CSA0564-JAVA PROGRAMMING

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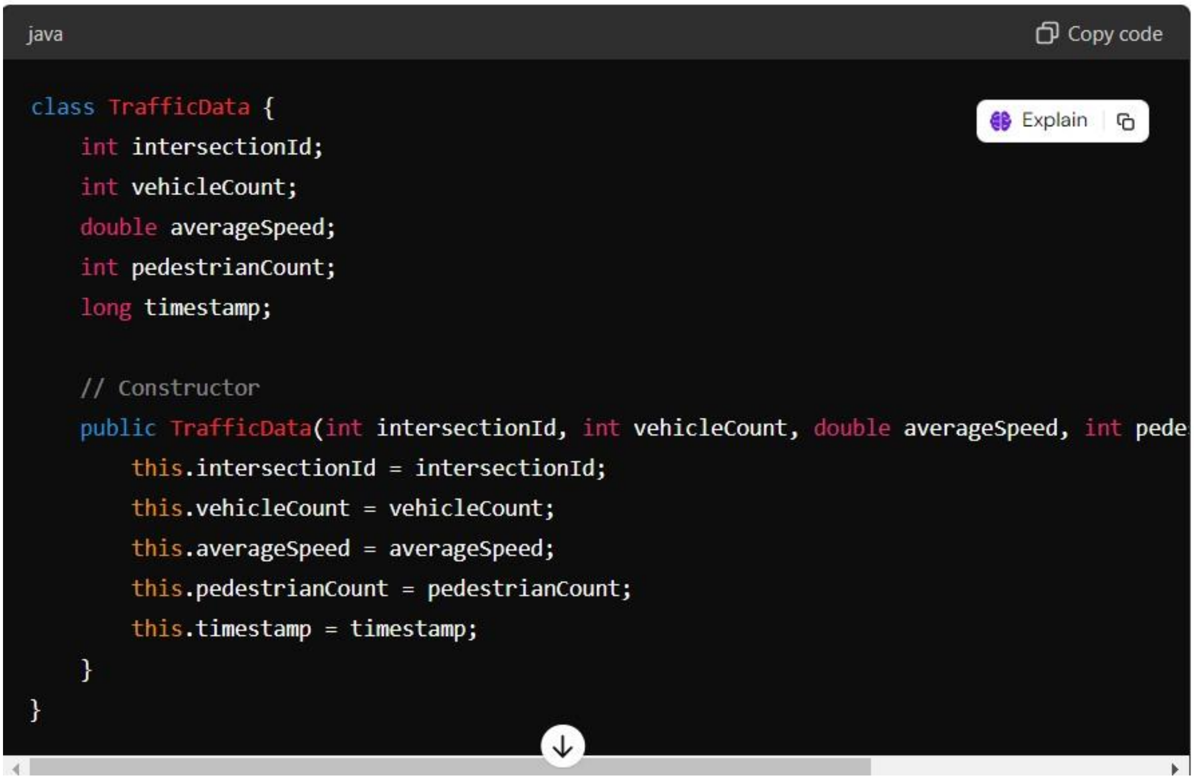
Smart Traffic Signal Optimization

Scenario: You are part of a team working on an initiative to optimize traffic signal management in a busy city to reduce congestion and improve traffic flow efficiency using smart technologies

1. Data Collection and Modeling

- **Objective:** Define the data structure to collect real-time traffic data from sensors.

Data Structure Example:



```java
class TrafficData {
    int intersectionId;
    int vehicleCount;
    double averageSpeed;
    int pedestrianCount;
    long timestamp;

    // Constructor
    public TrafficData(int intersectionId, int vehicleCount, double averageSpeed, int pede
        this.intersectionId = intersectionId;
        this.vehicleCount = vehicleCount;
        this.averageSpeed = averageSpeed;
        this.pedestrianCount = pedestrianCount;
        this.timestamp = timestamp;
    }
}
```

2. Algorithm Design

- **Objective:** Develop a simple algorithm to analyze the collected data and optimize traffic signal timings dynamically.

Pseudocode Example:

Algorithm OptimizeSignalTimings:

```
  Input: trafficData     Output:
signalTimings     for each data
in trafficData:        if
data.vehicleCount > 100:
      extend green light        else if
data.pedestrianCount > 20:
prioritize pedestrian crossing
    else:
      use default timings
return signalTimings
```

3. Implementation

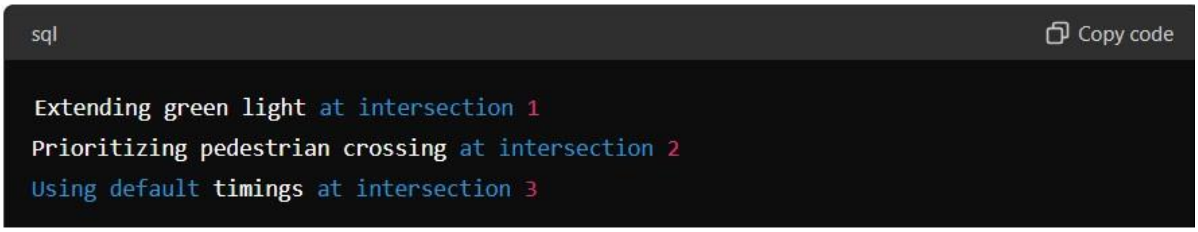
- **Objective:** Implement a Java application that adjusts signal timings in real-time. **Java Code**

```
import java.util.List; class TrafficSignalController {
List<TrafficData> trafficDataList;     public
TrafficSignalController(List<TrafficData> trafficDataList) {
this.trafficDataList = trafficDataList;
  }
  public void optimizeSignalTimings() {
for (TrafficData data : trafficDataList) {
if (data.vehicleCount > 100) {
        System.out.println("Extending green light at intersection " + data.intersectionId);
      } else if (data.pedestrianCount > 20) {
        System.out.println("Prioritizing pedestrian crossing at intersection " + data.intersectionId);
      } else {
        System.out.println("Using default timings at intersection " + data.intersectionId);
}
    }
    }
    public static void main(String[] args) {
        // Example data
        List<TrafficData> dataList = List.of(            new TrafficData(1,
150, 30.0, 10, System.currentTimeMillis()),           new TrafficData(2,
50, 25.0, 30, System.currentTimeMillis()),           new TrafficData(3,
80, 20.0, 5, System.currentTimeMillis())
        );
        TrafficSignalController controller = new TrafficSignalController(dataList);
controller.optimizeSignalTimings();
    }
}
```

4. Visualization and Reporting

- **Objective:** Develop basic visualizations to monitor traffic conditions and signal timings.
- **Tools:** Use simple console outputs for monitoring.

Example Console Output:



```sql
Extending green light at intersection 1
Prioritizing pedestrian crossing at intersection 2
Using default timings at intersection 3
```

5. User Interaction

- **Objective:** Provide a basic interface for traffic managers. **Basic Interface Example**

```
        class TrafficManagerUI {     public static void main(String[] args) {
    System.out.println("Traffic Signal Optimization System");
    System.out.println("1. Monitor Traffic");
    System.out.println("2. Adjust Signal Timings");
    // Here is a add code to interact with the user and call appropriate methods
  }
```

```
}
```

Deliverables:

1. **Data Flow Diagram:** : Illustrate how real-time traffic data flows from sensors to the optimization algorithms and traffic signals.

2. Pseudocode and Implementation:

Provide detailed pseudocode and Java code for the optimization algorithms to manage intersections efficiently.

3. Documentation:

Explain the basic design decisions behind the algorithms and data structures used.

4. User Interface:

Develop a basic console interface for traffic managers to interact with the system.

5. Testing:

Develop comprehensive test cases to validate the system's functionality and effectiveness under various traffic scenarios..

Testing Example:

- **Unit Tests:** Validate individual data processing logic.
- **Integration Tests:** Ensure data flow and interaction between data collection and signal adjustment.

This simplified version focuses on the core functionality and provides a foundation to build upon for a more comprehensive solution. Adjustments can be made to enhance features and complexity based on specific requirements.