Task Description

Project Title: **Design and Development of a Cloud-Based System for Counting Unique Customer Visits Across Global Retail Locations**

Project Overview

As a global AI company, we are developing a *scalable*, cloud-based solution for user behavior analytics tailored for retail environments. Our clients range from small businesses to large enterprise retailers who rely on our system to understand customer visit patterns across multiple stores. With millions of retail locations and hundreds of millions of cameras worldwide, the system must efficiently process vast volumes of video data to accurately identify and count unique customer visits, providing actionable insights to retailers of all sizes.

Business Objectives

1. **Customer Visit Frequency Analytics**: Provide our retail clients with insights into customer visit patterns, helping them optimize store layouts, improve customer engagement, and make data-driven marketing decisions.
2. **Accurate Visitor Identification Across Locations**: Ensure precise identification and counting of unique visitors across clients' stores globally, capturing repeat visits accurately without duplication.
3. **Scalability for High-Volume, Global Data**: Design a system that processes data from hundreds of millions of cameras across millions of locations worldwide, providing timely and actionable insights in a scalable, cloud-based solution.

Task Description

Technical Task: Scalable Solution for Unique Visitor Detection and Visit Counting

Objective: Develop a scalable solution to generate a list of unique visitors within a specified time period across selected camera feeds, detailing how many times each individual appeared.

Funcional Requirements:

1. **Time-Based Filtering**: The system must allow filtering by a specified time range to include only visitor data within that period.
2. **Cross-Camera Visitor Aggregation**: The solution must identify unique visitors across all selected cameras, ensuring that repeat visits by the same person are accurately counted.
3. **Visit Frequency Count**: For each unique visitor, the system must count and record the total number of times they appeared in the camera's field of view.

Scalability Requirements:

1. **Camera Coverage**: The solution must be scalable to support up to 100 million cameras distributed across multiple locations worldwide.
2. **Visitor Volume**: The system should efficiently handle data for millions of unique visitors, maintaining performance and accuracy in high-volume, real-time processing environments.

Task Description

Expected Outcome:

A time-bound, location-specific report listing unique visitors and their respective visit counts, adaptable to support massive scaling requirements.

Unique Visitor Report

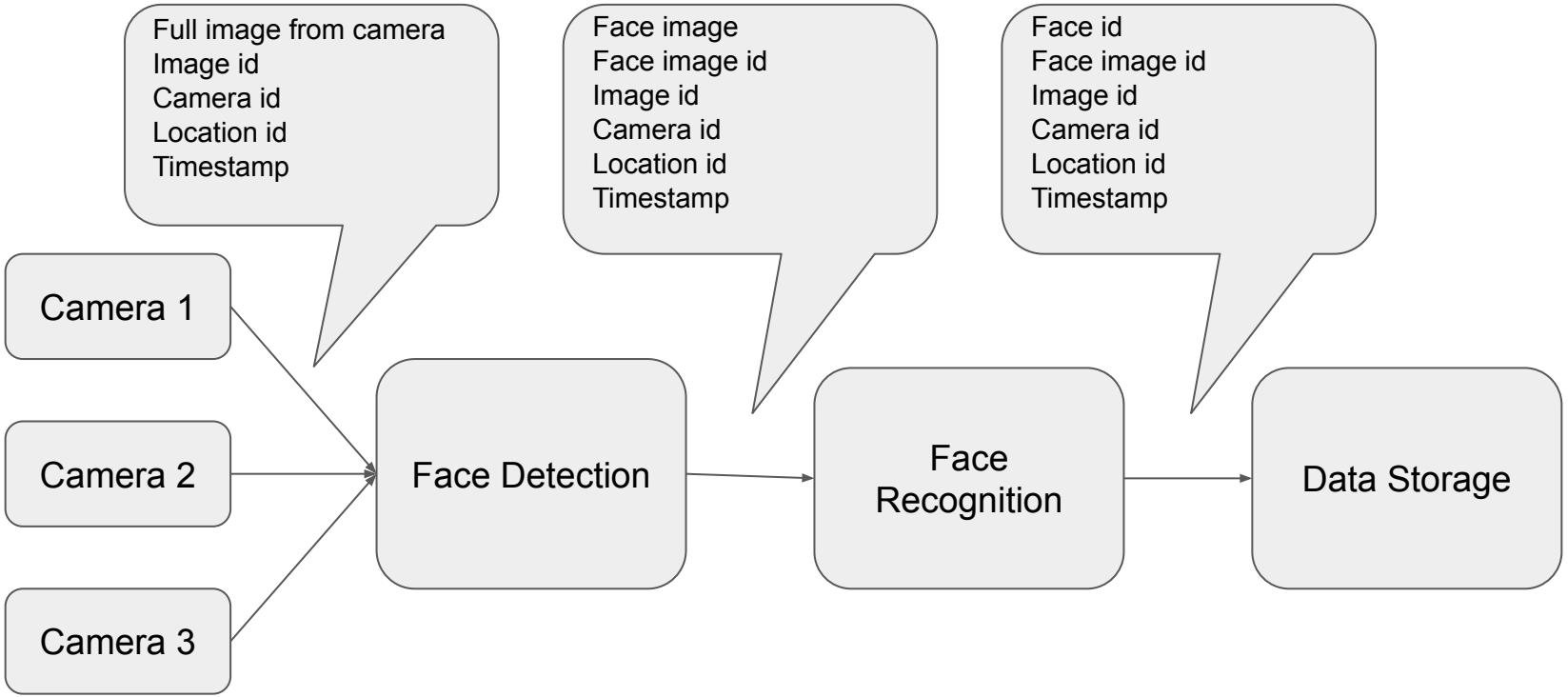
Time Period: January 1, 2024 - January 31, 2024

Camera Group: Selected Cameras across 10,000 Store Locations

Total Unique Visitors: 3,500,000

Visitor ID	Total Appearances	Locations Visited	Visit Frequency per Location
00123A	15	Store #101, Store #203	Store #101: 8, Store #203: 7
00876B	10	Store #105	Store #105: 10
04567C	5	Store #101, Store #301	Store #101: 2, Store #301: 3
07654D	22	Store #105, Store #106	Store #105: 15, Store #106: 7
09123E	18	Store #205, Store #208	Store #205: 12, Store #208: 6
...	...	...	...

System Design



Cameras

- Each Location where cameras are located has its own id (Location id)
- Each camera has its own id (Camera id)
- Every nth period of time (depends on system requirements) a screenshot is taken (Full image from camera). Each screenshot has its own id (Image id)
- Every image is associated with a timestamp when this image was taken (Timestamp)
- When a few images from camera are collected, camera combines this data into a batch and sends it to the face detection system

Face Detection

- Batches from cameras are stored in a queue
- Light-weight face detection model process each image from batch and detects facial bounds
- Each image is cropped using facial bounds
- Each image of face (Face image) gets its id (Face image id)
- Face images and their additional data are combined into batches and sent to the face recognition system

Face Recognition

- Batches from the face detection system are stored in a queue
- Face recognition model process each face image from batch and returns facial embeddings
- Most common vector is searched in a vector database
- By finding the most common vector, the person's identity is established (Face id)
- Data is sent to the data storage

Data Storage

- Data storage is updated with data from the face recognition system
- Data is stored in relational databases which allows to have fast access and scalability
- Obligatory columns are Face id, Face image id, Image id, Camera id, Location id, Timestamp
- These columns allow to make time-based filtering, cross-camera aggregation, visit frequency count