers Portal, https://www.farmer.gov.in/ (2013)