# **LLM Data Flow Analysis: Input Data and Output Results**

## **Data Pipeline Overview**

This system processes mall visitor data through a sophisticated pipeline that feeds comprehensive user behavior data to an LLM (Groq's Llama3-8b) and generates detailed marketing insights.

## **Input Data Fed to the LLM**

### **1. User Profile Data**

**Source**: users table

{

"name": "John Doe",

"age": "32 (calculated from date\_of\_birth)",

"visit\_frequency": "15 days/month",

"average\_visit\_duration": "2.5 hours",

"total\_stores\_visited": "45",

"current\_interests": "Fashion, Technology, Sports",

"existing\_behavior\_patterns": "Weekend shopper, Premium brand preference, Long browsing sessions"

}

### **2. Store Visit Analysis (Computed Metrics)**

**Derived from**: user\_movements and stores tables

{

"total\_unique\_stores": 12,

"total\_store\_visits": 38,

"store\_loyalty\_score": 0.65,

"category\_diversity\_score": 0.75,

"most\_visited\_stores": [

"Zara (Fashion): 8 visits, avg time: 45 minutes",

"Apple Store (Electronics): 5 visits, avg time: 30 minutes",

"Nike (Sports): 4 visits, avg time: 25 minutes"

],

"favorite\_categories": "Fashion (15 visits), Electronics (8 visits), Sports (6 visits)"

}

### **3. Recent Activity Data**

**Source**: visits and user\_movements tables

{

"recent\_visits": 8,

"store\_interactions": 25,

"sample\_interactions": [

{

"time": "2024-12-15 14:30:00",

"activity": "visit store",

"location": "Level 2, West Wing",

"store": "Zara",

"store\_category": "Fashion"

},

{

"time": "2024-12-15 15:15:00",

"activity": "exit store",

"location": "Level 2, West Wing",

"store": "Zara",

"store\_category": "Fashion"

}

]

}

### **4. Store Context Data**

**Source**: stores table

* Store names and categories
* Price levels (Budget/Mid-range/Premium)
* Footfall patterns (High/Medium/Low traffic)
* Store characteristics for context

## **LLM Processing**

### **Prompt Structure**

The system sends a comprehensive prompt containing:

1. **User demographics and visit patterns**
2. **Computed behavioral metrics** (loyalty scores, diversity indices)
3. **Store visit history with timing data**
4. **Category preferences with visit counts**
5. **Recent activity patterns**
6. **Request for structured JSON response**

### **LLM Configuration**

* **Provider**: Groq (free tier)
* **Model**: Llama3-8b-8192
* **Temperature**: 0.7 (balanced creativity/consistency)
* **Max tokens**: 2000
* **Timeout**: 120 seconds

## **Output Results from LLM**

### **1. Customer Segmentation**

{

"customer\_segment": "Premium Fashion Enthusiast with Tech Interest",

"confidence\_score": 85

}

### **2. Store Visit Insights**

{

"store\_visit\_insights": {

"shopping\_style": "focused", // or "explorer", "mixed"

"preferred\_categories": ["Fashion", "Electronics", "Accessories"],

"loyalty\_level": "high", // or "medium", "low"

"price\_sensitivity": "low - prefers premium brands",

"visit\_pattern": "frequent short visits on weekends"

}

}

### **3. Interest Recommendations**

{

"interest\_recommendations": [

{

"interest": "Luxury Fashion",

"reason": "visits premium fashion stores frequently",

"confidence": "high"

},

{

"interest": "Smart Home Technology",

"reason": "spends time in electronics section",

"confidence": "medium"

}

]

}

### **4. Store Recommendations**

{

"store\_recommendations": [

{

"store\_category": "Premium Accessories",

"reason": "complements current fashion shopping pattern",

"priority": "high"

},

{

"store\_category": "Home Decor",

"reason": "matches lifestyle profile and shopping duration",

"priority": "medium"

}

]

}

### **5. Cross-Selling Opportunities**

{

"cross\_selling\_opportunities": [

{

"from\_category": "Fashion",

"to\_category": "Accessories",

"reason": "natural complement to current shopping behavior"

},

{

"from\_category": "Electronics",

"to\_category": "Tech Accessories",

"reason": "frequently purchased together by similar customers"

}

]

}

### **6. Engagement Strategy**

{

"engagement\_strategy": {

"optimal\_contact\_times": ["weekend afternoons"],

"preferred\_channels": ["email", "app notification"],

"frequency": "weekly",

"personalization\_focus": "store-specific offers"

}

}

### **7. Revenue Opportunities**

{

"revenue\_opportunity": {

"estimated\_monthly\_potential": "$150-200",

"recommended\_offer\_type": "store-specific discount",

"target\_categories": ["fashion", "accessories"],

"upselling\_potential": "high"

}

}

### **8. Behavioral Insights**

{

"behavioral\_insights": [

"High store loyalty with focused shopping approach",

"Prefers quality over quantity - spends more time per visit",

"Weekend shopping pattern with peak activity 2-4 PM",

"Strong preference for premium brands and experiences"

]

}

### **9. Actionable Next Steps**

{

"next\_actions": [

"Send VIP weekend shopping event invitations",

"Introduce premium accessory brands matching current style",

"Create personalized weekend shopping assistant service",

"Offer early access to new premium collection launches"

]

}

## **Data Processing Intelligence**

### **Key Computed Metrics**

1. **Store Loyalty Score**: Herfindahl concentration index (0-1)  
   * 0 = visits many stores equally (explorer)
   * 1 = visits few stores repeatedly (loyal)
2. **Category Diversity Score**: Unique categories / total stores visited  
   * Higher score = more diverse shopping interests
3. **Time-based Analysis**: Average visit duration, frequency patterns
4. **Price Sensitivity**: Inferred from visited store price levels

## **Output Storage and Usage**

### **Database Storage**

* Complete insights stored as JSONB in user\_insights table
* New interests added to user\_interests table
* Behavioral patterns updated in users table

### **Business Applications**

1. **Personalized Marketing**: Targeted campaigns based on shopping patterns
2. **Store Placement**: Optimize store locations based on customer flow
3. **Inventory Management**: Stock planning based on customer preferences
4. **Revenue Optimization**: Identify upselling and cross-selling opportunities
5. **Customer Experience**: Personalize shopping experience and recommendations

## **System Strengths**

1. **Comprehensive Data Integration**: Combines demographic, behavioral, and transactional data
2. **Real-time Analysis**: Processes recent activity patterns
3. **Scalable Architecture**: Configurable processing limits and free LLM usage
4. **Actionable Insights**: Generates specific, implementable recommendations
5. **Multi-format Output**: Supports both technical integration and business analysis

This system transforms raw mall visitor data into sophisticated customer intelligence, enabling data-driven retail strategy and personalized customer experiences.