



Retrieval Augmented Generation(RAG) based Restaurant Chatbot with AI Testability

UNDER THE GUIDANCE OF DR. JERRY GAO

GROUP 1:

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AGENDA

- I. Introduction
- II. Data Collection
- III. Data Analytics results
- IV. Data pre-processing
- V. Training and test data preparation
- VI. Machine Learning Models
- VII. Testability
- VIII. Demo



BACKGROUND

*Customers want to converse smoothly and have quick personalized replies to their questions.
Restaurant chatbots serve to meet this need*



HANDLING
ORDERS



RESPONDING TO
INQUIRIES



OFFERING IMMEDIATE
SUPPORT TO CLIENTS



MAKING MENU
RECOMMENDATIONS BASED
ON PREFERENCES WITHOUT
HAVING TO WAIT IN LINE TO
TALK TO A CUSTOMER
REPRESENTATIVE.

“According to Markets and Markets Research the chatbot market size is expected to grow from USD 2.9 billion in 2020 to USD 10.5 billion by 2026, at a Compound Annual Growth Rate (CAGR) of 23.5%”

INTRODUCTION



RESTOBOT



MULTIPLE CUISINES



KNOWLEDGE GRAPH

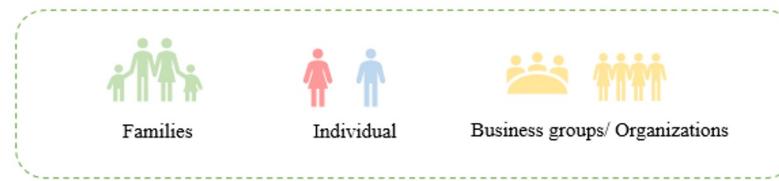


AUDIO OR TEXT I/O

Use Cases



Users



DATA COLLECTION



RESTAURANT DATA



CONVERSATIONAL DATA

Name	Description	Metadata	Size (records)
Restaurant Menu Data	Information retrieved from restaurant menu of multicuisine restaurants.	Restaurant, Cuisine, Type, Category, Sub-category, Ingredients, Price	567
Question & Answer Dataset for Knowledge Graph	Question & Answer conversations regarding the Restaurant location, working hours, Cuisines, Category, dishes, ingredients, price and general greetings	Question, Response	1,716
Conversations Data	Greetings Data, Order Data, Recipe Data, Ingredients Data, End Conversations Data	Question, Response	50,000

RESTAURANT MENU DATA



Restaurant	Cuisines	Type	Category	Sub-Category	Ingredients	Price
Denny's	American	Food	Burgers	Flamin 5-pepper Burger	Ground beef, 5-pepper blend, spicy sauce, bun	\$12.69
Chef Chu's	Chinese	Food	Signature Dishes	Live Manila Clams with Black Bean Sauce	Manila clams, quickly blanched, then flash stir-fried with a black bean sauce, so you can almost taste the sea!	\$20.95
Chef Chu's	Chinese	Food	Appetizers	Hot Dragon Wings	Chicken wings marinated and deep-fried, then tossed with a mixture of jalapeño and pepper-salt.	\$16.95
Dish N Dash	Mediterranean	Beverages	Smoothies	Berry	Orange juice, strawberries, blueberries, banana, raspberry sorbet, ice	\$8.00
Dish N Dash	Mediterranean	Food	Wraps/Pitas	Lamb Shawarma	Toasty lavash or homemade pita, greens, tomatoes, cucumbers, onions, pickles, parsley with lamb shawarma	\$18.75
Olive Garden	Italian	Food	Appetizers	Fried Mozzarella	Fried mozzarella cheese with marinara sauce.	\$10.29
Rock N Grill	Indian	Food	Soups	Spicy Seafood Broth	fiery and aromatic soup featuring a medley of seafood, such as shrimp, fish, and clams, cooked in a flavorful broth infused with spices like chili, garlic, and ginger, creating a tantalizing and satisfying seafood experience.	\$7.99

Q&A DATA FOR KNOWLEDGE GRAPH



Type	Question	Answer
Restaurant	What restaurants are available?	The restaurants available are dish N dash, CHEF CHU'S, Olive Garden, Rock N Grill, Denny's.
Address	Where is the restaurant "Olive Garden" located?	The address of Olive Garden is 1350 Great Mall Dr, Milpitas, CA 95035.
Address	What is the address of "CHEF CHU'S" restaurant?	The address of CHEF CHU'S is 1067 N San Antonio Rd #1300, Los Altos, CA 94022.
Address	Where is the restaurant "Rock N Grill" located?	The address of Rock N Grill is 1702 N Mays St Suite A, Round Rock, TX 78664.
Open and close time	What time does the restaurant CHEF CHU'S open?	The restaurant CHEF CHU'S opens at 11:30 AM.
Open and close time	What time does the restaurant dish N dash close?	The restaurant dish N dash closes at 9:00 PM.
Open and close time	What time does the restaurant Denny's open and close?	The restaurant Denny's opens at 9:00 AM and closes at 8:00 PM.
Contact	How can I contact Olive Garden restaurant?	You can contact Olive Garden restaurant at +1 (408) 935-8176.
Contact	How can I contact Rock N Grill restaurant?	You can contact Rock N Grill restaurant at +1 (512) 660-5373.
Contact	How can I contact CHEF CHU'S restaurant?	You can contact CHEF CHU'S restaurant at +1 (650) 948-2696.
Cuisine	What cuisine is available at CHEF CHU'S?	Chinese cuisine is available at this CHEF CHU'S restaurant.
Cuisine	What cuisine is available at Rock N Grill?	Indian cuisine is available at this Rock N Grill restaurant.

Q&A DATA FOR KNOWLEDGE GRAPH



Type	Question	Answer
Category	What are the different types of categories of food available in Chinese cuisine at CHEF CHU'S restaurant?	The different types of food available in Chinese cuisine at CHEF CHU'S restaurant are Signature Dishes, Appetizers, Cold Plates, Soups, Fowl, Seafood, Fresh Whole Fish, Beef & Lamb, Pork, Tofu, Vegetables, Fried Rice, Chow Mein, Desserts.
Category	What categories of beverages are available in Indian cuisine at Rock N Grill?	Categories of beverages available in Indian cuisine at Rock N Grill are Soft Drinks, Beer, Red Wine, White Wine.
Category	What categories of beverages are available in Mediterranean cuisine at dish N dash?	Categories of beverages available in Mediterranean cuisine at dish N dash are Beer, White Wine, Red Wine, Jucies, Smoothies, Tea, Extras.
Dish	What are the different dishes available under Beef & Lamb in Chinese cuisine at CHEF CHU'S restaurant?	The different dishes under Beef & Lamb in Chinese cuisine at CHEF CHU'S restaurant available are Classic Mongolian Beef, Beef Saut�, Grilled Beijing Beef, Crispy Sichuan Beef, Pan-Seared Black Pepper Steak, Tangerine Beef, Hunan-Style Lamb, Mongolian Lamb
Dish	What are the different dishes available under Naan And Roti in Indian cuisine at Rock N Grill restaurant?	The different dishes under Naan And Roti in Indian cuisine at Rock N Grill restaurant available are Paneer Kulcha, Garlic Naan, Cheese Naan, Butter Roti, Bullet Naan, Aloo Paratha
Dish	What are the different drinks/beverages available under Soju in Chinese cuisine at CHEF CHU'S restaurant?	The different drinks/beverages available under Soju in Chinese cuisine at CHEF CHU'S restaurant are Golden Barley 17 375 Ml, Golden Barley 40.
Dish	What drinks/beverages are available in Smoothies in Mediterranean cuisine at dish N dash?	Date, Nutella, Coconut, Berry, Tropical, Mango, Pomegranate drinks/beverages are available in Smoothies in Mediterranean cuisine at dish N dash.
Dish	What drinks/beverages are available in Soju in Chinese cuisine at CHEF CHU'S?	Golden Barley 17 375 Ml, Golden Barley 40 drinks/beverages are available in Soju in Chinese cuisine at CHEF CHU'S.

Q&A DATA FOR KNOWLEDGE GRAPH



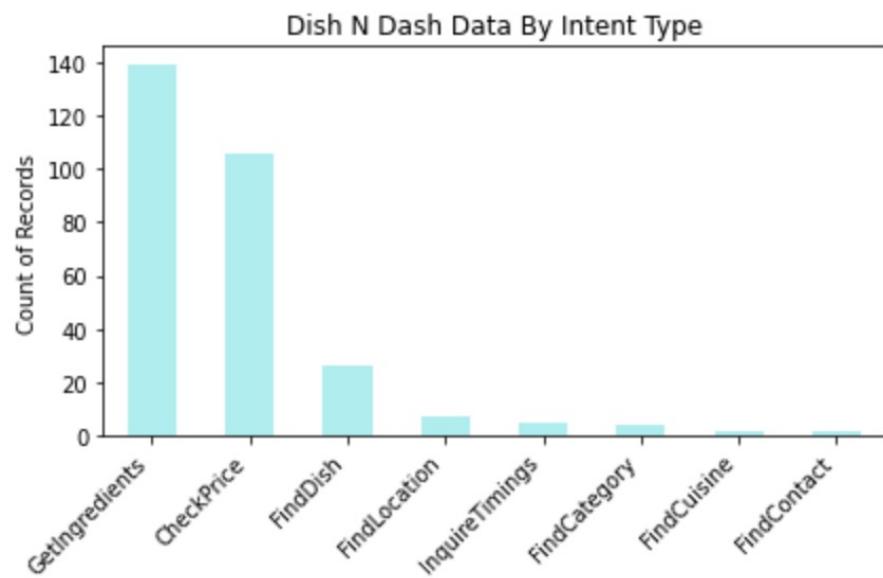
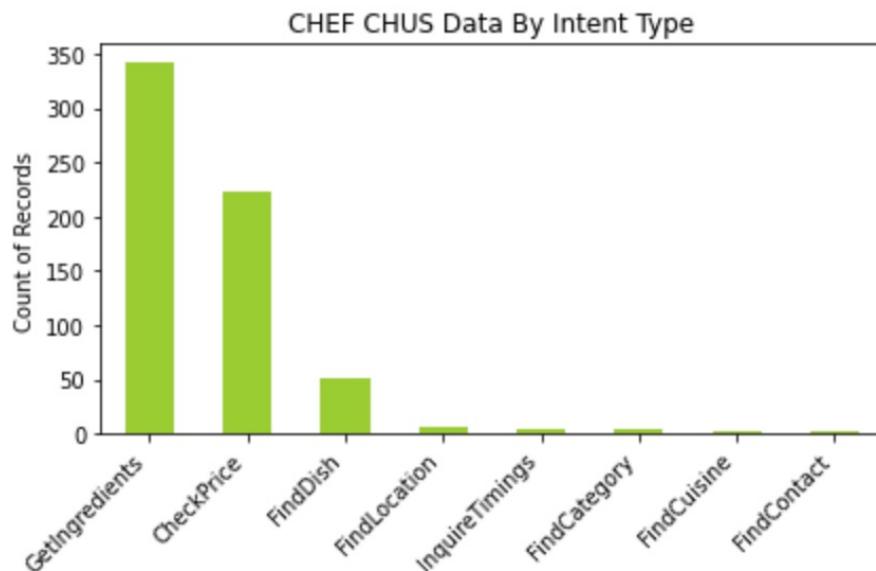
Type	Question	Answer
Ingredients	What is the Veg Ball Manchurian (Sauce) under Veg Appetizers in Indian cuisine at Rock N Grill made of?	The Veg Ball Manchurian (Sauce) under Veg Appetizers in Indian cuisine at Rock N Grill is made of Mixed Vegetable Blended And Thickened With Potato, Deep Fried Ball Tossed Into Manchurian Sauce..
Ingredients	What are the ingredients present in Hot Dragon Wings under Appetizers in Chinese cuisine at CHEF CHU'S restaurant?	The ingredients present in Hot Dragon Wings under Appetizers in Chinese cuisine at CHEF CHU'S restaurant are Chicken Wings Marinated And Deep-Fried, Then Tossed With A Mixture Of Jalapeno And Pepper-Salt..
Ingredients	What are the ingredients present in Pav Bhaji under Chat House in Indian cuisine at Rock N Grill restaurant?	The ingredients present in Pav Bhaji under Chat House in Indian cuisine at Rock N Grill restaurant are Thick Vegetable Curry Served With A Soft Bread Roll..
Ingredients	What are the details of the Hot Tea under Beverages in American cuisine at Denny's restaurant?	The details of the Hot Tea under Beverages in American cuisine at Denny's restaurant are Boil Water And Steep Tea Bag For 2-3 Minutes.
Price	What is the price of the Falafel under Appetizers (Hot) in Mediterranean cuisine at dish N dash restaurant?	The price of the Falafel under Appetizers (Hot) in Mediterranean cuisine at dish N dash restaurant is \$8.0.
Price	What is the price of the Wonton Soup - Shrimp Or Chicken under Soups in Chinese cuisine at CHEF CHU'S restaurant?	The price of the Wonton Soup - Shrimp Or Chicken under Soups in Chinese cuisine at CHEF CHU'S restaurant is \$13.95.
Price	What is the price of the Create Your Own Pasta under Classic Entrees in Italian cuisine at Olive Garden restaurant?	The price of the Create Your Own Pasta under Classic Entrees in Italian cuisine at Olive Garden restaurant is \$14.99.

CONVERSATIONS DATA



Question	Answer
I'm near 2077 N First St, San Jose, CA 95131. Is Denny's close?	Denny's is located at 2077 N First St, San Jose, CA 95131.
I had a great meal at CHEF CHU'S last time.	Thank you for sharing your experience. Your feedback is valuable to us!
Thanks!	You're welcome! Have a great day!
Do you have any Chinese restaurants?	For Chinese cuisine, you can try CHEF CHU'S.
Where is dish N dash located?	dish N dash is located at 20750 Stevens Creek Blvd, Cupertino, CA 95014.
I'm near 1067 N San Antonio Rd #1300, Los Altos, CA 94022. Is CHEF CHU'S close?	CHEF CHU'S is located at 1067 N San Antonio Rd #1300, Los Altos, CA 94022.
Help	No worries! I'm here to help. You can ask about restaurants, cuisines, timings, or any other queries you might have.
How does this work?	No worries! I'm here to help. You can ask about restaurants, cuisines, timings, or any other queries you might have.

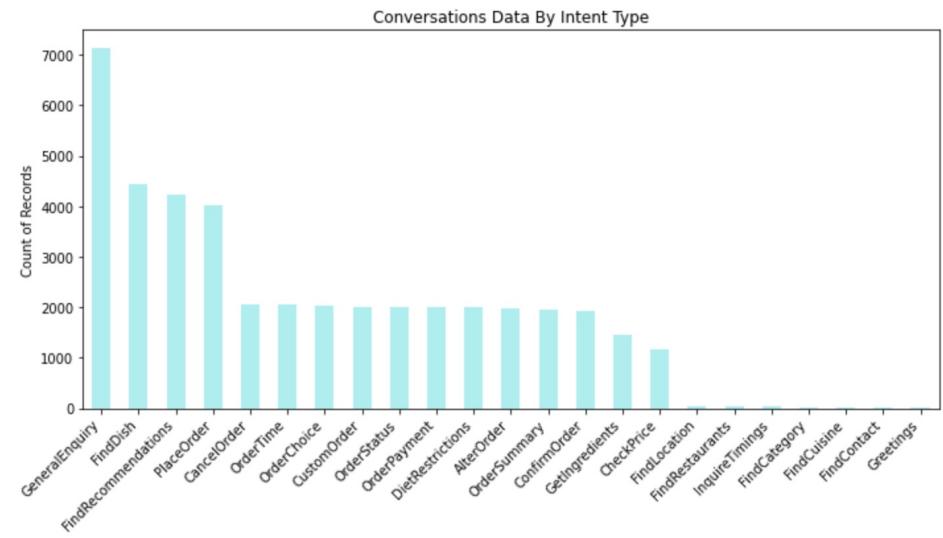
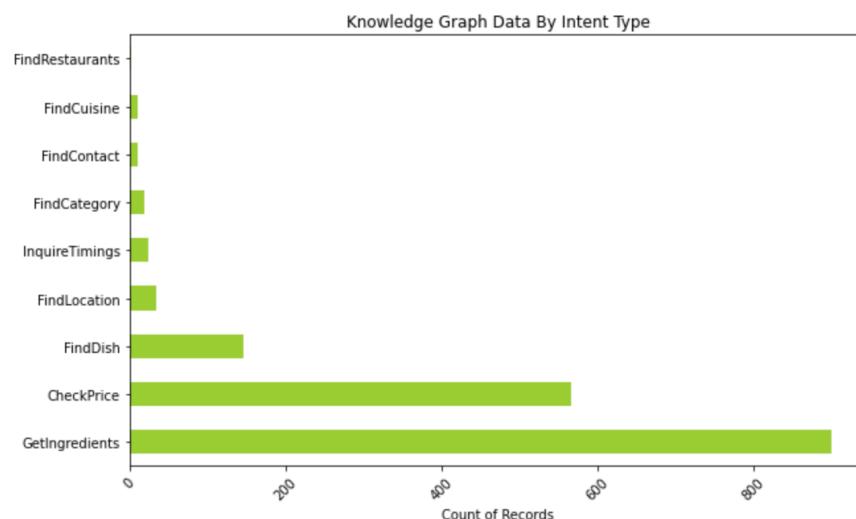
DATA ANALYTICS



Name	Description	Metadata	Size (records)
Restaurant Menu Data	Information retrieved from restaurant menu of CHEF CHU'S	Question, Response	637

Name	Description	Metadata	Size (records)
Restaurant Menu Data	Information retrieved from restaurant menu of Dish N Dash	Question, Response	291

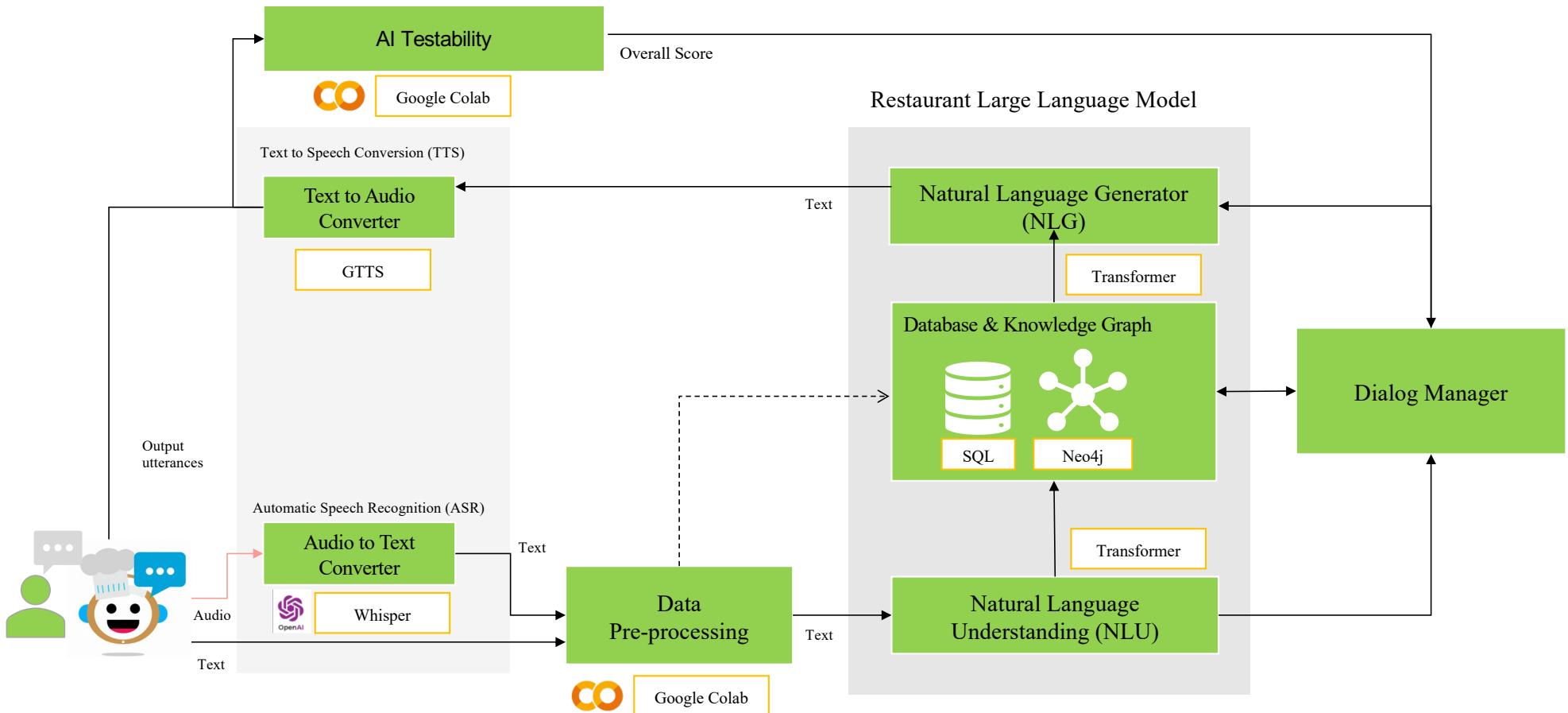
DATA ANALYTICS



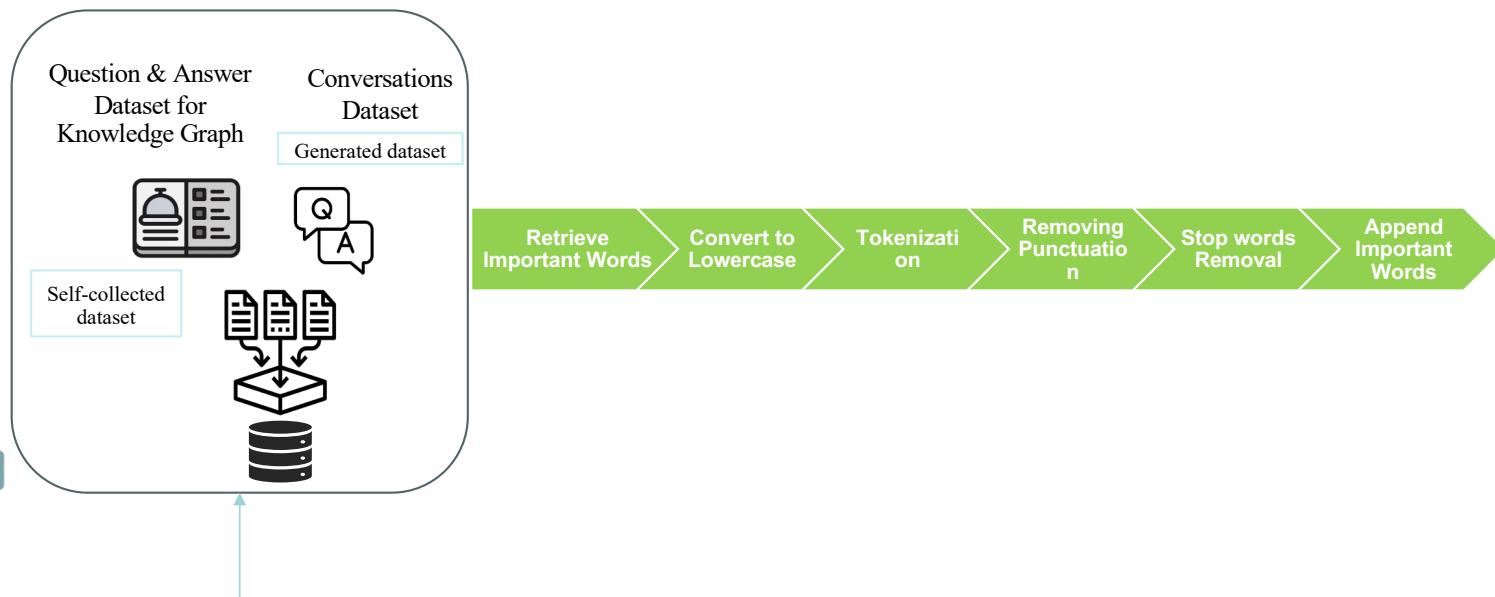
Name	Description	Metadata	Size (records)
Knowledge Graph Data	Question & Answer conversations regarding the Restaurant location, cuisines etc	Question, Response	1716

Name	Description	Metadata	Size (records)
Conversations Data	Greetings Data, Order Data, Recipe Data, Ingredients Data, End Conversations Data	Question, Response	50,000

ARCHITECTURE



DATA PRE-PROCESSING



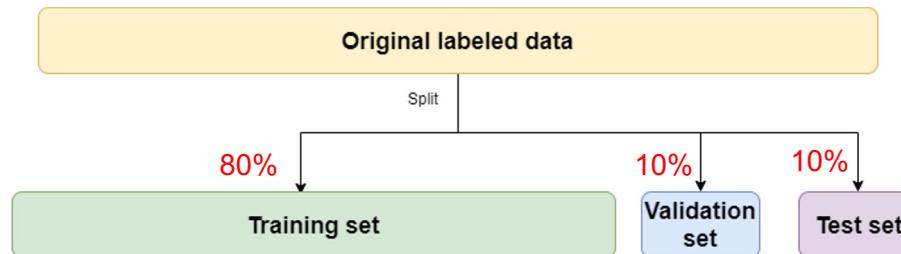
DATA PRE-PROCESSING

Pre-processing steps to transform conversations data for knowledge graph construction

Sr. No	Steps	Question Text	Answer Text
1.	Text for Pre-Processing	'What is the price of the Cheese Ravioli under Lunch-Sized Favorites in Italian cuisine at Olive Garden restaurant? '	'The price of the Cheese Ravioli under Lunch-Sized Favorites in Italian cuisine at Olive Garden restaurant is \$11.49. '
2.	Retrieve Important Words	Restaurant Names: 'Olive Garden' Price: None	Restaurant Names: 'Olive Garden' Price: '\$11.49'
3.	Tokenization	['What', 'is', 'the', 'price', 'of', 'the', 'Cheese', 'Ravioli', 'under', 'Lunch-Sized', 'Favorites', 'in', 'Italian', 'cuisine', 'at', 'restaurant?']	['The', 'price', 'of', 'the', 'Cheese', 'Ravioli', 'under', 'Lunch-Sized', 'Favorites', 'in', 'Italian', 'cuisine', 'at', 'restaurant', 'is', '.']
4.	Convert to Lowercase	['what', 'is', 'the', 'price', 'of', 'the', 'cheese', 'ravioli', 'under', 'lunch-sized', 'favorites', 'in', 'italian', 'cuisine', 'at', 'restaurant?']	['the', 'price', 'of', 'the', 'cheese', 'ravioli', 'under', 'lunch-sized', 'favorites', 'in', 'italian', 'cuisine', 'at', 'restaurant', 'is', '.']
5.	Remove Punctuation	['what', 'is', 'the', 'price', 'of', 'the', 'cheese', 'ravioli', 'under', 'lunchsized', 'favorites', 'in', 'italian', 'cuisine', 'at', 'restaurant']	['the', 'price', 'of', 'the', 'cheese', 'ravioli', 'under', 'lunchsized', 'favorites', 'in', 'italian', 'cuisine', 'at', 'restaurant', 'is', '.']
6.	Remove Stopwords	['what', 'is', 'the', 'price', 'of', 'the', 'cheese', 'ravioli', 'under', 'lunchsized', 'favorites', 'in', 'italian', 'cuisine', 'at', 'restaurant']	['the', 'price', 'of', 'the', 'cheese', 'ravioli', 'under', 'lunchsized', 'favorites', 'in', 'italian', 'cuisine', 'at', 'restaurant', 'is', '.']
7.	Tokens with Important Words	['Olive Garden', 'what', 'is', 'the', 'price', 'of', 'the', 'cheese', 'ravioli', 'under', 'lunchsized', 'favorites', 'in', 'italian', 'cuisine', 'at', 'restaurant']	['Olive Garden', '\$11.49', 'the', 'price', 'of', 'the', 'cheese', 'ravioli', 'under', 'lunchsized', 'favorites', 'in', 'italian', 'cuisine', 'at', 'restaurant', 'is', '.']
8.	Tokens Returned	Olive Garden, price, cheese, ravioli, lunchsized, favorites, italian, cuisine, restaurant	Olive Garden, \$11.49, price, cheese, ravioli, lunchsized, favorites, italian, cuisine, restaurant

DATA PREPARATION

- Creating training, testing, and validation datasets is one of the initial steps in Data Preparation. To ensure that the model is trained on a wide variety of instances and generalizes well to new data, data preparation is crucial.



Data	count	Training	Testing	Validation
Restaurant Data	42,000	33,600	4200	4200
Greetings Data	8000	6400	800	800
Total	50,000	40,000	5000	5000

Natural Language
Understanding
(NLU)

PROPOSED MODELS

Task	Proposed Model
Audio-to-text (ASR) system	OpenAI Whisper
Natural Language Unit (NLU)	BERT
Neo4j Knowledge Repository	Construct Knowledge Graph TF-IDF model Cosine Similarity
Natural Language Generation (NLG)	T5 Large Language Model (LLM)
Text-to-Audio	GTTS (Google Text To Speech)

AUTOMATIC SPEECH RECOGNITION (ASR)



- Provision for the user to converse with the chatbot in audio
- Pyaudio for audio recording
- OpenAI's Neural Net Whisper pre-trained module to convert audio to text achieving human-level robustness in English Speech Recognition

Automatic Speech Recognition (ASR) System for Chatbot

OpenAI Whisper

```
In [13]: # Run this command for the first time only
#!pip install -U openai-whisper

In [2]: # Install pyaudio for recording the audio
!pip install pyaudio

Requirement already satisfied: pyaudio in /Users/vanibhat/opt/anaconda3/lib/python3.9/site-packages (0.2.13)

In [3]: # import necessary libraries
import pyaudio
import wave

In [21]: # set the audio parameters
FORMAT = pyaudio.paInt16
CHANNELS = 1
RATE = 16000
CHUNK = 1024
RECORD_SECONDS = 5
WAVE_OUTPUT_FILENAME = "output.wav"

# create an instance of the pyaudio class
audio = pyaudio.PyAudio()

# open a stream for recording audio
stream = audio.open(format=FORMAT, channels=CHANNELS,
                    rate=RATE, input=True,
                    frames_per_buffer=CHUNK)

print("Recording...")
```

ASR - METRICS

Word Error Rate (WER)

- Common metrics used for evaluating speech recognition systems
- Compare the transcribed text (model's output) to a reference text (expected correct transcription)
- Measures % age of errors in the transcribed text compared to the reference text

reference = "What is the closing time of the restaurant?"

"What is the closing time of the restaurant?"

Audio 1: WER = 0.0

reference = "What beverages are available at Denny's?"

What beverages are available at Denny?

Audio 2: WER = 0.17

reference = "What drinks and beverages are available in Italian cuisine at Olive Garden?"

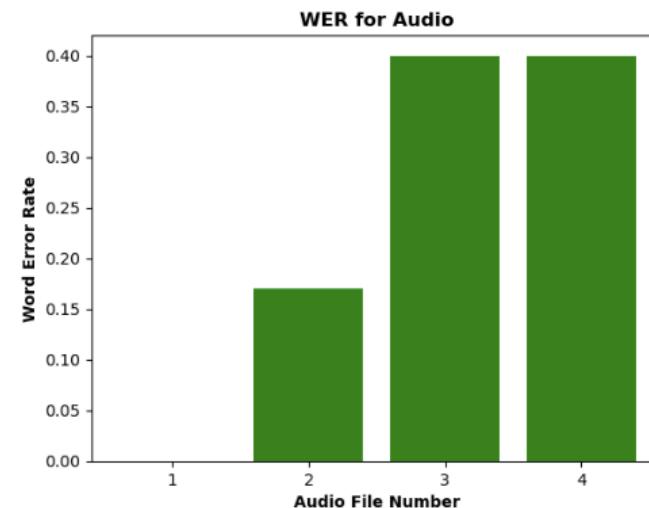
What drinks on beverages are available in Italy cuisine at Olive Garden?

Audio 3: WER = 0.40

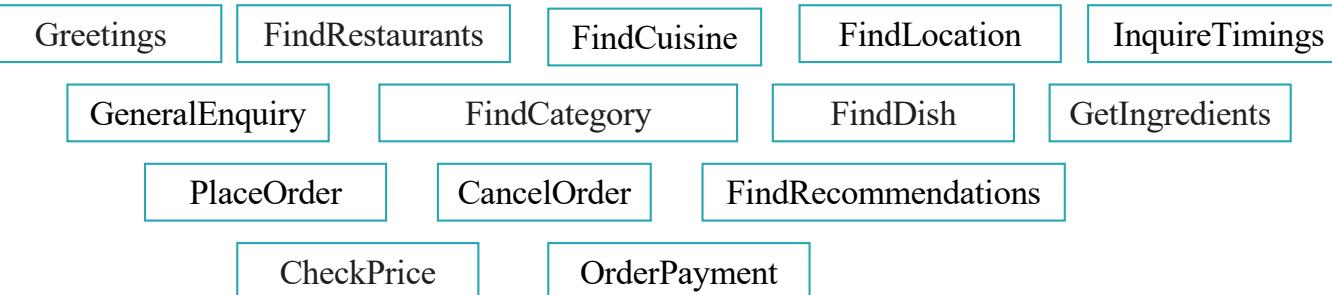
reference = "Where is Olive Garden located?"

Where is Oli Garden located?

Audio 3: WER = 0.40



NLU: INTENT AND ENTITIES

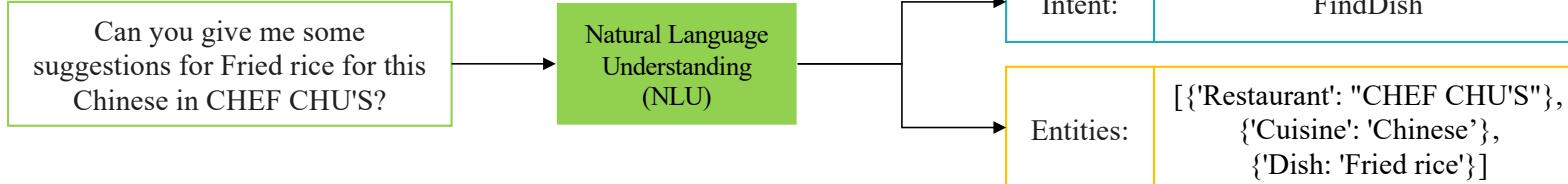
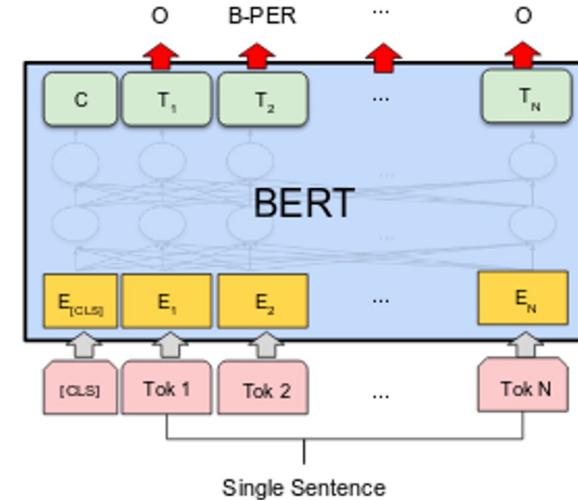


NLU: INTENT AND ENTITIES

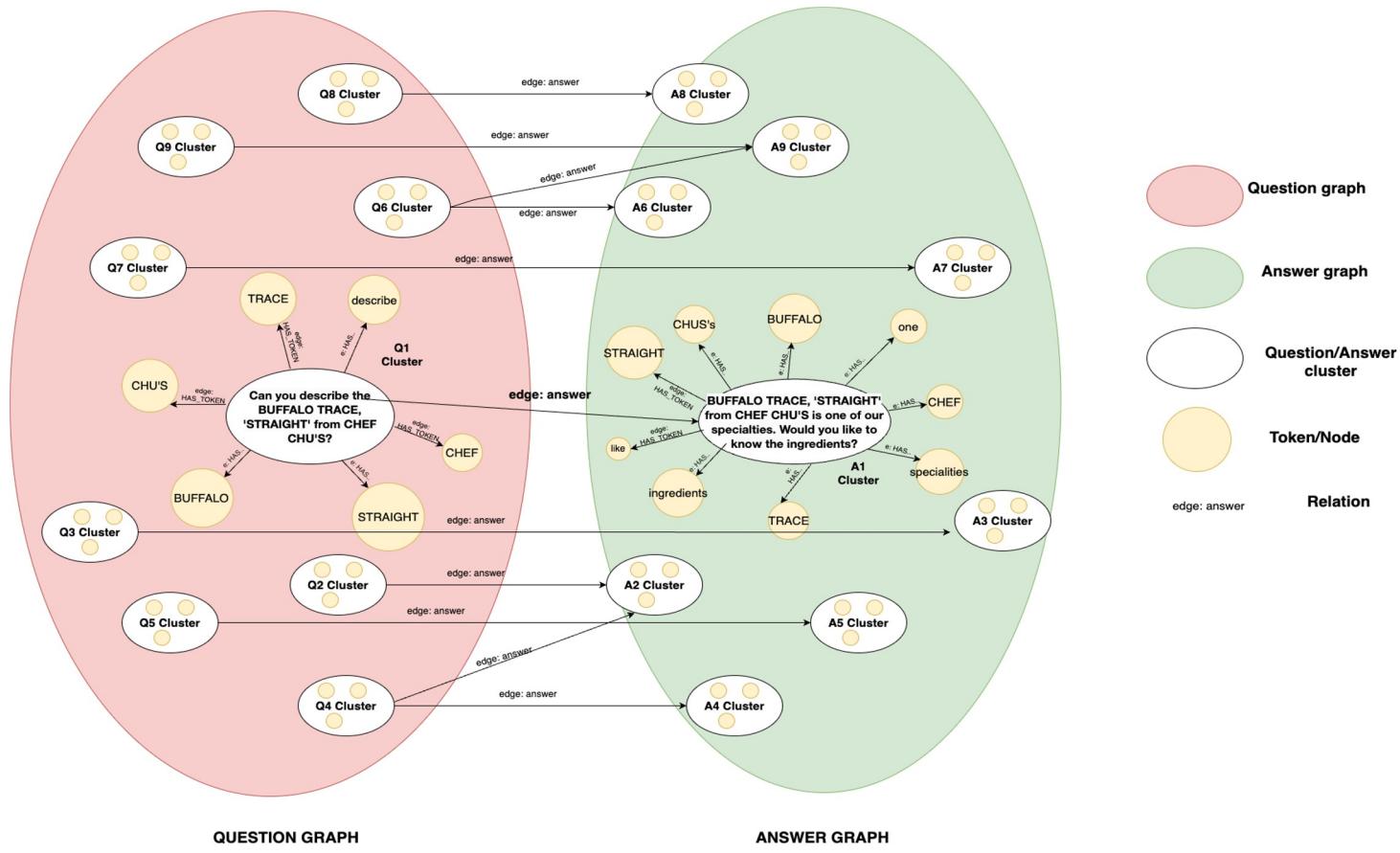
BERT:

- ❑ Fine-tuned the model for Intent and Entity recognition using the Q&A Dataset.
- ❑ Epochs: 3
Optimizer: **Adam**
Learning Rate: **2e-5**

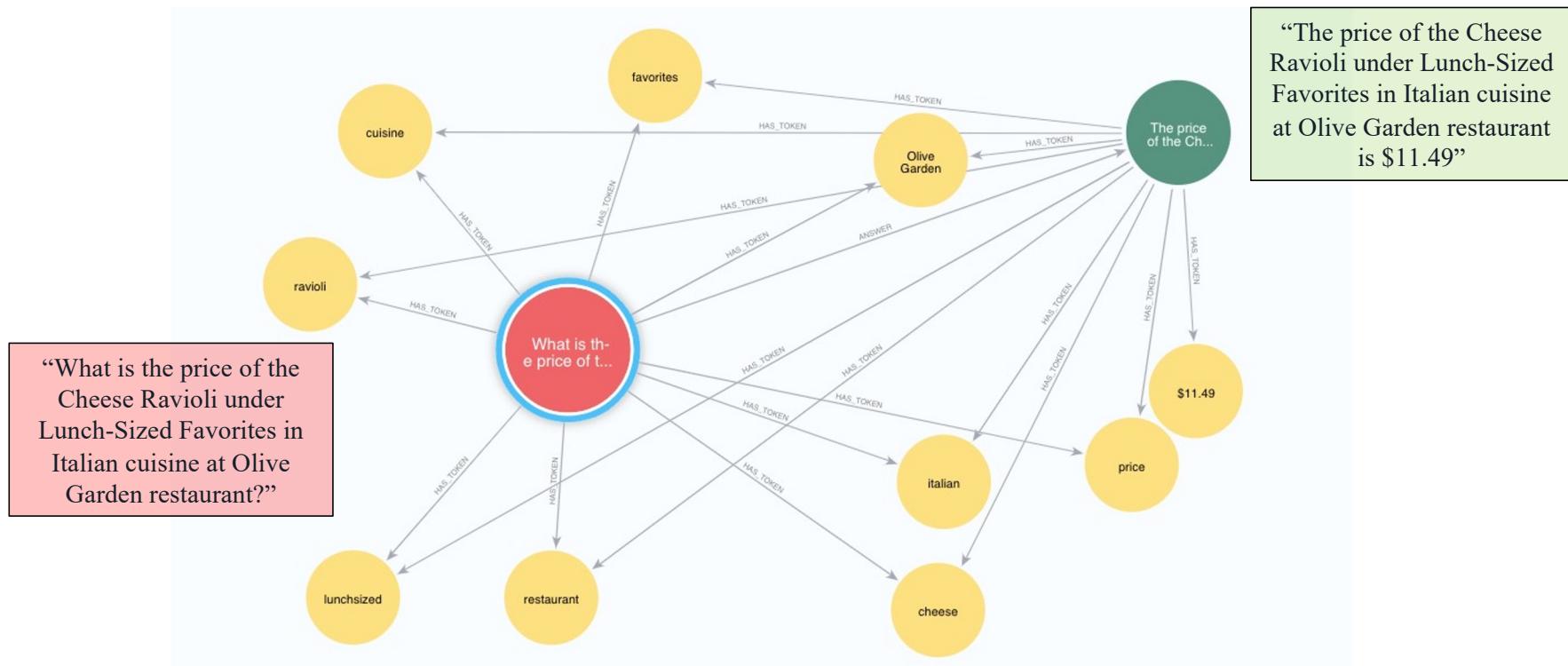
Intent Accuracy: 92.55%
Entity Accuracy: 84.55%



KNOWLEDGE GRAPH SCHEMA

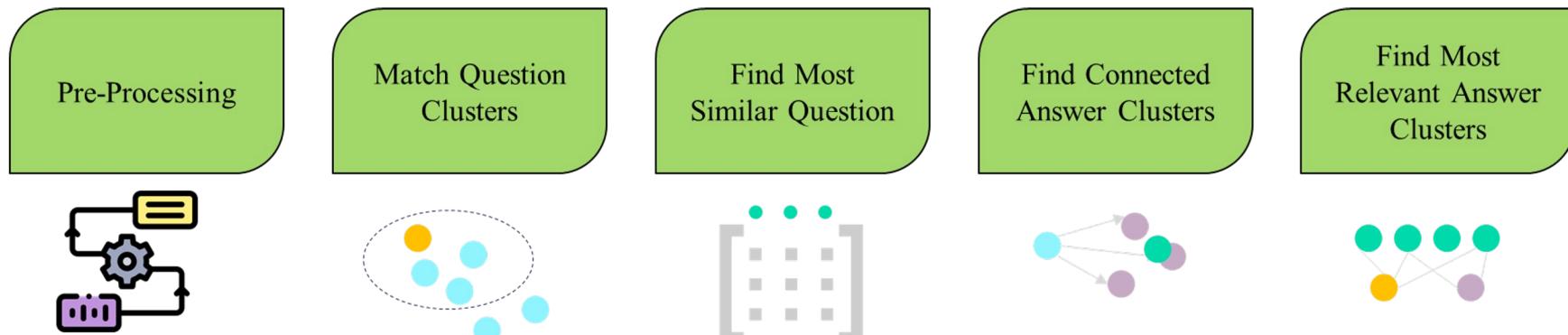


SAMPLE QUESTION-ANSWER CLUSTER



KNOWLEDGE GRAPH

Information Retrieval by graph traversal



- | | | | | |
|--|---|---|--|---------------------------------|
| i. Extract Entity List – restaurant, cuisine, category, dish | i. Pass current question and previous question entities | i. Find the Cosine Similarity of new question with matching questions in the buffer | i. Answer cluster connected to the most similar question | i. Provide answer tokens to NLG |
| ii. Extract and retain important words | ii. If information not retrieved from KG, return empty list | ii. Retrieve the matching question with highest similarity score | ii. Update conversation history | |
| iii. Tokenization | iii. Buffer of matching questions and latest new question | | | |
| iv. Change to lowercase | | | | |
| v. Punctuation removal | | | | |
| vi. Stop words removal | | | | |

KNOWLEDGE GRAPH

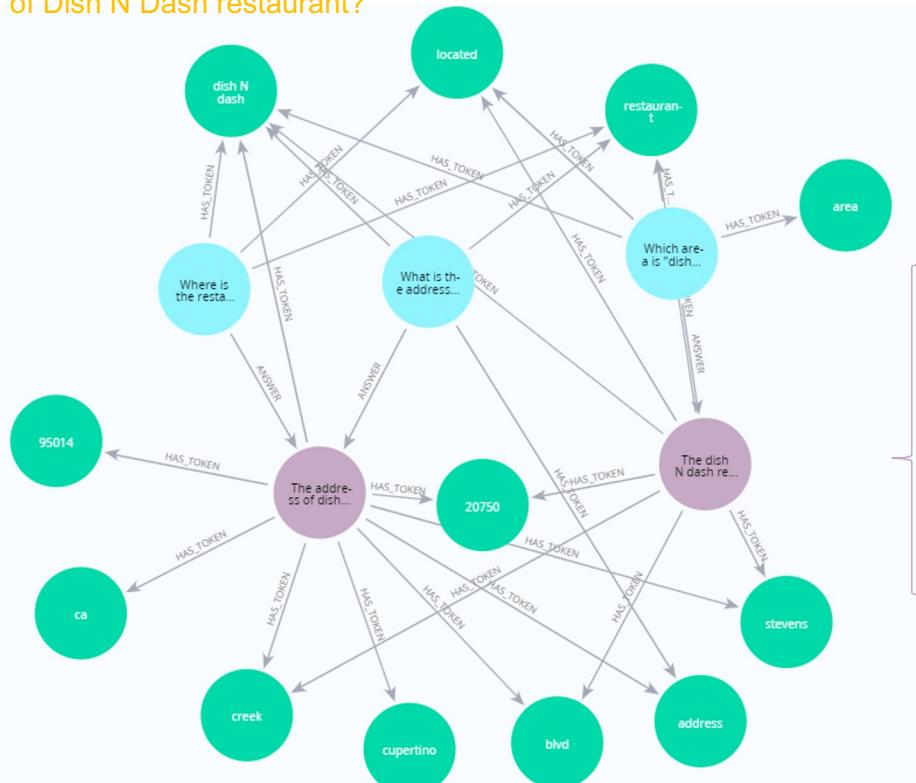
User Question: "What is the location of Dish N Dash restaurant?"

Similar Questions

Where is the restaurant Dish N Dash located?

What is the address of Dish N Dash restaurant?

Which area is Dish N Dash restaurant located in?



Similar Answers

The address of dish N dash is 20750 Stevens Creek Blvd, Cupertino, CA 95014.

The dish N dash restaurant is located in 20750 Stevens Creek Blvd.

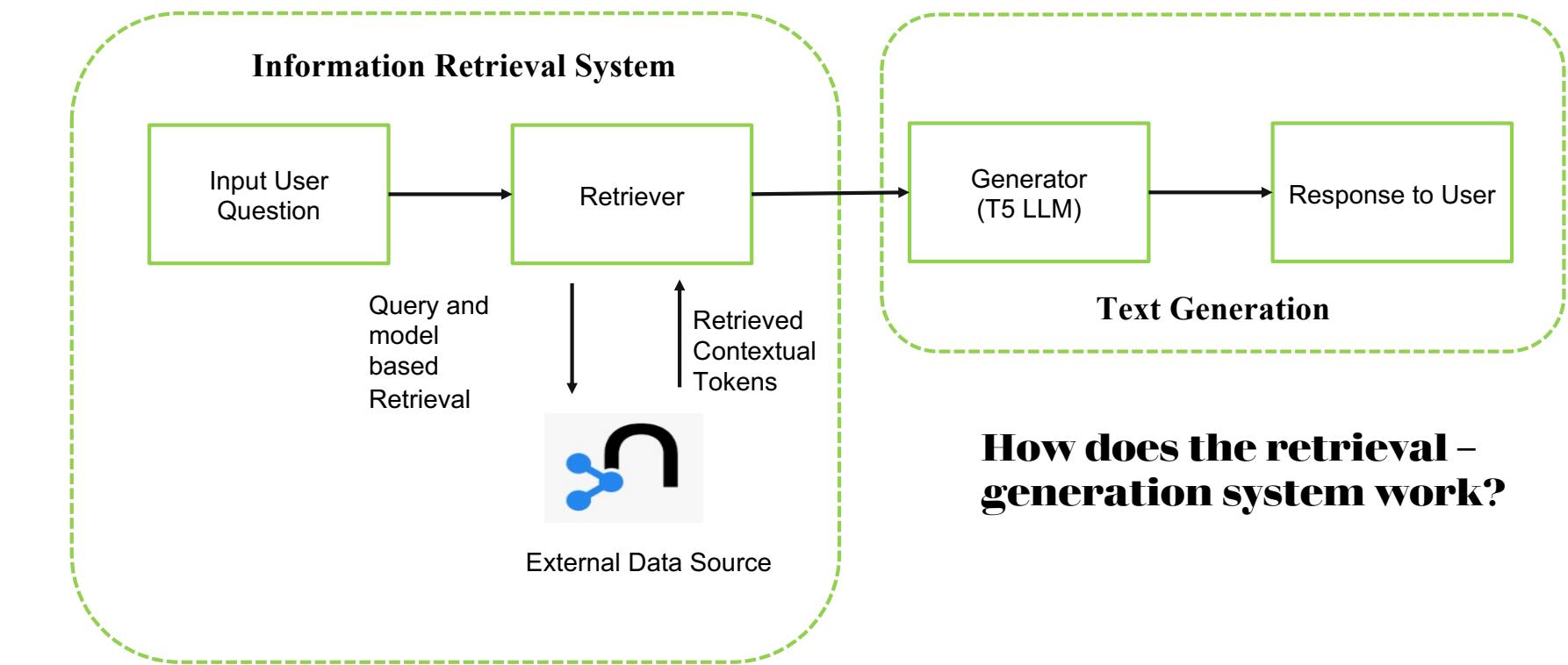
CHAT SESSION 1

Session	Seq	Input from Dataset	Entered Input Prompt	Recommended Answer (from KG)	Generated Answer (from NLG)
1	1	What is the address of "dish N dash" restaurant?	What is the address of "dish N dash" restaurant?	The address of dish N dash is 20750 Stevens Creek Blvd, Cupertino, CA 95014	Dish N Dash is located at 20750 Stevens Creek Blvd, Cupertino, CA 95014
	2	What state is the "dish N dash" restaurant located in?	In what state is the restaurant located in?	The dish N dash restaurant is located in California.	The restaurant is located in California.
	3	What cuisine is available at dish N dash?	What are the types of cuisine available?	The different types of food available in Mediterranean cuisine at dish N dash restaurant are Appetizers (Hot), Appetizers (Cold), Wraps/Pitas, Salad, Style Your Dish, Desserts.	We have desserts such as Dish Style Salad, Wrapspitas, Cold Hot Appetizers, Restaurant Cuisine / Mediterranean, Available In Different Dish N dash.
	4	What dishes are available in Wraps/Pitas in Mediterranean cuisine at dish N dash?	What dishes are available in Wraps/Pitas in Mediterranean cuisine?	Veggies, Falafel, Chicken Shawarma, Pulled Sumac Chicken, Beef Shawarma, Ground Lamb & Beef Kebab, Lamb Shawarma, Salmon dishes are available in Wraps/Pitas in Mediterranean cuisine at dish N dash	We have dishes such as Salmon Kebab, Lamb Ground Beef, Sumac Pulled Shawarma Chicken, Falafel, Veggies, Dish N dash.
	5	What are the ingredients present in Falafel under Wraps/Pitas in Mediterranean cuisine at dish N dash restaurant?	What are the ingredients present in Falafel?	The ingredients present in Falafel under Salad in Mediterranean cuisine at dish N dash restaurant are Fresh Mixed Greens, Cherry Tomatoes, Cucumbers, Onions, Herbs, Kalamata Olives, Za'Äatar Lavash Crisps & Lemon Oregano Vinaigrette Served With Edamame Corn Salsa And Falafels.	Falafel contains Served With Vinaigrette Oregano Lemon Crisps - Lavash Za'Äatar Olives, Kalamata Herbs, Onions, Cucumbers, Tomatoes, Cherry Greens, Mixed With A Fresh Restaurant With A Mediterranean Salad And Falafel. Presenting Ingredients Dish N dash.
	6	What is the Falafel under Appetizers (Hot) in Mediterranean cuisine at dish N dash made of?	What is it made of?	The Falafel under Salad in Mediterranean cuisine at dish N dash is made of Fresh Mixed Greens, Cherry Tomatoes, Cucumbers, Onions, Herbs, Kalamata Olives, Za'Äatar Lavash Crisps & Lemon Oregano Vinaigrette Served With Edamame Corn Salsa And Falafels.	Falafels, Salsa Corn Edamame Served With Vinaigrette Oregano Lemon Crisps - Lavash Za'Äatar Olives, Kalamata Herbs, Onions, Cucumbers, Tomatoes, Cherry Greens, Mixed With Fresh Made From A Mediterranean Salad And Falafel Dish N dash.

CHAT SESSION 2

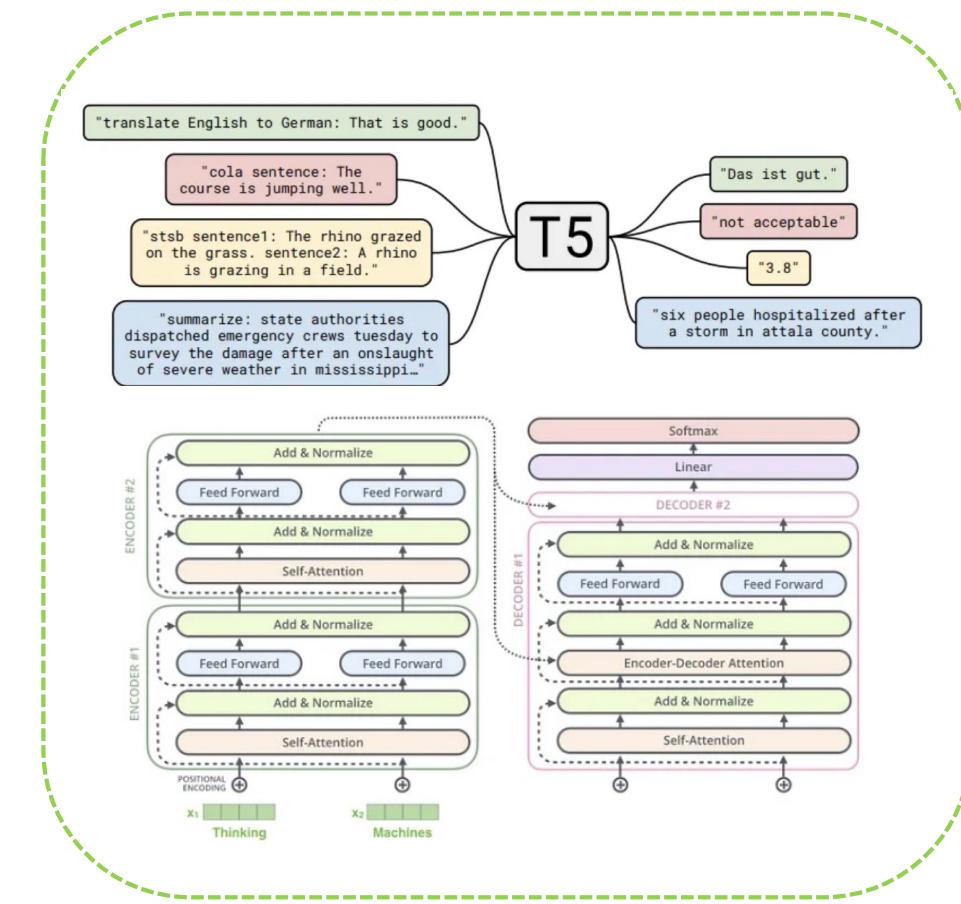
Session	Seq	Input from Dataset	Entered Input Prompt	Recommended Answer (from KG)	Generated Answer (from NLG)
2	1	What restaurants are available?	Which restaurants are available?	The restaurants available are dish N dash, CHEF CHU'S, Olive Garden, Rock N Grill, Denny's.	We have restaurants such as Rock N Grill Dish N dash Olive Garden CHEF CHU'S Denny's.
	2	What is the contact number of Olive Garden restaurant?	What is the contact number of Olive Garden restaurant?	The contact number of Olive Garden restaurant is +1 (408) 935-8176.	No contact for Olive Garden is 958176 408,1.
	3	What is the address of "Olive Garden" restaurant?	What is their address ?	The address of Olive Garden is 1350 Great Mall Dr, Milpitas, CA 95035.	They have a phone number of 95035, CA Milpitas, Dr Mall, Great 1350, address of Olive Garden.
	4	What are the different types of categories of food available in Italian cuisine at Olive Garden restaurant?	What are the different types of categories of food available?	The different types of food available in Italian cuisine at Olive Garden restaurant are Classic Entrees, Appetizers, Alfredos, Soups, Salads, And Breadsticks, Lunch-Sized Favorites, Desserts	We have desserts such as Favorites, Lunch-Size Breadsticks, Salads, Soups, Alfredos, Appetizers & Entrees, Classic Restaurant Cuisine, Italian Available In Types Of Food, Different Olive Garden.
	5	What are the different dishes available under Alfredos in Italian cuisine at Olive Garden restaurant?	What different dishes are available under Alfredos?	The different dishes under Alfredos in Italian cuisine at Olive Garden restaurant available are Chicken Alfredo, Shrimp Alfredo, Fettuccine Alfredo (V), Chicken Tortelloni Alfredo, Seafood Alfredo	We have dishes such as Different Olive Garden.
	6	What are the ingredients present in Fettuccine Alfredo under Classic Entrees in Italian cuisine at Olive Garden restaurant?	What are the ingredients present in Fettuccine Alfredo under Classic Entrees?	The ingredients present in Fettuccine Alfredo under Classic Entrees in Italian cuisine at Olive Garden restaurant are Includes: A Pan Of Fettuccine With Our Homemade Alfredo Sauce.	Fettuccine Alfredo under Classic Entrees contains Restaurant Cuisine Italian Entrees With Classic Alfredo, Fettuccine, Present Ingredients In Olive Garden.
	7	What is the price of the Fettuccine Alfredo (V) under Alfredos in Italian cuisine at Olive Garden restaurant?	What is its price ?	The price of the Fettuccine Alfredo (V) under Alfredos in Italian cuisine at Olive Garden restaurant is \$18.99.	Restaurant, Cuisine Italian Entrees, Classic Alfredo, Fettuccine Price: \$151.99 - Olive Garden

T5– LLM FOR NATURAL LANGUAGE GENERATION



T5 LLM

Model T5	Characteristics
Model Size	Small
Model Architecture	Encoder-Decoder Transformer model
Layers	6 (Encoder & Decoder)
No. of Parameters	60 Million
Tokenization	Sentence Piece
Input-Output	Text-To-Text

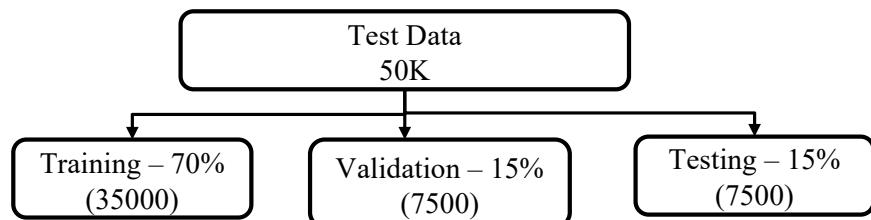


T5 LLM – TEST DATA PREPARATION

Test Data Sample

User Questions	Bot Responses	Answer Tokens
What restaurants are available?	The restaurants available are dish N dash, CHEF CHU'S, Olive Garden, Rock N Grill, Denny's.	Denny's,CHEF CHU'S,Olive Garden,dish N dash,Rock N Grill,restaurants,available
What different restaurants do you have?	The restaurants available are dish N dash, CHEF CHU'S, Olive Garden, Rock N Grill, Denny's.	Denny's,CHEF CHU'S,Olive Garden,dish N dash,Rock N Grill,restaurants,available
What are the options for the restaurants here?	The restaurants available are dish N dash, CHEF CHU'S, Olive Garden, Rock N Grill, Denny's.	Denny's,CHEF CHU'S,Olive Garden,dish N dash,Rock N Grill,restaurants,available
Where is the restaurant "dish N dash" located?	The address of dish N dash is 20750 Stevens Creek Blvd, Cupertino, CA 95014.	dish N dash,address,20750,stevens,creek,blvd,cupertino,ca,95014
What is the address of "dish N dash" restaurant?	The address of dish N dash is 20750 Stevens Creek Blvd, Cupertino, CA 95014.	dish N dash,address,20750,stevens,creek,blvd,cupertino,ca,95014
Which area is "dish N dash" restaurant located in?	The dish N dash restaurant is located in 20750 Stevens Creek Blvd.	dish N dash,restaurant,located,20750,stevens,creek,blvd
Which region is the restaurant "dish N dash" in?	The restaurant dish N dash is in United States.	dish N dash,restaurant,united,states
What state is the "dish N dash" restaurant located in?	The dish N dash restaurant is located in California.	dish N dash,restaurant,located,california
What is the name of the city in which the "dish N dash" restaurant is located?	The name of the city in which the dish N dash restaurant is located is Cupertino.	dish N dash,name,city,restaurant,located,cupertino
What's the zip code of "dish N dash" restaurant?	The zip code of dish N dash restaurant is 95014.	dish N dash,zip,code,restaurant,95014
Where is the restaurant "CHEF CHU'S" located?	The address of CHEF CHU'S is 1067 N San Antonio Rd #1300, Los Altos, CA 94022.	CHEF CHU'S,address,1067,n,san,antonio,rd,1300,los,altos,ca,94022
What is the address of "CHEF CHU'S" restaurant?	The address of CHEF CHU'S is 1067 N San Antonio Rd #1300, Los Altos, CA 94022.	CHEF CHU'S,address,1067,n,san,antonio,rd,1300,los,altos,ca,94022
Which area is "CHEF CHU'S" restaurant located in?	The CHEF CHU'S restaurant is located in 1067 N San Antonio Rd #1300.	CHEF CHU'S,restaurant,located,1067,n,san,antonio,rd,1300
Which region is the restaurant "CHEF CHU'S" in?	The restaurant CHEF CHU'S is in United States.	CHEF CHU'S,restaurant,united,states

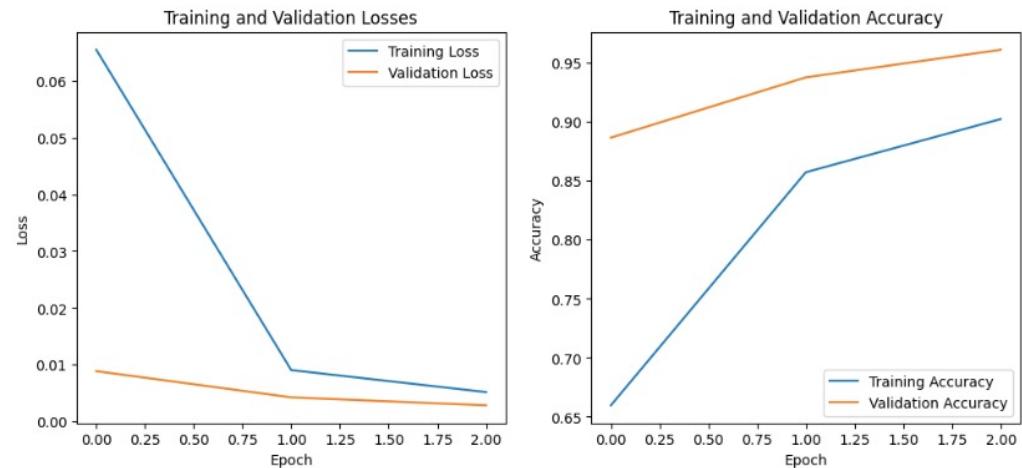
Test Data Split



T5 LLM - METRICS

Model T5	Hyperparameters
Trainable Parameters	109,855,232
Optimizer	AdamW
Learning Rate	5×10^{-5}
Epochs	3
Batch Size	1
Training Time	~4 hours

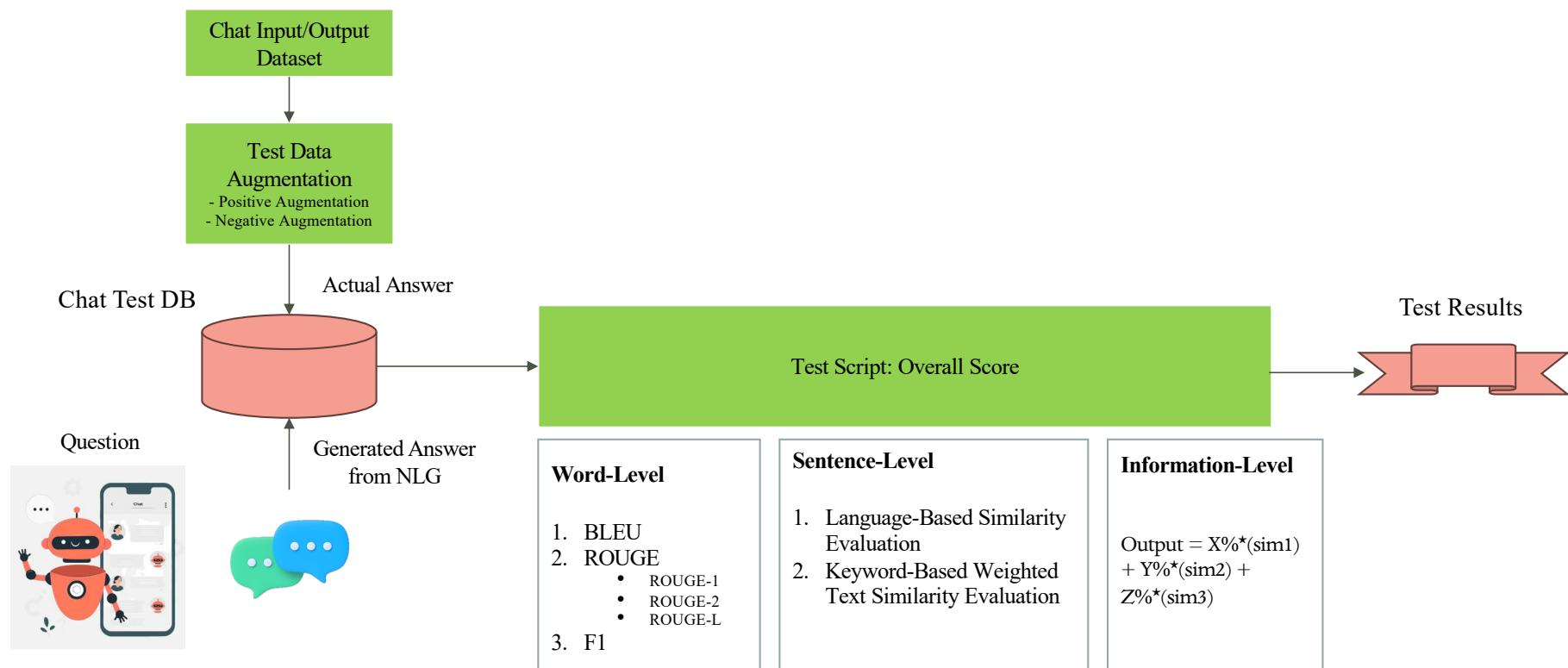
Training Loss and Accuracy Curves



BLEU Score – 0.58

Optimal range – 0.6 to 0.7

AI TESTABILITY



METRICS

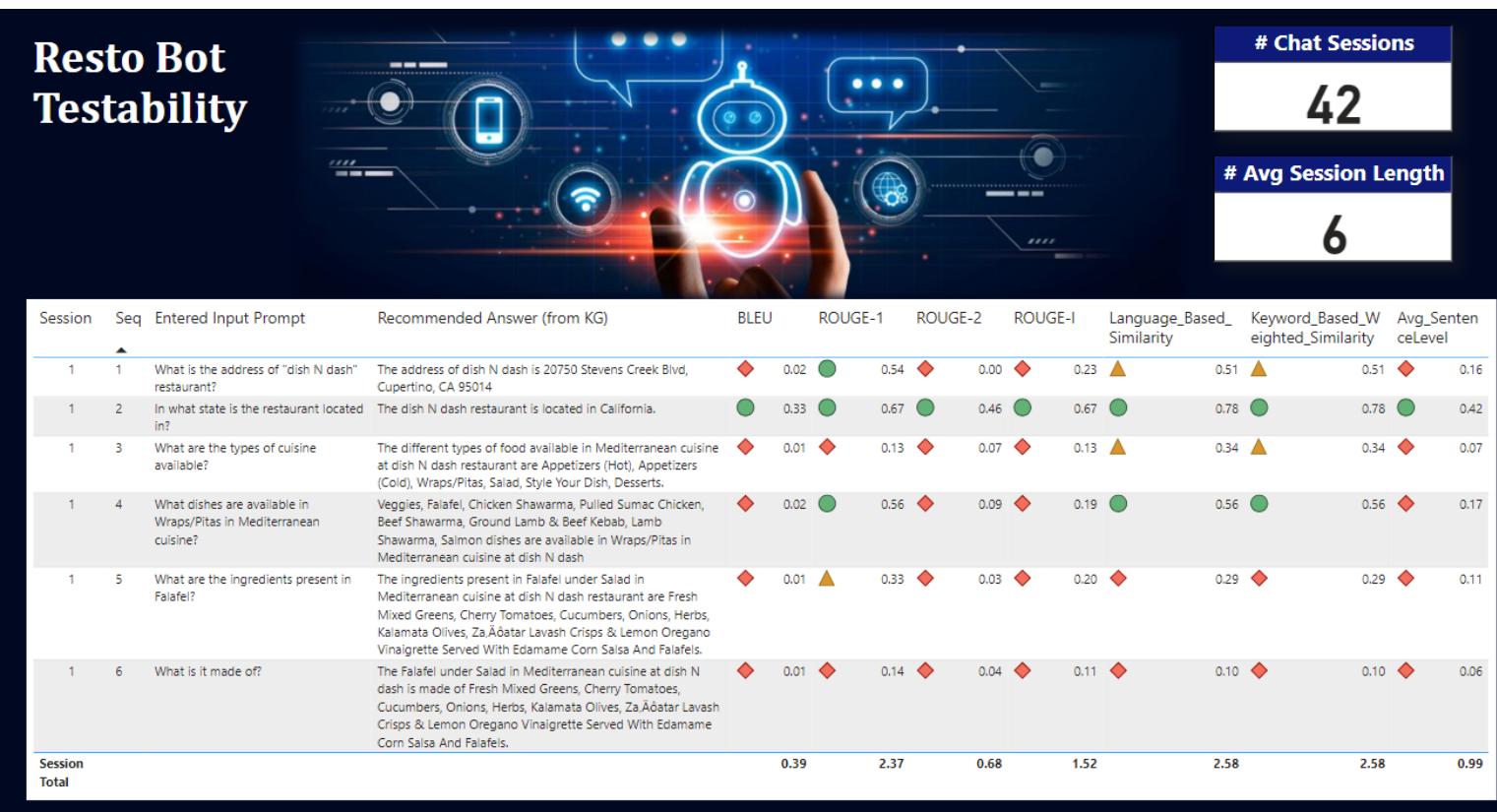
Testing Level	Metrics	Explanation
Word	BLEU	A metric that compares machine-generated text to reference material (written by humans) to determine how well the machine-generated text is.
	ROUGE	Set of metrics used to evaluate the quality of machine-generated text.
	ROUGE-1	Evaluation metric that compares the number of unigrams (single words) in the generated text to the number in the reference text.
	ROUGE-2	Evaluation metric, with an emphasis on contrasting bigrams between the reference text and the created text.
	ROUGE-L	This metric measures the longest common subsequence between the generated and reference text.
	METEOR	This metric is used to assess the quality of text from machine translations.
	F1 SCORE	This metric is the harmonic mean of two metrics precision and recall.
Sentence	Language-Based Similarity Evaluation	This metric measures how closely the content in question corresponds in terms of meaning, context, or structure
	Keyword-Based Weighted Text Similarity Evaluation	This metric finds similarity between texts based on specific keywords and their relevancy in calculating the similarity score.
Information	Domain Level metrics Evaluation	This metric includes evaluation standards and measurements that are unique to a given domain or field of interest

SESSION AND SEQUENCE METRICS

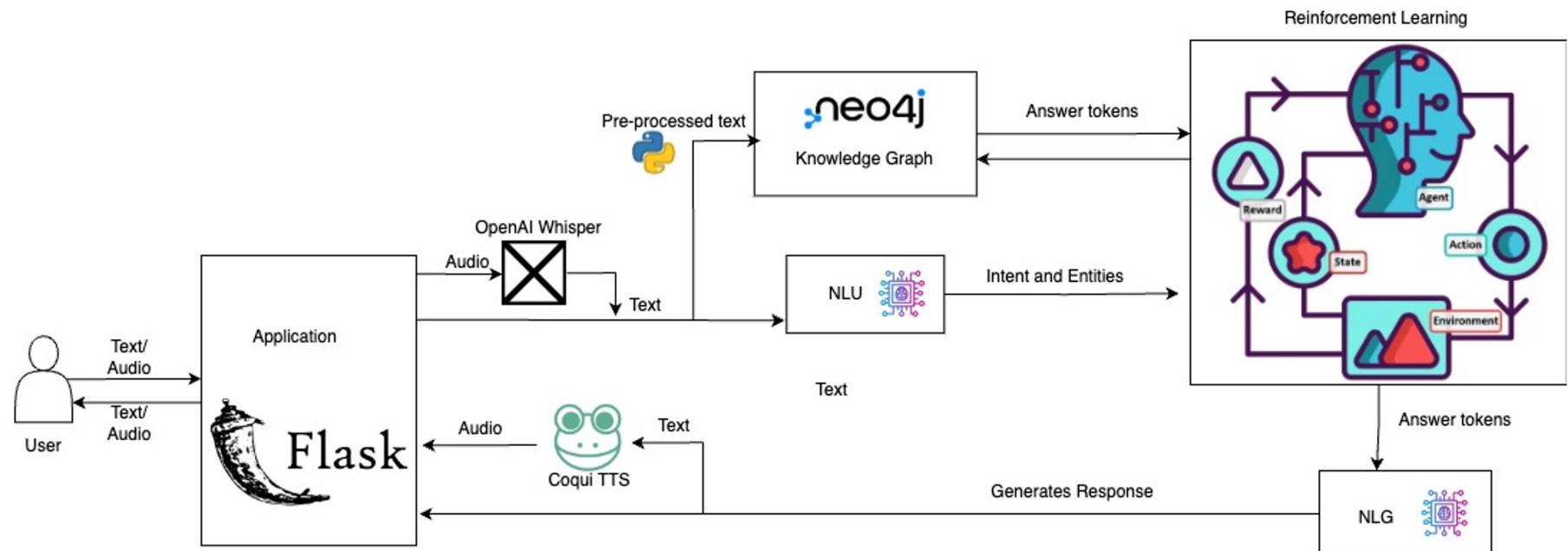
Session	BLEU_Score	ROUGE-1_Scores	ROUGE-2_Scores	ROUGE-1_Scores	F1_Score	Word-level_avg	Language_Based_Similarity	Keyword_Based_Weighted_Similarity
1	0.065503	0.394748	0.113964	0.253276	0.0	0.165498	0.429397	0.429397
2	0.047605	0.377613	0.113184	0.274159	0.0	0.162512	0.504024	0.504024

Session	Seq	BLEU_Score	ROUGE-1_Scores	ROUGE-2_Scores	ROUGE-1_Scores	F1_Score	Word-level_avg	Language_Based_Similarity	Keyword_Based_Weighted_Similarity
1	1	0.022566	0.538462	0.000000	0.230769	0.0	0.158359	0.507030	0.507030
1	2	0.325880	0.666667	0.461538	0.666667	0.0	0.424150	0.776515	0.776515
1	3	0.008687	0.129032	0.066667	0.129032	0.0	0.066684	0.344204	0.344204
1	4	0.019482	0.558140	0.086957	0.186047	0.0	0.170125	0.559107	0.559107
1	5	0.009199	0.333333	0.032258	0.200000	0.0	0.114958	0.288426	0.288426
1	6	0.007205	0.142857	0.036364	0.107143	0.0	0.058714	0.101100	0.101100
2	1	0.035580	0.413793	0.068966	0.275862	0.0	0.158840	0.592249	0.592249
2	2	0.048010	0.421053	0.117647	0.421053	0.0	0.201552	0.368480	0.368480
2	3	0.067701	0.482759	0.214286	0.275862	0.0	0.208122	0.663156	0.663156
2	4	0.012585	0.384615	0.040000	0.115385	0.0	0.110517	0.680125	0.680125
2	5	0.003482	0.200000	0.062500	0.200000	0.0	0.093196	0.122946	0.122946
2	6	0.139899	0.428571	0.222222	0.380952	0.0	0.234329	0.680969	0.680969
2	7	0.025981	0.312500	0.066667	0.250000	0.0	0.131030	0.420242	0.420242

BACKEND DASHBOARD



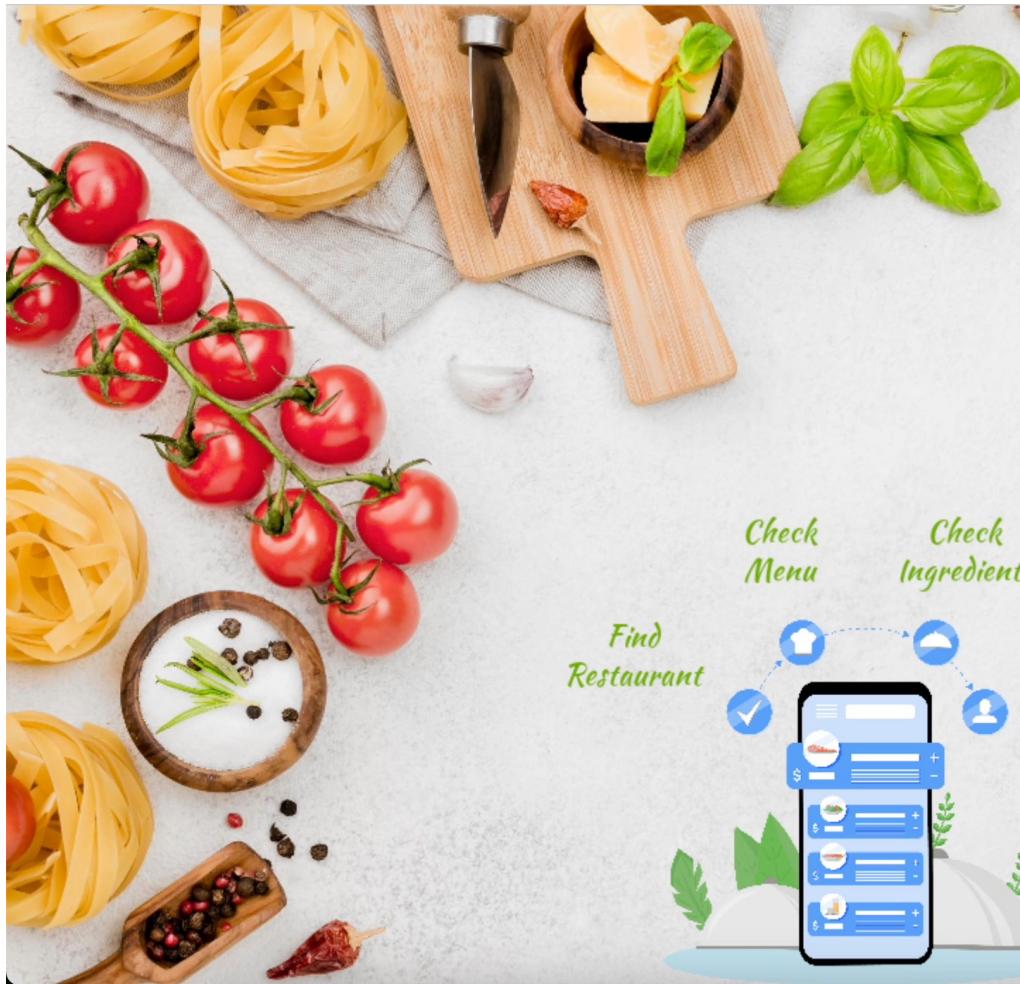
RESTOBOT BACKEND



RESTOBOT FRONTEND

Tuesday, Nov 21, 2023

DATA-298B Sec 25 Term Project: Group 1



RestoBot
BRUNCH & DINNER

Find Restaurant Check Menu Check Ingredients Speak with an Agent

RestoBot



THANK YOU