Choice 1: AetherMind – Multi-Modal Retrieval-Augmented Generation (RAG) Knowledge Assistant

Background and Objective:

In today's digital age, valuable insights often get lost amidst unstructured data, chaotic conversations, and dispersed multi-format information. Capturing, understanding, and distilling this data into clear, actionable knowledge is increasingly essential for effective decision-making.

Your task is to develop a Conversational Retrieval-Augmented Generation (RAG)-based multi-modal knowledge assistant. This system will handle inputs from text, audio, video, and common document formats (Excel, PPT/PPTx, Docx, PDF) to produce precise, insightful, and context-aware responses. The objective is to create a tool capable of preserving and synthesising complex dialogues and information streams into structured knowledge.

Deliverables:

1. Multi-Modal RAG Model (Core Task)

- Develop and implement a conversational RAG model to accurately respond to user queries over voice chat and text chat to answer queries of input documents such as (text, audio, video) files and various document formats.
- Utilise vector databases (e.g., Pinecone or FAISS) to support efficient retrieval.
- Provide examples demonstrating the capability of generating contextually relevant answers from provided multi-modal data.

2. Exploratory Data Analysis (EDA)

- Conduct exploratory analyses on the provided sample data to demonstrate how your system handles different input types and identifies relevant insights.
- Clearly visualise and explain your data processing pipeline.

3. User Interface (UI)

- Create a simple, intuitive chat interface supporting conversational interactions.
- Allow real-time uploading and processing of text documents, audio, and video files.
- Integrate voice interaction capabilities (Speech-To-Text and Text-To-Speech) to enhance user experience.

4. Secure Cloud Deployment

- Deploy your solution securely using free-tier resources on cloud platforms such as Azure, AWS, or GCP.
- Implement role-based access control and secure authentication (OAuth, JWT).
- Ensure data encryption both in transit and at rest using secure database solutions (e.g., Cosmos DB, Firebase, DynamoDB).

5. Documentation and Reporting

- Provide a comprehensive architecture diagram illustrating all system components and interactions.
- Document challenges encountered, error logs, and solutions clearly.
- Include detailed documentation on each component's functionality, technology stack, and integration with other system components.

Technical Guidelines:

- Use Python for system development.
- Ensure modularity, clear comments, and maintainability in your code.
- Include Jupyter Notebooks (.ipynb) documenting the development and testing stages clearly.

Assessment Criteria:

- Accuracy and reliability of the RAG model
- Effectiveness of multi-modal data processing
- User Interface usability and intuitiveness
- Quality and clarity of technical documentation and diagrams
- Security measures and efficient cloud resource management

Timeline:

- You have 7 days to complete this PoC task.

This PoC demonstrates your ability to integrate advanced AI models with multi-modal data, creating an intuitive knowledge extraction and conversational interface system.

Note: You will be invited to a repo on Github for resources and submitting your result.

Choice 2: HubNet – Predictive Analysis of User Engagement in Remote Working Hubs using Graph Convolutional Networks (GCNs)

Background and Objective:

Remote Working Hubs (RWHs) in Ireland provide critical infrastructure supporting modern workstyles. Understanding user interactions, commuting choices, carbon footprints, and usage patterns of hub facilities and nearby amenities is crucial to enhancing hub operations, sustainability, and user satisfaction.

The synthetic dataset provided contains activity data for 100 users over 30 days (total 3000 activities), capturing details such as:

- User location and chosen hub
- Commuting method (e.g., car, bicycle, public transport)
- Carbon emission estimates associated with commuting methods
- Engagement with hub facilities (e.g., meeting rooms, desks, internet use)
- Usage patterns of nearby amenities (cafés, parks, shops, etc.)

Your task is to develop a Graph Convolutional Network (GCN)-based predictive model focused on **one of the following aspects** (you may select one):

1. Commuting method prediction
2. Estimating carbon emissions based on commuting and user activity
3. Predicting hub facility engagement patterns
4. Predicting usage of local amenities

Deliverables:

1. Predictive Model (Core Task)

- Develop a GCN to predict the chosen user interaction/engagement aspect.
- Clearly define your nodes, edges, and features within the GCN structure.
- Use appropriate evaluation metrics to assess model performance (e.g., accuracy, F1-score, ROC-AUC).

2. Exploratory Data Analysis (EDA)

- Conduct a brief exploratory analysis to reveal patterns in the dataset relevant to your selected prediction task.
- Visualise key insights that inform your predictive approach.

3. Graph Representation

- Clearly document how you represent user interactions, hub attributes, and other relevant data as nodes, edges, and graph attributes.
- Explain the rationale behind your graph structure choices.

4. User Interface (Optional Enhancement)

- Develop a simple, intuitive UI to demonstrate real-time predictive insights from your GCN model.
- The UI should clearly visualise predictions, node attributes, and key interaction patterns.

5. Documentation

- Clearly describe your methodology, including data preprocessing, feature selection, GCN architecture, training and validation strategy, and performance evaluation.
- Provide actionable recommendations based on your model's predictions.

Technical Guidelines:

- Use Python and popular GCN libraries (PyTorch Geometric, NetworkX, etc.).
- Ensure your model and code are clean, modular, and well-commented.
- Provide code notebooks (.ipynb) clearly documenting each step of your analysis and modelling.

Assessment Criteria:

- **Model performance and predictive accuracy**
- **Clarity and rationale of graph structure design**
- **Quality of data analysis and insights**
- **Cleanliness and readability of code and documentation**
- **(Optional) UI usability and effectiveness**

Timeline:

- You have 7 days to complete this PoC task.

This PoC will demonstrate your ability to leverage advanced graph-based ML methods to provide valuable, actionable insights into user engagement patterns with Remote Working Hubs.

Note: You will be invited to a repo on Github for resources and submitting your result.