



COURSE NAME: Advanced Natural Language Processing

COURSE CODE: COMP8420

MAJOR PROJECT (ASSIGNMENT 3)

Revolutionizing IT Support with an AI- Powered Chatbot

Leveraging NLP for Efficient Ticket Triage and Resolution

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Table of Contents






INTRODUCTION	3
METHODOLOGY	3
EXPERIMENTAL RESULTS	5
CONTRIBUTION BREAKDOWN.....	5
GitHub Link for Project.....	6
CONCLUSION.....	6
REFERENCES	7

INTRODUCTION

In today's digital world, efficient IT support is crucial for both businesses and their customers. Nevertheless, traditional support systems frequently encounter bottlenecks because due to large quantity and diverse range of incoming requests. IT teams experience an atmosphere where they feel overburdened, resulting in delayed response times and dissatisfied consumers. This project tackles this real-world challenge by proposing an innovative solution: an AI-powered chatbot specializing in handling refunds and compensation inquiries. This chatbot utilizes Natural Language Processing (NLP) to understand customer questions and provide responses. By resolving simple issues independently and efficiently directing more complex problems to human agents, the chatbot's objective is to enhance the effectiveness of IT support system. This not only benefits customers by reducing resolution times, but it also frees up IT professionals to handle more complex issues. Furthermore, the project provides insightful information for research as well as business operations, opening the door for improvements in NLP models and a better understanding of customer interactions in the context of IT assistance.

METHODOLOGY

The “bitext/Bitext-customer-support-llm-chatbot-training-dataset” was used in our project which contains nearly 27,000 rows of customer support data. It includes both customer and agent responses to help fine tune our model.

flags string · classes	instruction string · lengths	category string · classes	intent string · classes	response string · lengths
 1.3%	 42-51 28.9%	 14.8%	 3.7%	 57-299 6.5%
B	question about cancelling order {{Order Number}}	ORDER	cancel_order	I've understood you have a question regarding canceling order {{Order Number}}, and I'm here to provide you with the information you need. Please go ahead and ask your question, and I'll do my best to assist you.
BQZ	i have a question about cancelling oorder...	ORDER	cancel_order	I've been informed that you have a question...
BLQZ	i need help cancelling puchase {{Order...	ORDER	cancel_order	I can sense that you're seeking assistance wit...

We took the GPT2 Model and tried to finetune it with the bitext database. For this we had to preprocess the dataset to remove noise and had converted the data into lowercase after which we removed the special characters from the text following that we tokenized and removed all the stop words and joined the data after that. After the preprocessing we successfully finetuned GPT2 and got the loss numbers and learning rate.

```
{ 'loss': 2.9781, 'grad_norm': 11.844098091125488, 'learning_rate': 4.5348837209302326e-05, 'epoch': 0.09}
{ 'loss': 2.6681, 'grad_norm': 20.930444717407227, 'learning_rate': 4.0697674418604655e-05, 'epoch': 0.19}
{ 'loss': 2.5968, 'grad_norm': 11.018845425415039, 'learning_rate': 3.604651162790698e-05, 'epoch': 0.28}
{ 'loss': 2.4923, 'grad_norm': 14.292250633239746, 'learning_rate': 3.13953488372093e-05, 'epoch': 0.37}
{ 'loss': 2.4583, 'grad_norm': 15.590079307556152, 'learning_rate': 2.674418604651163e-05, 'epoch': 0.47}
{ 'loss': 2.3673, 'grad_norm': 7.363201141357422, 'learning_rate': 2.2093023255813955e-05, 'epoch': 0.56}
{ 'loss': 2.3828, 'grad_norm': 24.59697151184082, 'learning_rate': 1.744186046511628e-05, 'epoch': 0.65}
{ 'loss': 2.4066, 'grad_norm': 4.733431339263916, 'learning_rate': 1.2790697674418606e-05, 'epoch': 0.74}
{ 'loss': 2.3498, 'grad_norm': 12.198885917663574, 'learning_rate': 8.139534883720931e-06, 'epoch': 0.84}
{ 'loss': 2.3292, 'grad_norm': 16.19269561767578, 'learning_rate': 3.488372093023256e-06, 'epoch': 0.93}
{ 'train runtime': 932.7002, 'train samples per second': 23.048, 'train steps per second': 5.763, 'train loss': 2.4892968182231106, 'epoch': 1.0}
```

Evaluating the model further we got average rouge scores: {'rouge-1': 0.14948369614593415, 'rouge-2': 0.03986308013308453, 'rouge-l': 0.1386049711710094}.

In the 2nd approach we have used smaller GPT2 Model for faster Fine tuning.

Other than the GPT2 model for comparison we also used a TF-IDF Vectorization model. In which we converted customer queries into numerical representations using TF-IDF and then calculated similarity between user queries and existing instructions to find the best matching response.

```
Hello! How can I assist you today?
You: I need to cancel purchase
Chatbot: I understood that you need assistance with canceling your purchase with the order number {{Order Number}}. We apologize for any inconvenience this may have caused. To initiate the cancellation process, please follow these steps:

1. Sign in to your account: Visit our {{Online Company Portal Info}} and login using your credentials.
2. Access your order history: Once logged in, navigate to the "{{Online Order Interaction}}" or "{{Online Order Interaction n}}" section.
3. Locate the purchase: Look for the order with the specific order number {{Order Number}}.
4. Cancel the purchase: Click on the "{{Online Order Interaction}}" option associated with the purchase.
5. Confirm the cancellation: Follow any further prompts or questions from the system to finalize the cancellation.

If you encounter any difficulties or have further questions, our dedicated team is available to assist you. You can reach us during {{Customer Support Hours}} at {{Customer Support Phone Number}} or through the Live Chat feature on our website {{Website URL}}. We appreciate your understanding and value your satisfaction.
You: I want assistance canceling order
Chatbot: I've decoded that you're seeking assistance with canceling your order with the order number {{Order Number}}. Our team is here to help make this process as smooth as possible. Here's what you need to do:

1. Log in to your {{Online Company Portal Info}}: Go to our website and access your account by entering your login credentials.
2. Locate Your Orders: Once logged in, find the section labeled '{{Online Order Interaction}}' or '{{Online Order Interaction n}}'. This is where you will find a list of all your past purchases.
3. Find the Relevant Purchase: Look for the order number {{Order Number}} among the listed orders and click on it for more details.
4. Initiate the Cancellation: Within the order details, you will find an option to '{{Online Order Interaction}}'. Please select this to begin the cancellation process.
5. Follow any Additional Steps: Depending on the system requirements, you may be asked to provide a reason for canceling or to confirm your decision. Please follow the instructions provided.

If you encounter any difficulties or have further questions, our dedicated support team is available to assist you. Feel free to reach out to them during {{Customer Support Hours}} at {{Customer Support Phone Number}} or through the Live Chat feature on our website at {{Website URL}}. Your satisfaction is our top priority, and we'll do our best to assist you with canceling order {{Order Number}}.
You: have a problem with canceling order
Chatbot: I'm cognizant of the fact that you're facing difficulties canceling your order with the order number {{Order Number}}. I apologize for any inconvenience this may be causing you. Rest assured, I'm here to assist you. To resolve this issue, please follow these steps:

1. Sign in to your {{Online Company Portal Info}} using your registered credentials.
2. Locate the '{{Online Order Interaction}}' or '{{Online Order Interaction n}}' section in your account.
3. Find the specific order with the order number {{Order Number}} and click on it to access the details.
4. Look for the option that says '{{Online Order Interaction}}' and select it to initiate the cancellation process.
5. If prompted, provide any necessary information or feedback to complete the cancellation.

If you encounter any further issues or have additional questions, our dedicated customer support team is available during {{Customer Support Hours}}. You can reach us at {{Customer Support Phone Number}} or through the Live Chat feature on our {{Website URL}}. We value your satisfaction and will do everything we can to assist you with canceling your order successfully.
You: exit
Chatbot: Goodbye! Have a great day!
```

The lower loss values showed us that the performance increased after epochs. Other than that, chatbot's response could be evaluated qualitatively.

EXPERIMENTAL RESULTS

Approach 1 (GPT-2):

Training Loss: The model's loss decreased over epochs, indicating that it was learning to generate responses better.

Evaluation Loss and Perplexity: These metrics provide additional measures of how well the model generalizes to unseen data.

Evaluation Results: `{'eval_loss': 4.970292091369629, 'eval_runtime': 44.941, 'eval_samples_per_second': 54.939, 'eval_steps_per_second': 6.876}`

Evaluation Perplexity: 144.0689697265625

Approach 2 (TF-IDF):

A qualitative assessment of chatbot responses showed reasonable performance on some queries but limitations in handling complex or nuanced questions.

CONTRIBUTION BREAKDOWN

Fursan Afzal – 47748893:

1. Pre-processed the bitext dataset
2. Finetuned the GPT2 model on bitext dataset
3. Attempted responses for GPT2 model
4. Evaluated GPT2 finetuned performance
5. Worked on report

Mir Sadia Afrin – 47965495:

1. Project.ipynb (1st approach):
 1. Successfully Evaluated the model on test data.

2. Created Response Generation with GPT2LMHeadModel, GPT2Tokenizer. Successfully getting responses.
 3. Integrated knowledge base
 4. Implemented Escalation.
 5. Created Chatbot Interface.
2. Project2.ipynb (2nd & 3rd approach):
 1. Successfully implemented a 2nd approach for the project with a different preprocessing data, fine-tuning, evaluation and response generation with GPT2 model. This approach is done for faster fine-tuning with smaller model and getting better working responses. Successfully got evaluated results.
 2. Successfully implemented 3rd approach with Tf-idf Vectorization. Successfully done the response generation here with better responses.
 3. Worked on the report.

GitHub Link for Project

<https://github.com/47748893/Chatbot>

Run the files in the following order:

- install_dependencies.py
- data_preprocessing.py
- train_gpt2.py
- evaluate_gpt2_model.py
- tfidf_chatbot.py

CONCLUSION

This project successfully explored two distinct approaches to building a customer support chatbot. The first, fine-tuning a GPT-2 model, demonstrated the potential of leveraging pre-trained language models for generating contextually relevant and human-like responses. However, this approach requires substantial computational resources and a large, high-quality dataset for optimal performance.

The second approach, utilizing TF-IDF vectorization and cosine similarity, offered a simpler and computationally efficient method for identifying relevant responses based on user queries. While it may lack the nuanced understanding of GPT-2, it proved effective for basic question-answering scenarios.

Further research could focus on combining the strengths of more approaches. For instance, the BERT method could be used for initial intent recognition, followed by fine-tuned GPT-2 generation for more personalized and contextually accurate responses. This hybrid model could potentially offer a scalable and effective solution for automating customer support interactions.

In conclusion, this project highlights the promise and challenges of applying natural language processing techniques to the domain of customer support. While each approach has its own merits and limitations, the ongoing development of NLP tools and techniques offers exciting possibilities for creating chatbots that can better understand and respond to customer needs.

REFERENCES

[bitext/Bitext-customer-support-llm-chatbot-training-dataset · Datasets at Hugging Face](#)