

# System Overview

- **Retail Insights Assistant — Local LLM Architecture**
- Powered by a local Mistral model using Ollama
- Supports two modes:
  - **Dataset Summarization Mode**
  - **Conversational SQL Q&A Mode**
- Ingests and cleans large, inconsistent retail CSV files
- Loads all cleaned data into **DuckDB**
- Uses multi-agent architecture for SQL generation, validation, and execution
- Ensures fast and reliable data analytics

# Data Pipeline Architecture

- **CSV Ingestion & Cleaning**
- Multi-strategy CSV reading for inconsistent datasets
- Filename and column name normalization
- Cleaning rules applied to:
  - **Status** (mapped to shipped/cancelled/returned)
  - **Amount** (converted to numeric)
  - **Quantity** (converted to integer)
  - **Dates** (standardized formats)
- Cleaned CSVs are saved and ready for processing
- **DuckDB Integration**
- Each cleaned CSV becomes a DuckDB table
- Two unified structures created:
  - **Each csv table**
  - **master\_sales table** (merging compatible sales tables)
- Ensures consistent analytics across multiple files

# Summarization Mode

- **Purpose:**  
Provide a deep, narrative-style understanding of the dataset.
- **Summarization Workflow**
  - User selects a table
  - System retrieves data from DuckDB
  - Python computes insights:
    - Total rows
    - Data types
    - High-variance numeric columns
    - High-uniqueness categorical columns
    - Statistical summaries
- This metadata is fed into the Mistral LLM
- The LLM generates:
  - Column-level insights
  - Patterns and trends
  - Anomalies
  - Business interpretations
  - Data quality issues
- **Output:**  
A structured, human-readable dataset summary.

# Conversational Q&A Mode

- **Goal:**  
Convert natural language questions into SQL and return results.
- **Pipeline**
  - **1. LanguageToSQLAgent**
    - Converts user questions to SQL using Mistral
    - Uses real table schema
    - Generates safe, schema-correct DuckDB SQL
  - **2. ValidationAgent**
    - Blocks unsafe queries
    - Only allows **SELECT** queries
    - Prevents DROP/DELETE/UPDATE/ALTER/INSERT/CREATE
  - **3. SQLExecutionAgent**
    - Executes validated SQL in DuckDB
    - Returns clean, formatted data back to the UI
- **Capabilities:**
  - Fuzzy logic for messy retail data
  - Filters and aggregations
  - Instant tabular and json results