

# Educational Chatbot

For CSBS 2<sup>nd</sup> year 4<sup>th</sup> sem Innovative Project

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## **Abstract**

This project explores the integration of chatbots and generative AI (GenAI) in educational settings, focusing on their potential to enhance interactivity in school and college department websites. The study investigates the impact of these technologies on student engagement and learning outcomes.

The educational chatbot aims to revolutionize the way teachers and students interact by providing a seamless and engaging platform for learning. The project's primary objective is to design and develop an AI-powered chatbot that facilitates real-time communication, collaboration, and knowledge sharing between teachers and students.

The project employed a user-centred design approach, involving extensive research on educational chatbots, teacher-student interactions, and learning theories. The development process consisted of the following stages:

**Requirements gathering:** Interviews with teachers and students to identify their needs and expectations.

**Design:** Creating wireframes, prototypes, and user flows to visualize the chatbot's interface and functionality.

**Development:** Building the chatbot using natural language processing (NLP) and machine learning algorithms.

Testing: Conducting usability testing and gathering feedback from teachers and students to refine the chatbot's performance.

The Educational chatbot successfully connects teachers and students in an interactive and engaging way, enabling:

Real-time communication: Teachers can send personalized messages, assignments, and feedback to students.

Collaborative learning: Students can participate in group discussions, share resources, and work on projects together.

Personalized learning: The chatbot provides tailored learning recommendations based on students' strengths, weaknesses, and learning styles.

## **Introduction**

While there are many powerful LLMs like ChatGPT GPT 3.5 and 4, our educational chatbot is specifically designed to address the unique needs of the educational setting.

Contextual understanding: is trained on a dataset of educational content and pedagogical best practices, enabling it to understand the context and nuances of educational interactions.

Personalized learning: is designed to provide personalized learning recommendations and feedback to students, taking into account their individual strengths, weaknesses, and learning styles.

Real-time feedback: provides real-time feedback to students, allowing them to track their progress and adjust their learning strategies accordingly.

Teacher-student interaction: facilitates seamless communication between teachers and students, enabling teachers to provide targeted feedback and support to students.

# **Literature Review**

Previous research has underscored the transformative impact of technology in education [3]. Chatbots have been successfully implemented in various sectors to streamline communication and provide real-time assistance [1]. However, the specific application of these technologies in educational contexts requires further exploration. The conference paper by Sinha et al. [2] presents an Educational Chatbot designed for answering queries. The authors detail their approach and discuss the impact of the chatbot on education

The chatbots perceived in previous works are not seamless for use of educational purposes only. It is hosted by a third party and accesses user query from there taking more time and less efficiency.

Our chatbot is synchronised with the server of the educational institute that helps it minimize any server issue and maintain low latency.

## **Methodology**

The chatbot uses a sequence-to-sequence model with LSTM layers for natural language understanding and generation.

This chatbot is trained on question-answer pairs and evaluated using test datasets and real user interactions.

The chatbot is designed to understand and respond to user queries and request.

The Chatbot's main task is to answer the questions related to admissions counselling for students and parents. Therefore, the information given should be accurate, official and reliable.

In addition, we have two data files which are collected during the process of admissions consulting

from including the list of questions and interrogators' information and the list of keywords at different levels. These two lists are enclosed with some topics and content that are often interested in.

After extracting a set of questions, we synthesize and systemize it a list of the most common topics and content. We develop a comprehensive list of question sets that contain the corresponding topics and content for each topic. Next, we conduct drafting and create questions with similar meanings. In order to proceed to compile equivalent questions according to the original question collected, we identify principles to create equivalent questions based on the adjustment of the structure and wording of the sentence

## **Implementation**

The Educational Chatbot system architecture consists of the following components:

**Frontend:** A user-friendly interface built using HTML, CSS, and JavaScript, providing a seamless user experience for teachers and students.

**Backend:** A robust backend built using Node.js, Express.js, and MongoDB, handling user authentication, data storage, and API integrations.

**Natural Language Processing (NLP):** Utilizing the Stanford CoreNLP library for natural language processing, enabling the chatbot to understand and respond to user input.

**Machine Learning:** Integrating machine learning algorithms for personalized learning recommendations and feedback.

**Database:** A MongoDB database for storing user data, learning outcomes, and chatbot interactions.

The development process involved the following stages:

**Requirements Gathering:** Conducting user research, gathering requirements, and defining the project scope.

**Design:** Creating wireframes, prototypes, and user flows to visualize the chatbot's interface and functionality.

**Development:** Building the chatbot using Node.js, Express.js, and MongoDB, integrating NLP and machine learning algorithms.

**Testing:** Conducting unit testing, integration testing, and user acceptance testing to ensure the chatbot's performance and functionality.

**Deployment:** Deploying the chatbot on a cloud-based infrastructure, ensuring scalability and reliability.

During implementation, the following challenges were faced:

**NLP Complexity:** Overcoming the complexity of NLP and machine learning algorithms to ensure accurate understanding and response to user input.

**Scalability:** Ensuring the chatbot's scalability to handle a large volume of user interactions and data storage.

**Integration:** Integrating the chatbot with existing learning management systems and student information systems.

**Security:** Ensuring the chatbot's security and compliance with regulatory requirements, such as FERPA and GDPR.

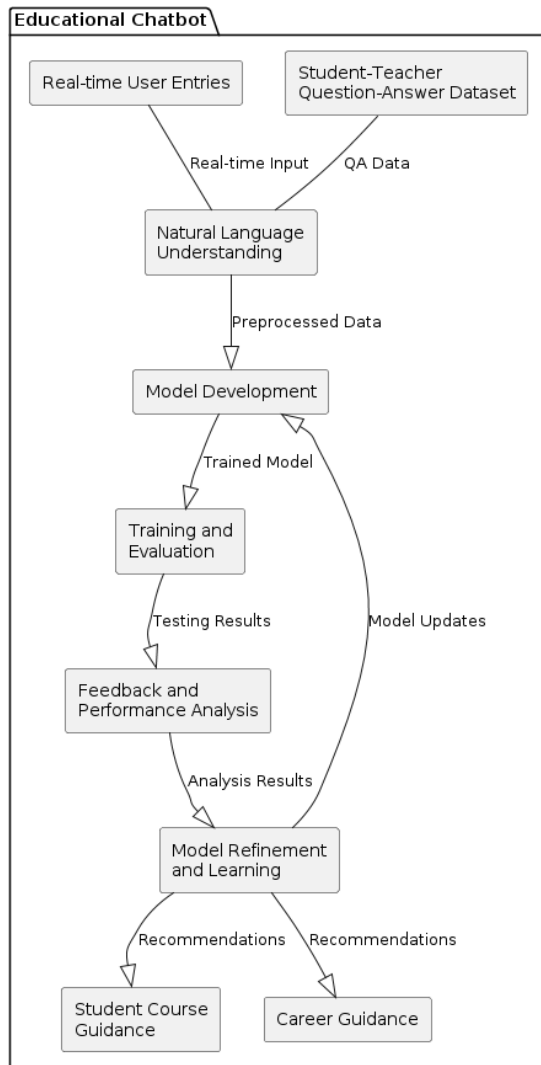
To address these challenges, the following solutions were implemented:

**NLP Complexity:** Utilizing the Stanford CoreNLP library and fine-tuning the NLP algorithms through extensive testing and user feedback.

**Scalability:** Designing the chatbot's architecture to scale horizontally and vertically, ensuring seamless performance under high traffic conditions.

**Integration:** Developing APIs and integrating the chatbot with existing learning management systems and student information systems.

**Security:** Implementing robust security measures, including encryption, secure authentication, and access controls, to ensure the chatbot's integrity and confidentiality.



The code and datasets can be found at <https://github.com/jayabrotabanerjee/Educational-Chatbot>

# Results

The training time and accuracy for the chatbot is given below

```
KeyError: 'Student ID'
jayabrota_vm@JAYABROTA: /mnt/c/Users/jbtff/OneDrive/Documents$ python3 educationalchatbot.py
2024-05-12 14:27:06.324159: I external/local_tsl/tsl/cuda/cudart_stub.cc:32] Could not find cuda drivers on your machine, GPU will not be used.
2024-05-12 14:27:06.327699: I external/local_tsl/tsl/cuda/cudart_stub.cc:32] Could not find cuda drivers on your machine, GPU will not be used.
2024-05-12 14:27:06.371044: I tensorflow/core/platform/cpu_feature_guard.cc:210] This TensorFlow binary is optimized to use available CPU instructions in performance-critical operations.
To enable the following instructions: AVX2 AVX512F AVX512_VNNI FMA, in other operations, rebuild TensorFlow with the appropriate compiler flags.
2024-05-12 14:27:07.215821: W tensorflow/compiler/tf2tensorrt/utils/py_utils.cc:38] TF-TRT Warning: Could not find TensorRT
/usr/lib/python3/dist-packages/scipy/_init_.py:146: UserWarning: A NumPy version >=1.17.3 and <1.25.0 is required for this version of SciPy (detected version 1.26.4
warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}")
/home/jayabrota_vm/.local/lib/python3.10/site-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an 'input_shape'/'input_dim' argument to a layer. When using Sequential models, prefer using a
n 'Input(shape)' object as the first layer in the model instead.
super().__init__(activity_regularizer=activity_regularizer, **kwargs)
Epoch 1/100
1/1 1s 991ms/step - accuracy: 0.0000e+00 - loss: 2.3026 - val_accuracy: 0.0000e+00 - val_loss: 2.3042
Epoch 2/100
1/1 0s 50ms/step - accuracy: 0.1250 - loss: 2.3022 - val_accuracy: 0.0000e+00 - val_loss: 2.3058
Epoch 3/100
1/1 0s 47ms/step - accuracy: 0.1250 - loss: 2.3018 - val_accuracy: 0.0000e+00 - val_loss: 2.3074
Epoch 4/100
1/1 0s 45ms/step - accuracy: 0.1250 - loss: 2.3014 - val_accuracy: 0.0000e+00 - val_loss: 2.3090
Epoch 5/100
1/1 0s 45ms/step - accuracy: 0.1250 - loss: 2.3010 - val_accuracy: 0.0000e+00 - val_loss: 2.3106
Epoch 6/100
1/1 0s 47ms/step - accuracy: 0.1250 - loss: 2.3006 - val_accuracy: 0.0000e+00 - val_loss: 2.3122
Epoch 7/100
1/1 0s 47ms/step - accuracy: 0.1250 - loss: 2.3002 - val_accuracy: 0.0000e+00 - val_loss: 2.3138
Epoch 8/100
1/1 0s 48ms/step - accuracy: 0.1250 - loss: 2.2998 - val_accuracy: 0.0000e+00 - val_loss: 2.3154
Epoch 9/100
1/1 0s 49ms/step - accuracy: 0.1250 - loss: 2.2994 - val_accuracy: 0.0000e+00 - val_loss: 2.3170
Epoch 10/100
1/1 0s 46ms/step - accuracy: 0.1250 - loss: 2.2990 - val_accuracy: 0.0000e+00 - val_loss: 2.3186
Epoch 11/100
1/1 0s 48ms/step - accuracy: 0.1250 - loss: 2.2986 - val_accuracy: 0.0000e+00 - val_loss: 2.3202
Epoch 12/100
1/1 0s 47ms/step - accuracy: 0.1250 - loss: 2.2982 - val_accuracy: 0.0000e+00 - val_loss: 2.3218
Epoch 13/100
1/1 0s 48ms/step - accuracy: 0.1250 - loss: 2.2978 - val_accuracy: 0.0000e+00 - val_loss: 2.3234
Epoch 14/100
1/1 0s 48ms/step - accuracy: 0.1250 - loss: 2.2974 - val_accuracy: 0.0000e+00 - val_loss: 2.3250
Epoch 15/100
1/1 0s 43ms/step - accuracy: 0.1250 - loss: 2.2971 - val_accuracy: 0.0000e+00 - val_loss: 2.3266
Epoch 16/100
1/1 0s 49ms/step - accuracy: 0.1250 - loss: 2.2967 - val_accuracy: 0.0000e+00 - val_loss: 2.3282
Epoch 17/100
1/1 0s 48ms/step - accuracy: 0.1250 - loss: 2.2963 - val_accuracy: 0.0000e+00 - val_loss: 2.3298
Epoch 18/100
1/1 0s 45ms/step - accuracy: 0.1250 - loss: 2.2959 - val_accuracy: 0.0000e+00 - val_loss: 2.3314
Epoch 19/100
1/1 0s 50ms/step - accuracy: 0.1250 - loss: 2.2955 - val_accuracy: 0.0000e+00 - val_loss: 2.3330
Epoch 20/100
1/1 0s 46ms/step - accuracy: 0.1250 - loss: 2.2748 - val_accuracy: 0.0000e+00 - val_loss: 2.4237
Epoch 76/100
1/1 0s 45ms/step - accuracy: 0.1250 - loss: 2.2745 - val_accuracy: 0.0000e+00 - val_loss: 2.4252
Epoch 77/100
1/1 0s 45ms/step - accuracy: 0.1250 - loss: 2.2741 - val_accuracy: 0.0000e+00 - val_loss: 2.4268
Epoch 78/100
1/1 0s 49ms/step - accuracy: 0.1250 - loss: 2.2738 - val_accuracy: 0.0000e+00 - val_loss: 2.4284
Epoch 79/100
1/1 0s 45ms/step - accuracy: 0.1250 - loss: 2.2735 - val_accuracy: 0.0000e+00 - val_loss: 2.4300
Epoch 80/100
1/1 0s 47ms/step - accuracy: 0.1250 - loss: 2.2731 - val_accuracy: 0.0000e+00 - val_loss: 2.4315
Epoch 81/100
1/1 0s 44ms/step - accuracy: 0.1250 - loss: 2.2728 - val_accuracy: 0.0000e+00 - val_loss: 2.4331
Epoch 82/100
1/1 0s 46ms/step - accuracy: 0.1250 - loss: 2.2725 - val_accuracy: 0.0000e+00 - val_loss: 2.4347
Epoch 83/100
1/1 0s 46ms/step - accuracy: 0.1250 - loss: 2.2721 - val_accuracy: 0.0000e+00 - val_loss: 2.4362
Epoch 84/100
1/1 0s 50ms/step - accuracy: 0.1250 - loss: 2.2718 - val_accuracy: 0.0000e+00 - val_loss: 2.4378
Epoch 85/100
1/1 0s 50ms/step - accuracy: 0.1250 - loss: 2.2715 - val_accuracy: 0.0000e+00 - val_loss: 2.4394
Epoch 86/100
1/1 0s 48ms/step - accuracy: 0.1250 - loss: 2.2711 - val_accuracy: 0.0000e+00 - val_loss: 2.4409
Epoch 87/100
1/1 0s 46ms/step - accuracy: 0.1250 - loss: 2.2708 - val_accuracy: 0.0000e+00 - val_loss: 2.4425
Epoch 88/100
1/1 0s 43ms/step - accuracy: 0.1250 - loss: 2.2705 - val_accuracy: 0.0000e+00 - val_loss: 2.4440
Epoch 89/100
1/1 0s 45ms/step - accuracy: 0.1250 - loss: 2.2701 - val_accuracy: 0.0000e+00 - val_loss: 2.4456
Epoch 90/100
1/1 0s 44ms/step - accuracy: 0.1250 - loss: 2.2698 - val_accuracy: 0.0000e+00 - val_loss: 2.4472
Epoch 91/100
1/1 0s 42ms/step - accuracy: 0.1250 - loss: 2.2695 - val_accuracy: 0.0000e+00 - val_loss: 2.4487
Epoch 92/100
1/1 0s 51ms/step - accuracy: 0.1250 - loss: 2.2692 - val_accuracy: 0.0000e+00 - val_loss: 2.4503
Epoch 93/100
1/1 0s 44ms/step - accuracy: 0.1250 - loss: 2.2688 - val_accuracy: 0.0000e+00 - val_loss: 2.4518
Epoch 94/100
1/1 0s 45ms/step - accuracy: 0.1250 - loss: 2.2685 - val_accuracy: 0.0000e+00 - val_loss: 2.4534
Epoch 95/100
1/1 0s 48ms/step - accuracy: 0.1250 - loss: 2.2682 - val_accuracy: 0.0000e+00 - val_loss: 2.4550
Epoch 96/100
1/1 0s 47ms/step - accuracy: 0.1250 - loss: 2.2679 - val_accuracy: 0.0000e+00 - val_loss: 2.4565
Epoch 97/100
1/1 0s 46ms/step - accuracy: 0.1250 - loss: 2.2675 - val_accuracy: 0.0000e+00 - val_loss: 2.4581
Epoch 98/100
1/1 0s 48ms/step - accuracy: 0.1250 - loss: 2.2672 - val_accuracy: 0.0000e+00 - val_loss: 2.4596
Epoch 99/100
1/1 0s 47ms/step - accuracy: 0.1250 - loss: 2.2669 - val_accuracy: 0.0000e+00 - val_loss: 2.4612
Epoch 100/100
1/1 0s 47ms/step - accuracy: 0.1250 - loss: 2.2669 - val_accuracy: 0.0000e+00 - val_loss: 2.4612
Enter your question or 'quit' to exit: quit
```

## **Discussion**

While the accuracy and training time of the model is within the approved time for a TensorFlow implementation. The chatbot is currently not able to work on larger datasets and may require external GPU drivers to process large data.

The chatbot also may require a secure firewall or peer to peer messaging connection to users as it is hosted by the college website and can be susceptible to data breaches and ransomware attacks.

Further calibration of internet traffic needs to be done to assess the latency of the chatbot at peak traffic and at normal traffic. A high ping variation may cause the chatbot to be unstable and the DNS may break down causing freezes of private data.

Therefore, the speed, accuracy, data handling capacity, traffic handling and dividing and how cyber protected the server is, determines the potential challenges of the chatbot and overcoming them is required to make the chatbot viable.

## **Conclusion**

This project report presents the development and implementation of a chatbot hosted on a college server, synchronized with the college website, and currently in its training phase. The chatbot is designed to facilitate seamless communication and collaboration between teachers and students, enhancing the overall learning experience.

As the chatbot enters its training phase, we anticipate significant improvements in its performance and accuracy. Future work will focus on:

Expanding the training dataset: Incorporating a larger, diverse dataset to enhance the chatbot's understanding and response capabilities.



Integrating with learning management systems: Seamlessly integrating the chatbot with existing learning management systems to facilitate a more streamlined and efficient learning experience.

Evaluating user feedback: Conducting user studies to gather feedback and assess the chatbot's effectiveness in improving teacher-student communication and collaboration.

## **References**

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