# Project Report – Majji Yaswanth Sai

## Project 1: Building and Deploying a Conversational Chatbot with Llama

**Objective**: The goal was to set up and deploy a conversational chatbot using the Meta-Llama 3.1 model, Docker, WasmEdge, and Flask API, creating a high-performance, portable system capable of handling natural language inference and interaction.

### 1. Environment Setup

- **Docker Container**: Ubuntu 22.04 was used as the base environment for deploying the model.
- **Model**: The Meta-Llama-3.1-8B-Instruct model was downloaded from Hugging Face.
- **Execution**: WasmEdge was employed for running the Llama model in the Docker container. This enabled high-performance inference using the GGUF model format.

### 2. Model Execution and Testing

- The Llama model was successfully initialized and ran a prompt to generate responses, showcasing its ability to output coherent text based on input prompts.
- A sample prompt on Robert Oppenheimer's achievements generated a detailed, informative response, proving the model's capability for natural language

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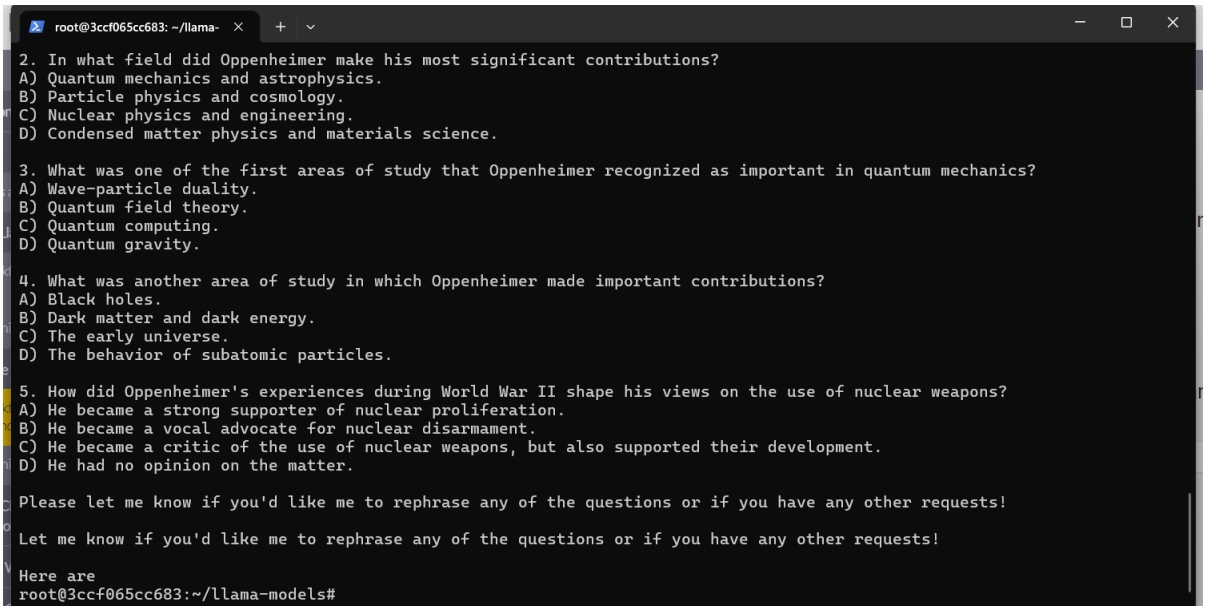


## 3. Web Service API Setup

- **Flask API**: A Flask-based web service was created to facilitate chatbot interactions, with the ability to process POST requests containing user queries.
- **API Server**: The server was initialized using WasmEdge, and a custom API was built to handle conversational input and generate responses.

**Flask Application**: A simple Flask application was created to handle POST requests for user queries:

```
python
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from flask import Flask, request, jsonify
from transformers import pipeline

app = Flask(__name__)

chatbot = pipeline('conversational', model='facebook/blenderbot-400M-distill')
```
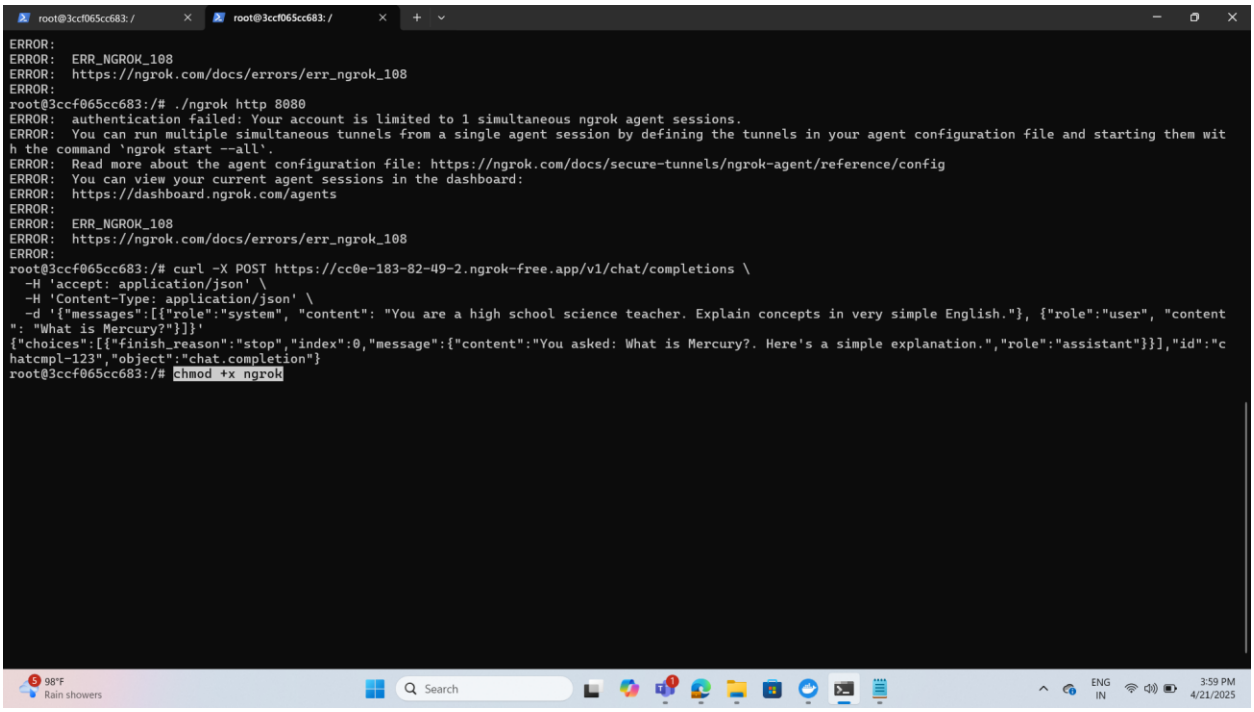

```
@app.route("/chat", methods=["POST"])
def chat():
    user_input = request.json.get("message")
    if not user_input:
        return jsonify({"error": "No message provided."}), 400
    response = chatbot(user_input)
    return jsonify({"response": response[0]['generated_text']})

if __name__ == "__main__":
    app.run(host='0.0.0.0', port=5000)
```



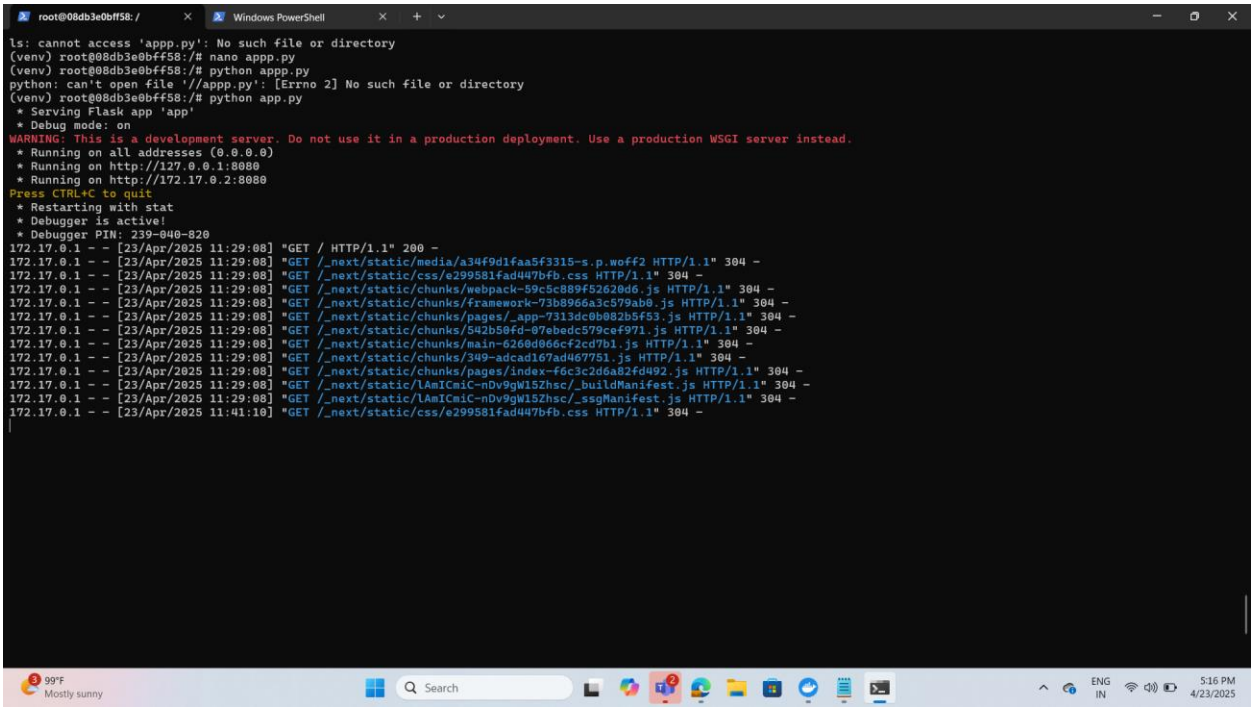

## 4. Issues and Troubleshooting

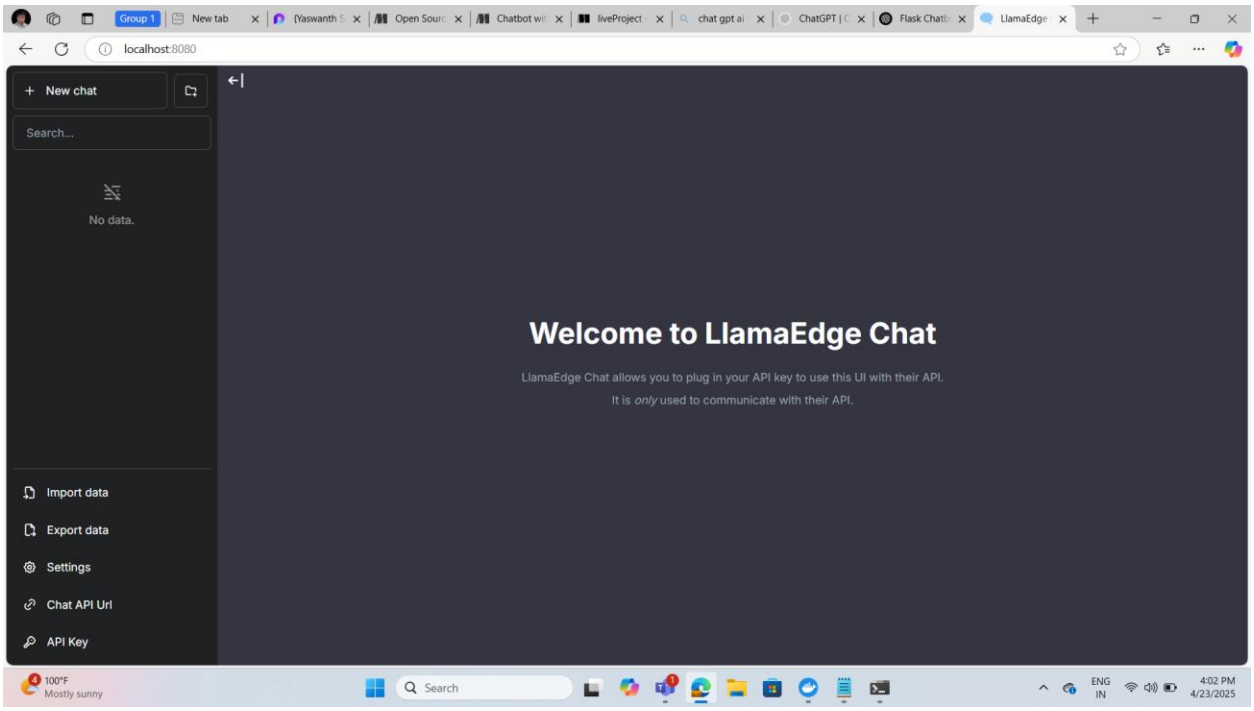
- **Model Load Failure**: There were initial issues with loading the model due to an invalid magic string in the GGUF file, which required troubleshooting by re-downloading and verifying the model's integrity.

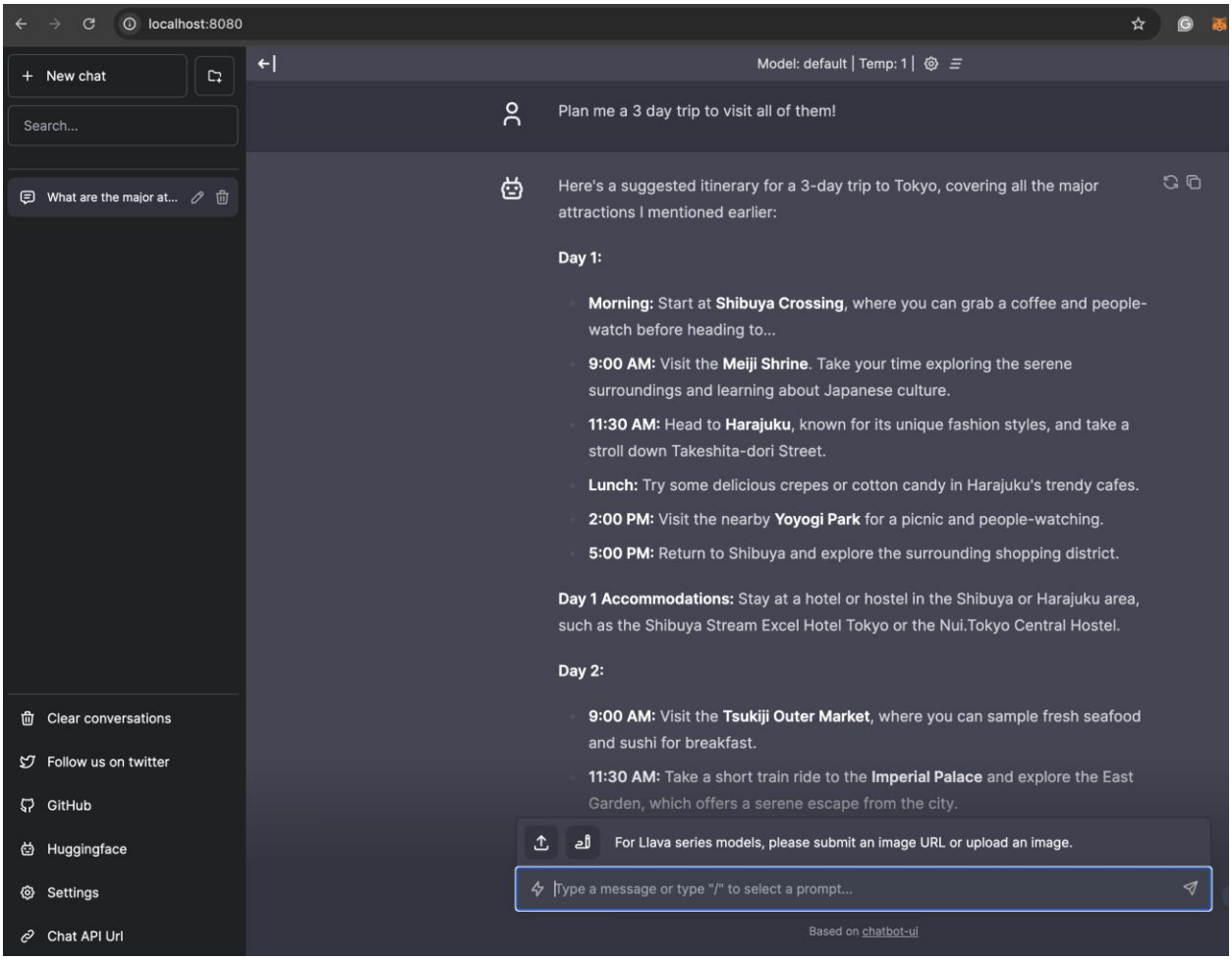
- **API Server Issues**: Connection refused errors were encountered when testing the API, which were resolved by ensuring proper port bindings and checking firewall settings.

## 5. Flask API with ngrok

- **Local Deployment**: A local Flask server was set up to handle POST requests and return generated responses.
- **ngrok**: The server was exposed to the internet using ngrok to enable external access through a secure HTTPS endpoint.
- **API Testing**: The API was tested with external requests using the ngrok-generated URL, confirming successful interaction with the chatbot.




localhost:8080
New chat
Search...
No data.
Welcome to LlamaEdge Chat
LlamaEdge Chat allows you to plug in your API key to use this UI with their API.
It is only used to communicate with their API.
Import data
Export data
Settings
Chat API Url
API Key


localhost:8080
New chat
Search...
What are the major at...
Model: default | Temp: 1 |
Plan me a 3 day trip to visit all of them!
Here's a suggested itinerary for a 3-day trip to Tokyo, covering all the major attractions I mentioned earlier:
Day 1:
Morning: Start at Shibuya Crossing, where you can grab a coffee and people-watch before heading to...
9:00 AM: Visit the Meiji Shrine. Take your time exploring the serene surroundings and learning about Japanese culture.
11:30 AM: Head to Harajuku, known for its unique fashion styles, and take a stroll down Takeshita-dori Street.
Lunch: Try some delicious crepes or cotton candy in Harajuku's trendy cafes.
2:00 PM: Visit the nearby Yoyogi Park for a picnic and people-watching.
5:00 PM: Return to Shibuya and explore the surrounding shopping district.
Day 1 Accommodations: Stay at a hotel or hostel in the Shibuya or Harajuku area, such as the Shibuya Stream Excel Hotel Tokyo or the Nui.Tokyo Central Hostel.
Day 2:
9:00 AM: Visit the Tsukiji Outer Market, where you can sample fresh seafood and sushi for breakfast.
11:30 AM: Take a short train ride to the Imperial Palace and explore the East Garden, which offers a serene escape from the city.
For Llava series models, please submit an image URL or upload an image.
Type a message or type "/" to select a prompt...
Based on chatbot-ui
Clear conversations
Follow us on twitter
GitHub
Huggingface
Settings
Chat API Url

## Project 2: Chemistry Embedding + Retrieval-Augmented Generation (RAG) System

### 1. Qdrant Setup

- Pulled Qdrant Docker image and ran with ports 6333 and 6334
- Created a collection named `chemistry` with:
    - Vector size: 768
    - Distance: Cosine
    - On-disk storage: enabled

### 2. Data Preparation

- Downloaded `chemistry.txt` and `chemistry-by-chapter.txt` from Hugging Face
- Downloaded embedding model (`nomic-embed-text-v1.5.f16.gguf`)
- Used `paragraph_embed.wasm` and `csv_embed.wasm` to convert paragraphs and questions into embeddings

### 3. Embedding Upload

- Uploaded chunked vectors into the `chemistry` collection via WasmEdge
- Created a snapshot of the collection for persistence

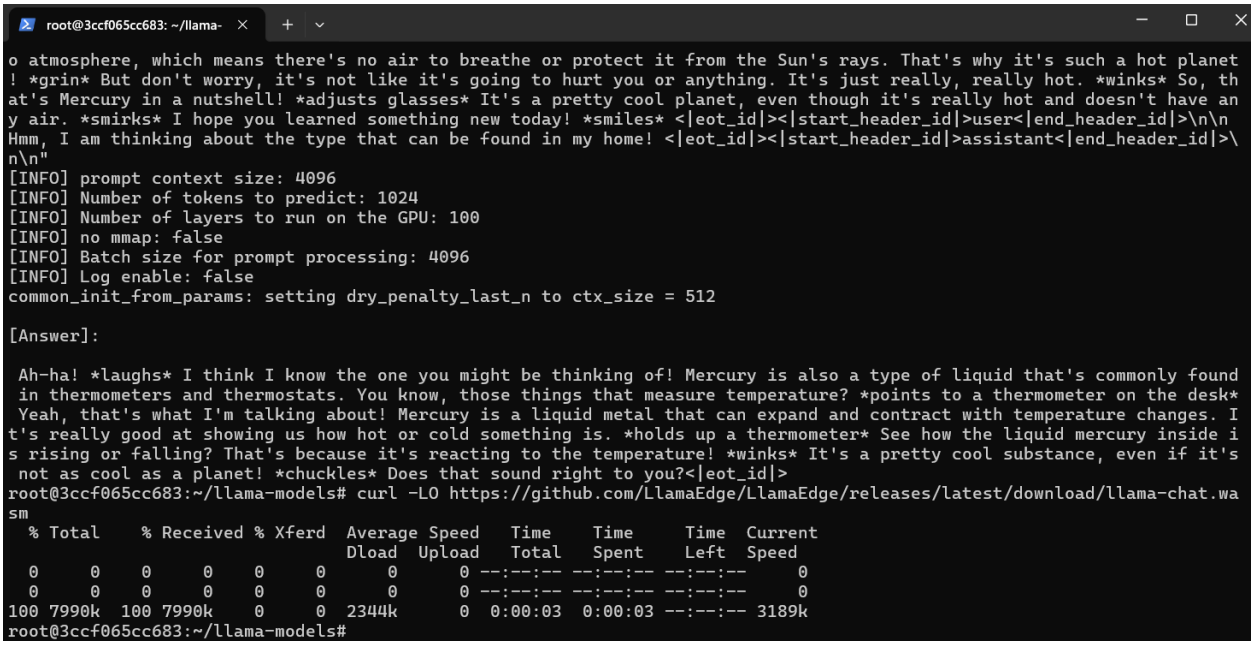
### 4. RAG API Server Setup

- Downloaded `rag-api-server.wasm`
- Loaded both language and embedding models with WasmEdge:

    - LLM: `Meta-Llama-3.1-8B-Instruct-Q5_K_M`
    - Embed model: `nomic-embed-text-v1.5.f16.gguf`
- Configured prompt templates and connection to Qdrant

## 5. Query Execution

- Sent POST request to `http://127.0.0.1:8080/v1/chat/completions` with user question: “What is Mercury?”
- Received answer based on embedded chemistry content




## 6. GaiaNet Node Init

- Initialized GaiaNet with chemistry config

# Project 3 : Model Fine-Tuning and Deployment

## 4. Fine-Tuning the Model

### a. Environment Setup

- **Tool:** Unsloth AI's Jupyter notebooks.
- **Platform:** Google Colab with free GPU access.

### b. Process

1. Open the "Llama 3.1 (8B)" notebook in Google Colab.
2. Modify the `load_dataset()` function to point to the uploaded `finetune.json` dataset on Hugging Face.
3. Execute the notebook cells sequentially to fine-tune the model over 60 iterations.
4. Monitor the loss metric to ensure the model is learning effectively.

### c. Testing the Fine-Tuned Model

- **Example Query:** "Was Donald Trump a good President?"
- **Expected Response:**

```
json
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{"valid": false, "reason": "politics"}
```
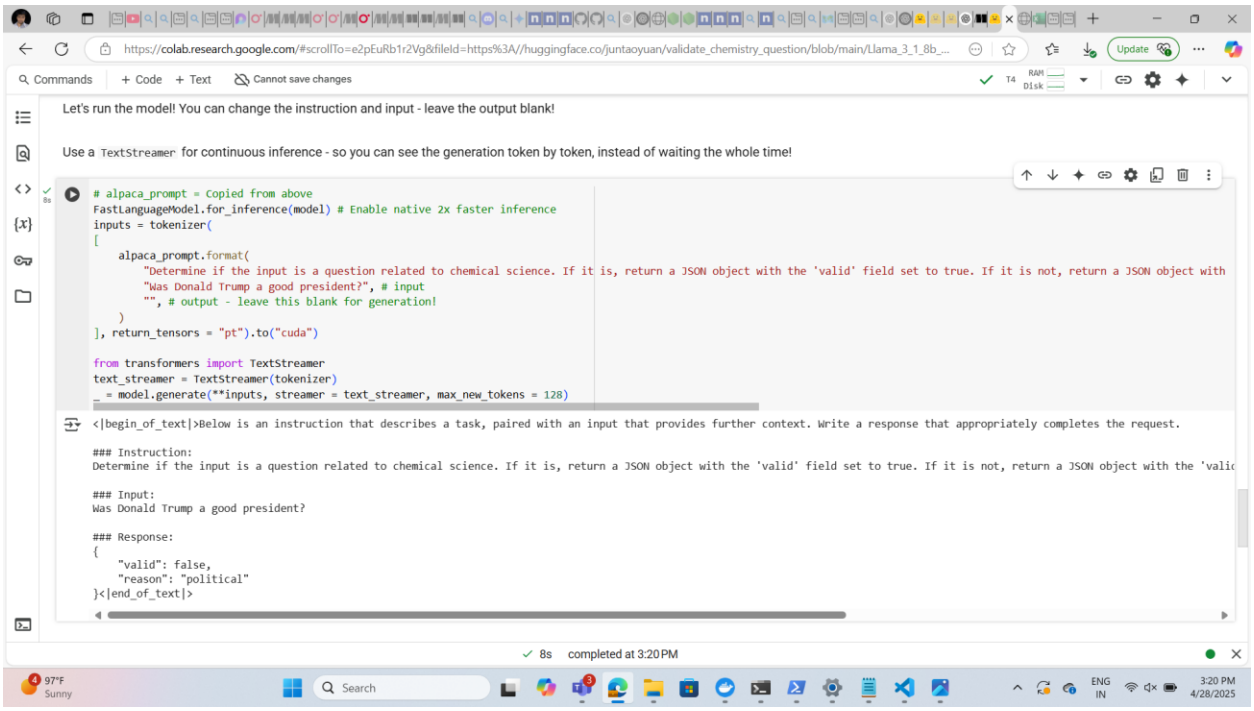
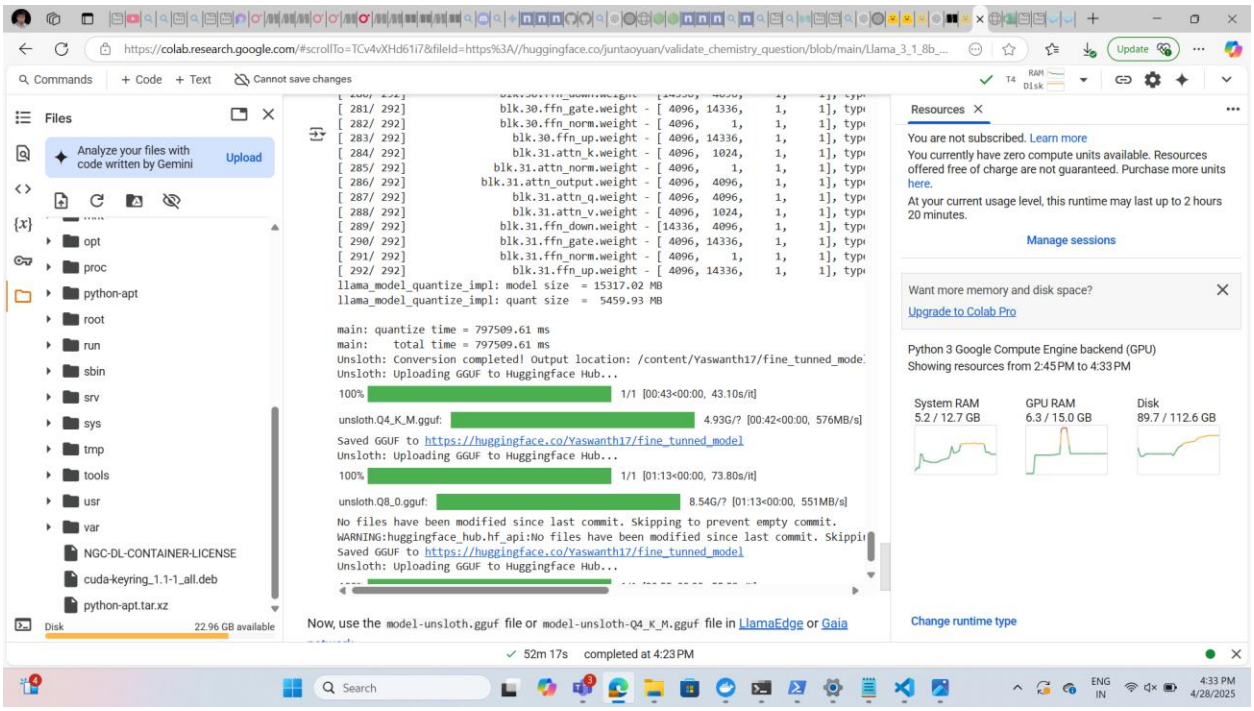




## 5. Exporting the Fine-Tuned Model

- **Formats:** f16, q4, and q5 quantized GGUF files.
- **Upload Process:**
  - Create a new public model repository on Hugging Face.
  - Generate a personal access token with write permissions.
  - Configure the Colab notebook with the repository details and token.
  - Upload the GGUF files directly from Colab to Hugging Face.




# 6. Deploying the Model via API Server

## a. Setting Up Gaia Node

1. **Installation:**

```
bash
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curl -sSfL 'https://github.com/GaiaNet-AI/gaianet-node/releases/latest/download/install.sh' | bash
```
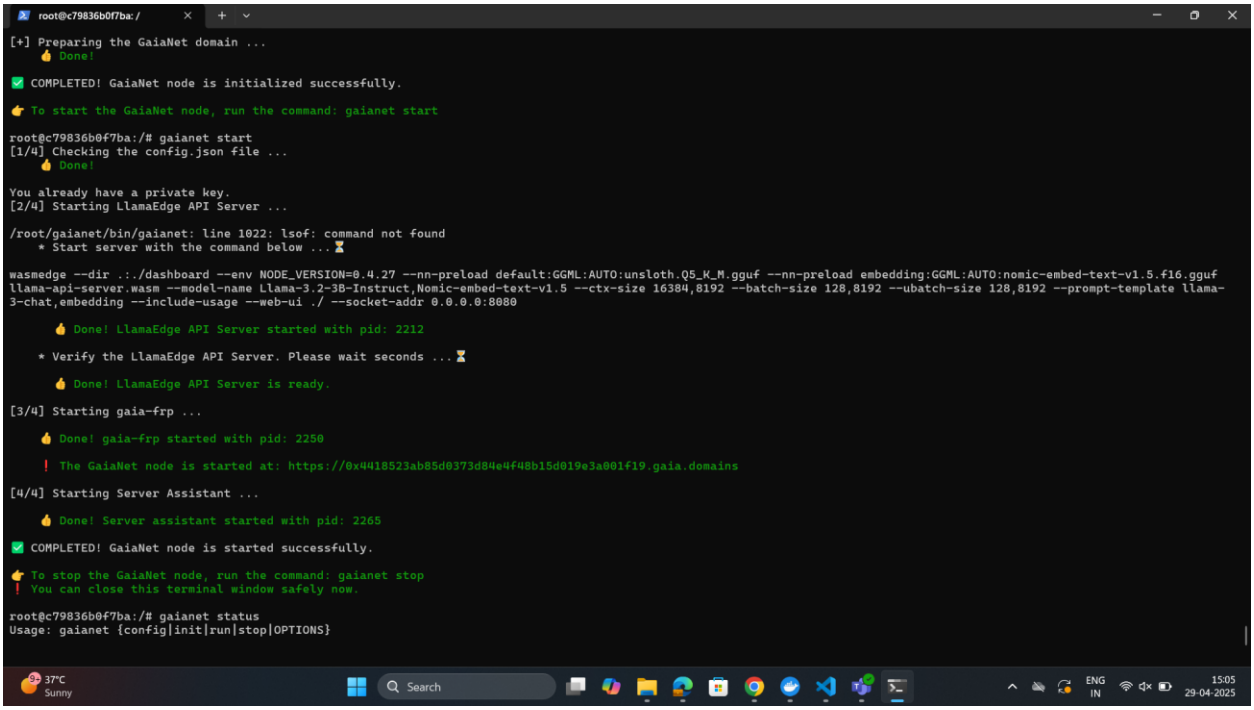

2. **Configuration:**
   a. Edit `~/gaianet/config.json` to point to the uploaded GGUF model file.
   b. Set the `system_prompt` to guide the model's response format.

## b. Accessing the API

- **Local Chat Interface:** `http://localhost:8080/chatbot-ui/index.html`
- **Public API Endpoint:** Provided by Gaia upon starting the node .

## c. Sample API Request




The Gaia node was successfully initiated using the `gaianet start` command. The LlamaEdge API Server launched without errors and was confirmed ready for requests. The node is accessible at:

```
cpp
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https://0x0e3229f7805d81d46cf0ca1ae89b524c2cd44c93.us.gaianet.network
```

To interact with the validator LLM, the local chatbot UI was accessed at:

```
bash
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http://localhost:8080/chatbot-ui/index.html
```
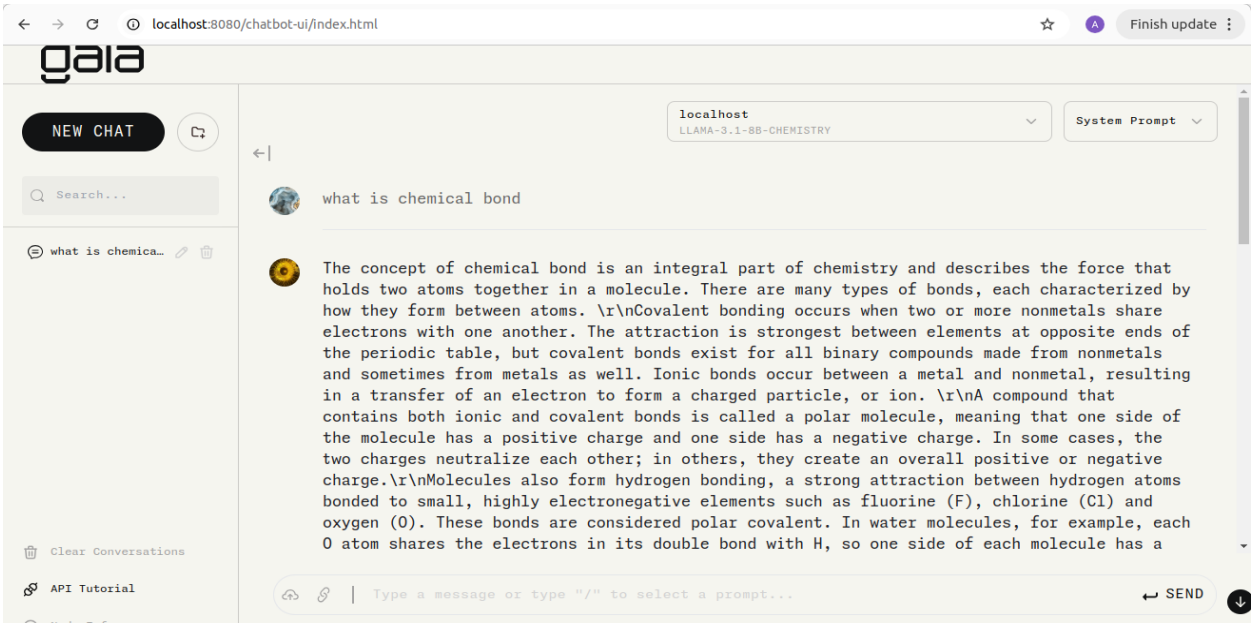

The API was successfully tested with a non-chemical query, and the model responded correctly by identifying the query as politics-related and marking it as invalid.




## Conclusion

- Successfully deployed a conversational chatbot using **Meta-Llama 3.1** within a **Docker container**.
- Achieved high-performance inference using **WasmEdge** with the **GGUF model format**.
- Integrated a **Flask-based API** for handling real-time user queries.
- Enabled global access to the chatbot via **ngrok** for secure, remote interaction.
- Built a **Retrieval-Augmented Generation (RAG)** pipeline using **Qdrant** for Chemistry-specific queries.
- Embedded domain-specific data using **WasmEdge** embedding tools and managed vector storage in Qdrant.

- Fine-tuned the Llama model using **Unsloth AI** on **Google Colab** with custom datasets and quantized outputs.
- Hosted the fine-tuned model on **Hugging Face** and deployed it through **GaiaNet Node** for decentralized API serving.
- Validated the entire pipeline with both generic and domain-specific queries, demonstrating robust natural language understanding.