**3. Data Flow & System Behavior**

**3.1 Data Flow Diagram (DFD)**

**Context-Level DFD (Level 0)**

This diagram represents the system at a high level, showing how data moves between external entities and the system.

**Entities & Data Flow:**

1. **User** uploads a CSV file.
2. **Data Preprocessing Module** cleans and prepares data.
3. **Neural Network Engine** processes data using domain-specific models.
4. **Supervising Neural Network** refines and combines outputs.
5. **Prediction Layer** generates final insights.
6. **API Integration Module** enhances results with semantic search, voice, and multimedia output.
7. **User** receives predictions via text, audio, or video.

**Detailed-Level DFD (Level 1)**

This expands the **Context-Level DFD** into more specific data flows between components.

**Processes & Flow:**

1. **User Interaction:**
   * Upload CSV → Passes through validation → Data moves to preprocessing.
2. **Preprocessing:**
   * Missing value handling, normalization, encoding → Processed data stored in a temporary buffer.
3. **Model Processing:**
   * Data sent to appropriate **Neural Network Engine** (LSTM for time-series, Transformer for tabular data).
4. **Supervising Network:**
   * Aggregates predictions → Refines insights → Routes results to output.
5. **Final Output:**
   * Predictions sent to APIs (Semantic Search, Text-to-Speech, Text-to-Video) → Enhanced insights delivered to the **User**.

**3.2 Sequence Diagrams**

Illustrates the sequence of interactions between the system components.

**Prediction Request Sequence:**

1. **User** → Uploads CSV.
2. **System** → Validates file format and structure.
3. **Preprocessing Module** → Cleans and transforms data.
4. **Neural Network Engine** → Selects model (LSTM/Transformer) and runs predictions.
5. **Supervising Neural Network** → Aggregates results.
6. **API Module** → Enhances results (e.g., generates text/audio/video insights).
7. **User** → Receives predictions.

**3.3 Activity Diagram**

Visualizes the workflow from CSV upload to final insight generation.

**Steps:**

1. **Start**
2. **User uploads CSV file**
3. **System validates format & structure**
   * If invalid → Show error & terminate.
   * If valid → Continue to preprocessing.
4. **Data Preprocessing Module cleans and encodes data**
5. **Neural Network Engine selects appropriate model (LSTM or Transformer)**
6. **Supervising Network aggregates outputs**
7. **API Integration Module enhances results**
8. **User receives final insights via text, speech, or video**
9. **End**

**3.4 State Diagram**

Represents different system states and how transitions occur.

**States:**

1. **Idle State** – System waits for user input.
2. **CSV Uploading State** – System receives and validates CSV.
3. **Preprocessing State** – Data cleaning and encoding happen.
4. **Model Processing State** – Neural network predictions are generated.
5. **Aggregation State** – Supervising network refines results.
6. **Output State** – Insights are formatted and delivered.
7. **Idle State** – System resets for the next request.

**3.5 Class Diagram**

Defines the structure, attributes, methods, and relationships between classes.

**Main Classes & Relationships:**

1. **User**
   * Attributes: userID, name, email
   * Methods: uploadCSV(), requestPrediction(), receiveOutput()
2. **Data Preprocessing**
   * Attributes: rawData, cleanedData
   * Methods: normalize(), encodeCategorical(), handleMissingValues()
3. **Neural Network Engine**
   * Attributes: modelType, parameters
   * Methods: trainModel(), predict()
4. **Supervising Network**
   * Attributes: aggregatedPredictions
   * Methods: combineOutputs(), refinePredictions()
5. **API Integration**
   * Attributes: apiType, responseFormat
   * Methods: generateText(), convertSpeech(), createVideo()
6. **Prediction Output**
   * Attributes: result, accuracy, timestamp
   * Methods: displayText(), playAudio(), renderVideo()

**Conclusion**

This section provides a structured **Data Flow & System Behavior** breakdown, ensuring clarity in system interactions. You can now visualize each component's function within the **Neural Network-Based Prediction Pipeline**.