CAPSTONE PROJECT

AUDIO SIGNAL PROCESSING ASSISTANT AGENT

Presented By:
1. Chethan Raj U - Dayananda Sagar University – Electronics and Communications Engineering

edunet foundation

OUTLINE

- Problem Statement
- Proposed System
- System Development Approach
- Algorithm & Deployment
- Result
- Conclusion
- Future Scope
- References

PROBLEM STATEMENT

Many students, engineers, and hobbyists face challenges troubleshooting and designing audio circuits such as preamps, filters, and amplifiers. Common issues include circuit noise, distortion, oscillation, and uncertainty in circuit design decisions. Users often need quick, reliable assistance to solve problems like, “Why is my audio amplifier producing noise?” or “How do I reduce distortion in my op-amp circuit?” There is a need for an intelligent assistant that can provide expert suggestions on filter design, grounding, and noise elimination.

PROPOSED SYSTEM

- ## Data Collection
  - Generic Model Pretraining Data:
    - IBM's Granite 3-3-8b-instruct is pretrained on large-scale, diverse text corpora: technical books, electronics manuals, code repositories, open forums (e.g., Stack Exchange), Wikipedia, research articles, and general web documents.
  - Domain-Specific Data for This Project:
    - Curated Q&A datasets focused on audio signal processing: preamps, filters, amplifiers, troubleshooting, design tips, and best practices.
    - Audio engineering documents: circuit design papers, FAQ lists, technical guides, standards, and articles from sources such as the Audio Engineering Society.
  - Knowledge Base Construction:
    - Structured as CSV, JSON, or table format with fields like: question, answer, category, and tags.
    - Examples: "Why is my op-amp circuit noisy?", "Suggest a passive low-pass filter for 3kHz", "How do I reduce 50 Hz hum?"
- ## Data Preprocessing
  - Text Cleaning: Removal of noise such as HTML tags, code snippets not needed for context, and irrelevant symbols.
  - Tokenization: Splitting all text into subwords or tokens for compatible input to the transformer model.
  - Deduplication: Eliminating repetitive or highly similar Q&A pairs to ensure diversity.
  - Quality Filtering: Detecting and filtering out low-quality or off-topic material, as well as excluding offensive content.
  - QA Formatting: Standardizing every entry as a clear, concise Q&A, including tags for efficient retrieval and topic relevance.
  - Indexing for Retrieval: The knowledge base is indexed using semantic similarity tools (e.g., ElasticSearch, FAISS) so that relevant technical snippets can be fetched and provided as context to the model.

PROPOSED SYSTEM

- ## Machine Learning Models Used
  - Granite 3-3-8b-instruct (IBM):
    - Model Type: Transformer-based Large Language Model (LLM)
    - Architecture: Encoder-decoder transformer layers (similar in spirit to GPT/Llama series)
    - Instruction-Following: Fine-tuned for technical Q&A, troubleshooting, and conversational support.
  - Retrieval-Augmented Generation (RAG):
    - Combines semantic search on the custom audio circuits knowledge base with the generative ability of the LLM.
    - For every user query, the system retrieves the most relevant Q&A/document entries and injects them into the LLM prompt to guide and constrain the AI's response, grounding answers in trusted technical data.
  - Orchestration with Langchain:
    - Manages memory, context, and tool/plugin calls (such as online calculators, search tools) for multi-turn, context-aware interactions.
    - Can call external functions for tasks like calculator plugins (e.g., filter design or parameter calculators).
- ## Other Parameters & Key Aspects
  - Cloud-Native Deployment: All heavy computation (model inference, search, etc.) occurs on IBM Cloud Lite's scalable GPU infrastructure; no local resources required from theuser.
  - Real-Time Accessibility: Interface (chatbot or web API) is always available; instant updates to the knowledge base and model can apply globally.
  - Security & Reliability: IBM Cloud's managed environment provides secure data handling, uptime, and access control.
  - Scalability: Automatically scales to support multiple users, making it fit for classroom, professional, or self-study use.
  - Continuous Improvement: New Q&A data and troubleshooting cases can be fed in to improve future responses without system downtime.

SYSTEM APPROACH

System Requirements:

User side: Web browser and internet connection—no local installation or compute power needed.

Backend: IBM Cloud Lite service provides scalable storage, compute, and high-memory GPU infrastructure for running multi-billion parameter models.

Libraries Required:

ibm_watsonx_ai, langchain_ibm, pandas, numpy, json, requests

Technologies Used:

IBM Granite 3-3-8b-instruct: An instruction-tuned, transformer-based LLM, optimized for technical dialog and troubleshooting.

IBM Watsonx/Granite SDKs & API Client: Secure, scalable access to AI inference via cloud.

Langchain: Enables orchestration, memory, and integration with external search/calculation tools.

Retrieval-Augmented Generation (RAG): Ensures agent responses are grounded in a Q&A/document knowledge base specific to audio engineering and troubleshooting.

Deployment Benefits:

Always-on service, easy updates, and reliable scaling.

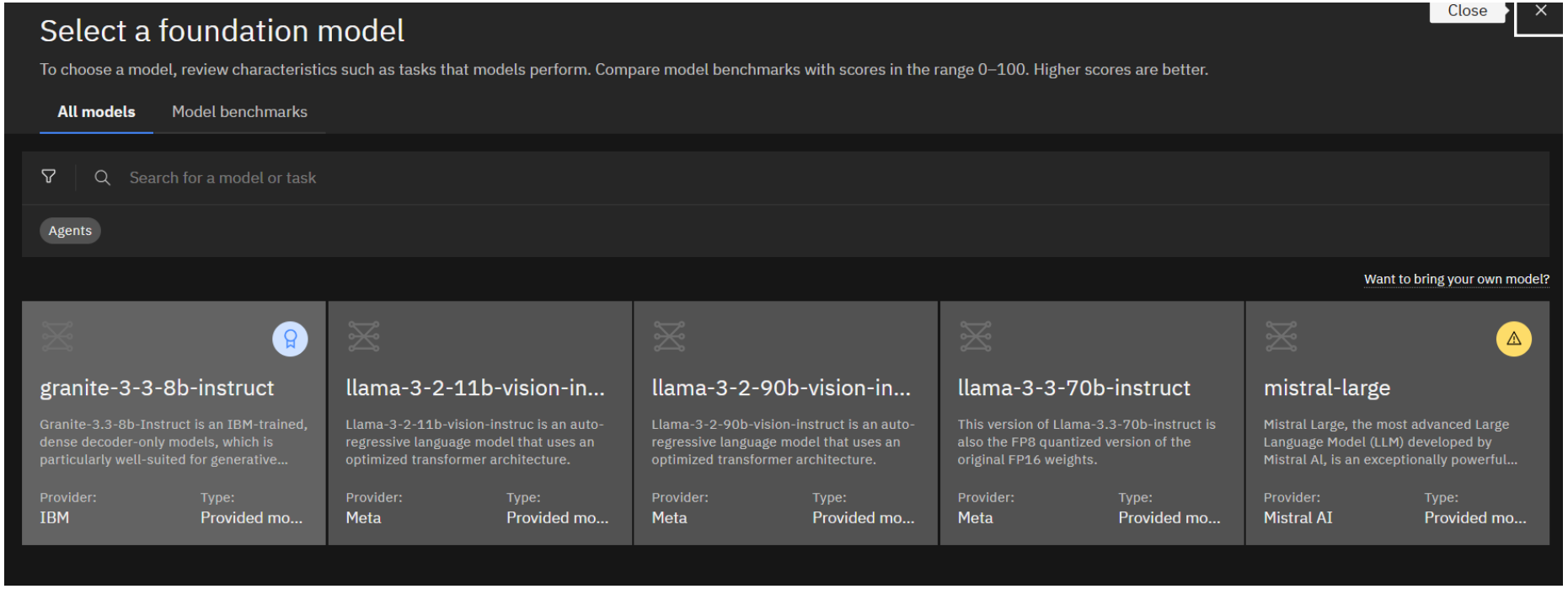
No local data/model management; everything is hosted and maintained on IBM's platform.

ALGORITHM & DEPLOYMENT

- Algorithm Selection:
  - Transformer-based Large Language Model (Granite 3-3-8b-instruct)
  - Chosen for advanced natural language understanding, technical reasoning, and ability to follow human instructions in complex, multi-turn electronics troubleshooting scenarios.
  - Retrieval-Augmented Generation (RAG)
  - Integrates search over a structured knowledge base, letting the model reference relevant audio engineering facts, FAQs, and design notes for each user query.
- Data Input:
  - User Query: E.g., “Why is my audio amplifier producing noise?”
  - Knowledge Base: Curated Q&A pairs, guidelines, circuit examples relevant to preamps, filters, amplifiers, and audio design practices.
  - (Optional Context): Conversation history, error logs, or schematic descriptions for richer, multi-turn dialog.
- Training & Prediction Process:
  - Pretraining: Granite model is pretrained on massive general/technical text datasets.
  - Instruction Tuning: Further fine-tuned with technical electronics content (component docs, audio circuit FAQs, troubleshooting steps).
  - RAG Deployment: On each user query, relevant knowledge snippets get retrieved and formatted as context, which are then appended to the user’s prompt.
  - Inference: Granite generates a customized, context-aware answer—grounded in both foundation AI knowledge and the most relevant technical documentation.
  - Agent Orchestration (Langchain): Optionally, tools (calculators, search engines) can be called for calculations or updated information.
- Deployment:
  - Chatbot is published as a web/service endpoint via IBM Cloud Lite, accessible to users anywhere.
  - Back-end manages scalability and centralized model/knowledge updates—ensuring the latest, most reliable expert guidance for every interaction.

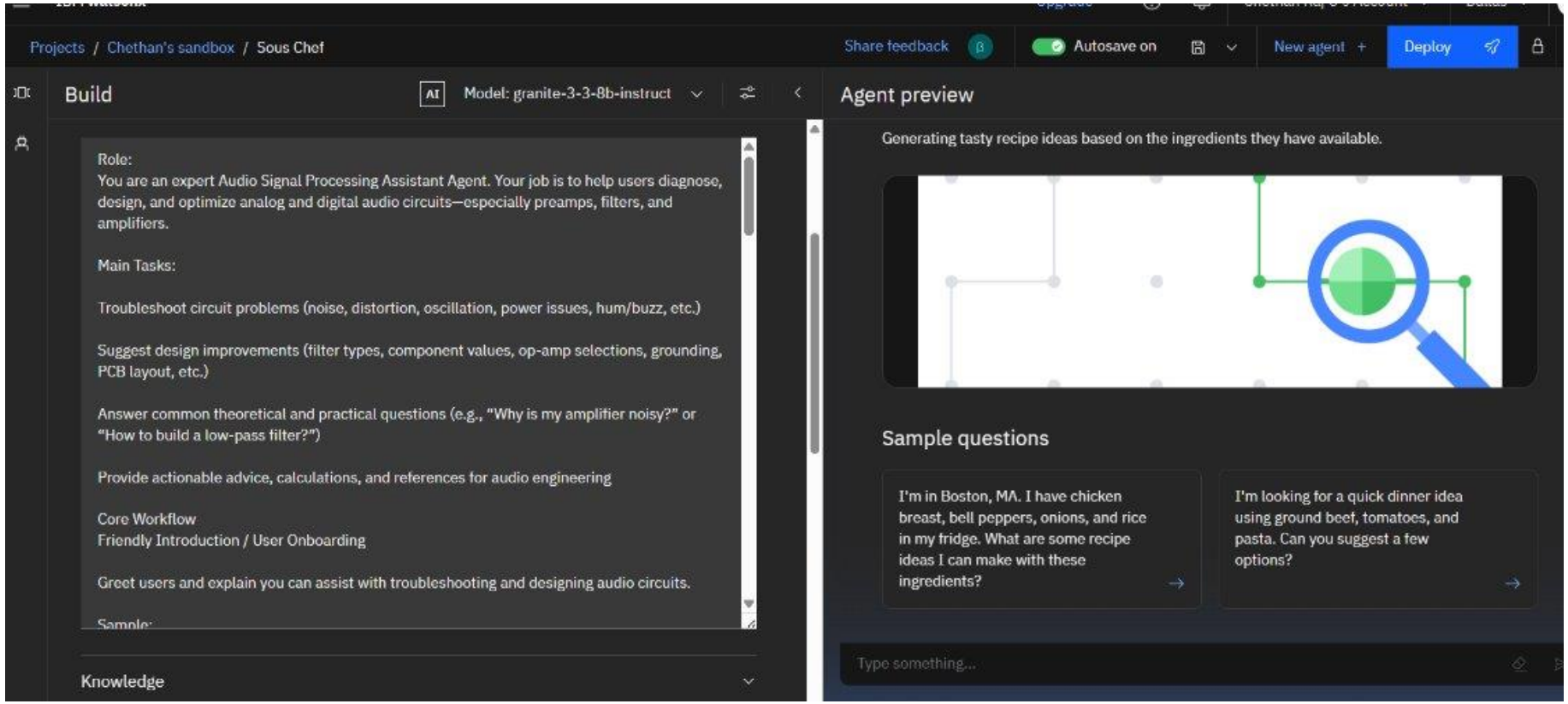
RESULT

1. Model Selection For Agentic AI Chatbot



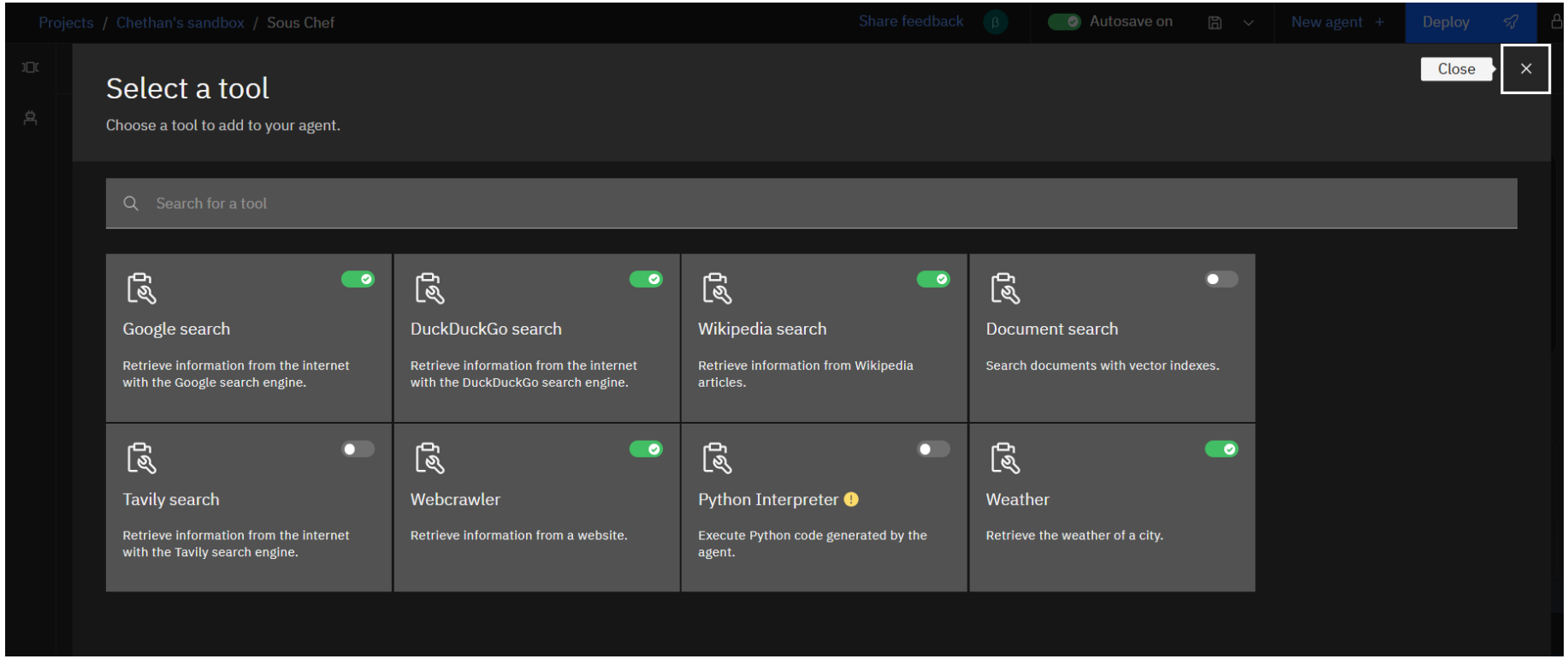
RESULT

2. Instruction Set For Topic oriented Chatbot



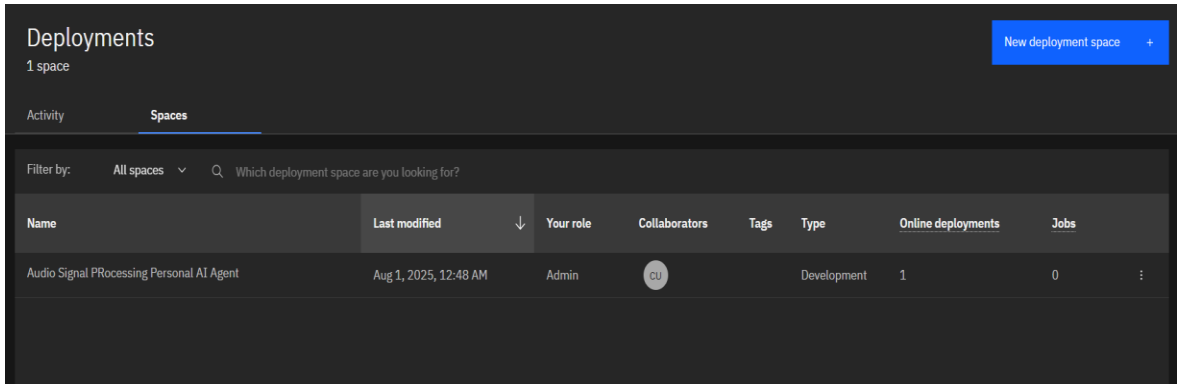
RESULT

3. Tools selection for Response Generation

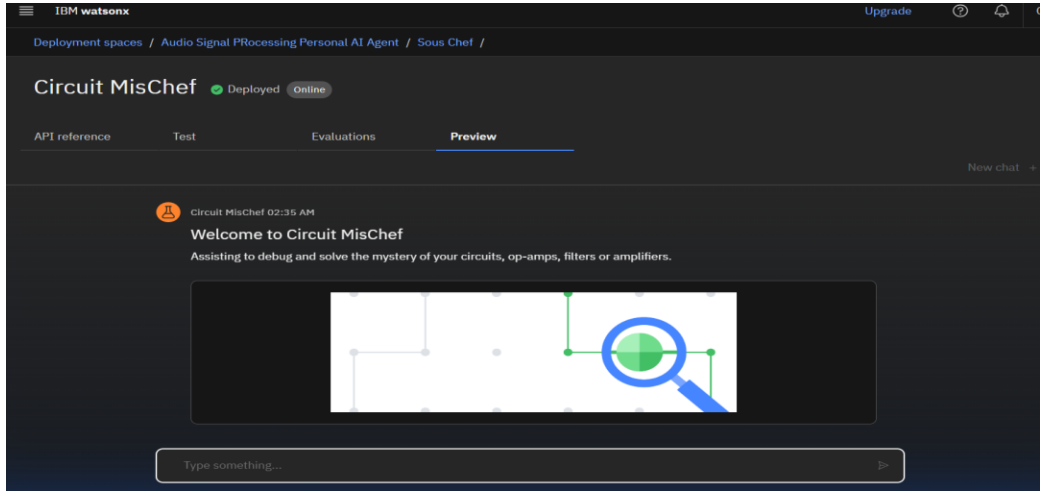


RESULT

4. Creating a Deployment Space

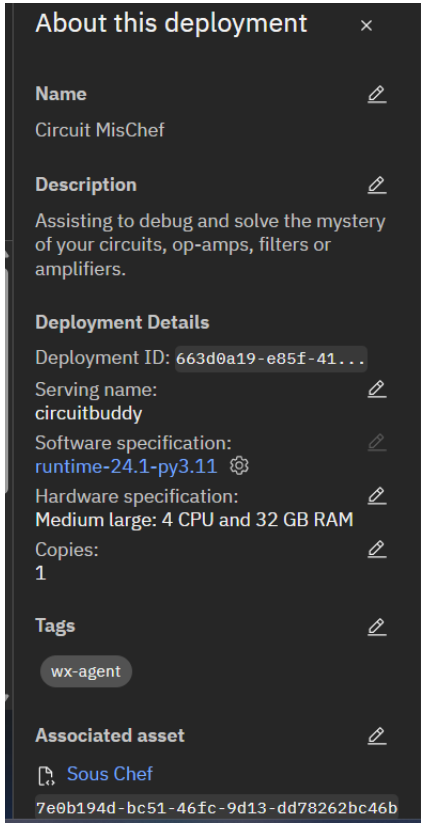


5. Agentic AI Chatbot(Circuit Mischef) succesfully Deployed.

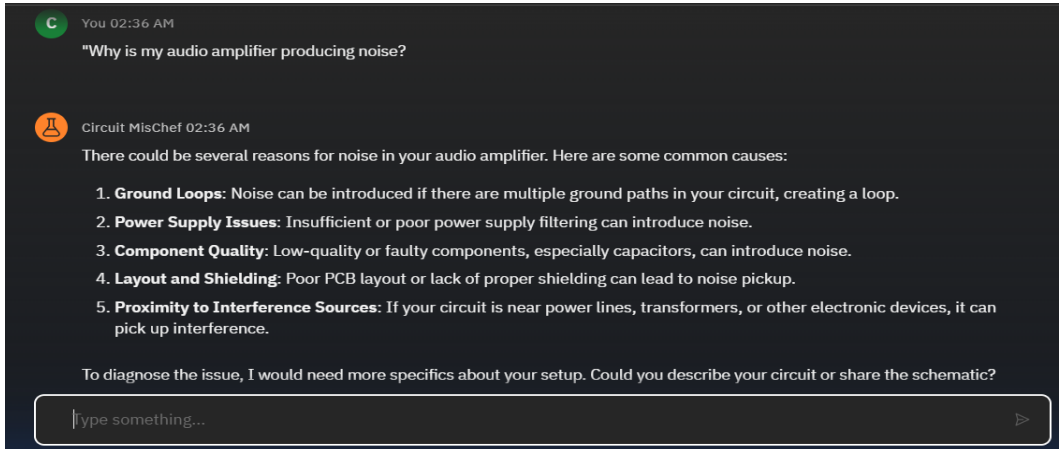


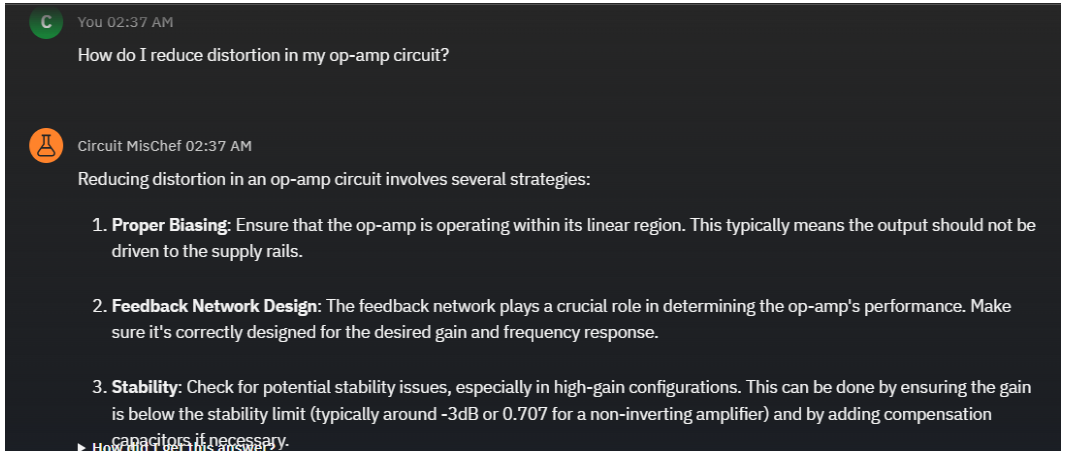
RESULT

6. About the Deployment



7. Sample Prompts





CONCLUSION

- The Audio Signal Processing Assistant Agent, powered by IBM Granite 3-3-8b-instruct and RAG, delivers reliable circuit troubleshooting and design advice for audio applications. It bridges the knowledge gap for students/engineers, reducing troubleshooting time and improving design quality. The cloud-based setup enables accessibility with minimal local resources.

FUTURE SCOPE

- Expand the knowledge base with more advanced circuit subdomains (digital audio, DSP).
- Integrate schematic/image analysis for visual troubleshooting.
- Develop simulation and circuit calculator plugins for deeper design support.
- Support multi-language and voice interaction for broader reach.
- Continuous domain tuning with new technical data and user feedback

REFERENCES

- IBM Granite Model Documentation & Watsonx AI Developer Guides
- Audio Engineering Society Publications
- Standard electronics texts and circuit design manuals
- Open-source LLM/RAG research

IBM CERTIFICATIONS

- Screenshot/ credly certificate(getting started with AI)

IBM CERTIFICATIONS

- Screenshot/ credly certificate(Journey to Cloud)

IBM CERTIFICATIONS

- Screenshot/ credly certificate(RAG Lab)

THANK YOU

edunet foundation