**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)**