5. System Deployment & Integration

5.1 Technology Stack

Backend:

- **Programming Language: Python**
- **Framework: FastAPI (for API-based interaction)**
- **Machine Learning: TensorFlow/PyTorch for model training and inference**
- **Data Processing: Pandas & NumPy for CSV file handling and preprocessing**
- **API Integrations:**
    - **Cohere API (Semantic Search)**
    - **Whisper API (Speech-to-Text)**
    - **Llama API (Text-based Insights)**
    - **Text-to-Speech & Text-to-Video APIs**

Frontend:

- **Framework: Streamlit (for interactive and user-friendly UI)**
- **Features:**
    - **File Upload Component (for CSV files)**
    - **Interactive Data Visualization (using Plotly, Matplotlib, Seaborn)**
    - **Model Selection & Parameter Tuning (Sliders, Dropdowns, etc.)**
    - **Live Prediction & Results Display**

Database:

- **Type: PostgreSQL / MongoDB**
- **Purpose: Stores user-uploaded files, processed datasets, model metadata, and user preferences**

DevOps & Deployment:

- **Containerization: Docker (for environment consistency)**
- **Cloud Deployment:**
    - **Streamlit Cloud / Hugging Face Spaces (for frontend hosting)**
    - **AWS / GCP / Azure (for model storage and inference)**
- **CI/CD Pipeline: GitHub Actions (for automated testing and deployment)**

5.2 Deployment Diagram

Key Components & Their Distribution:

1. **User Device (Client-Side):**
    - **Access via web browser**
    - **Uploads CSV files and views predictions**
2. **Streamlit Frontend Server:**
    - **Hosted on Streamlit Cloud / Hugging Face Spaces**
    - **Provides an interactive UI for users**
3. **Backend API Server:**
    - **FastAPI service running inside a Docker container**
    - **Handles CSV processing, model inference, and API calls**
4. **Database Server:**
    - **Stores structured datasets and user preferences**
5. **Model Server:**
    - **Runs TensorFlow/PyTorch models on GPU-enabled instances**
    - **Manages multiple neural networks for prediction**
6. **Cloud Storage & APIs:**
    - **Stores uploaded CSV files, logs, and generated outputs**
    - **Integrates external AI services (Cohere, Whisper, Llama, etc.)**

5.3 Component Diagram

Major System Components & Dependencies:

1. **Frontend Component (Streamlit)**
    - **Provides an interactive UI**
    - **Uploads CSV files and receives predictions**
    - **Visualizes results using charts**
2. **Backend Component (FastAPI)**
    - **Receives user inputs and processes requests**
    - **Calls AI/ML models for prediction**
3. **Machine Learning Models (LSTM, Transformers, etc.)**
    - **Runs neural network predictions**

- **Uses pre-trained models and fine-tuned versions**

4. **Database Component (PostgreSQL/MongoDB)**
    - **Stores metadata, logs, and model training results**
5. **External API Integrations**
    - **Whisper API (for voice input)**
    - **Cohere API (for semantic search)**
    - **Llama API (for text insights)**
    - **Text-to-Speech API (for audio-based results)**