**Contribution Report for Team Member 2:**

* **Model Training and Analysis**

**Problem Statement**

The primary goal of the project is to analyse vehicle movement patterns, monitor parking occupancy, and match vehicles to an approved database within a college campus using Edge AI. This comprehensive system aims to enhance traffic management, optimize parking space usage, and improve campus security by providing real-time insights and alerts.

**Objectives**

1. **Vehicle Movement Pattern Analysis:**
   * Track and analyze vehicle movements within the campus to identify peak traffic hours and congestion points.
2. **Parking Occupancy Monitoring:**
   * Continuously monitor parking lots and street parking areas to provide real-time occupancy data and optimize the usage of available spaces.
3. **Vehicle Matching:**
   * Identify and match vehicles entering the campus with a database of authorized vehicles to ensure compliance with parking permits and enhance campus security.

**Contribution Report for Team Member 2**

**Name:** Piyush Mahajan

**Role:** Model Training and Analysis

**Tasks and Responsibilities**

1. **Model Training:**

**Objective:** Develop and train machine learning models for vehicle detection, classification, and recognition using state-of-the-art frameworks to ensure accurate analysis and insights.

**Activities:**

* + **Utilize TensorFlow, PyTorch, and Keras:**
    - Leveraged TensorFlow, PyTorch, and Keras to develop and fine-tune models for vehicle detection, classification, and recognition.
    - Trained models using the Stanford Cars Dataset and Open Images Dataset, applying techniques such as transfer learning to improve model performance and adapt pre-trained models to specific campus conditions.
  + **Hyperparameter Tuning:**
    - Conducted extensive hyperparameter tuning to optimize model performance, including adjusting learning rates, batch sizes, and network architectures.
  + **Validation and Testing:**
    - Used cross-validation and testing on a hold-out dataset to evaluate model accuracy and generalization capabilities.

**Outcome:** Developed accurate and robust machine learning models capable of detecting, classifying, and recognizing vehicles in real-time, providing essential data for further analysis.

1. **Vehicle Movement Pattern Analysis:**

**Objective:** Analyze vehicle movement patterns to identify peak traffic times, congestion points, and provide actionable insights for traffic management.

**Activities:**

* + **Implement YOLO, SSD, and Faster R-CNN:**
    - Deployed YOLO, SSD, and Faster R-CNN for real-time object detection and tracking.
    - Fine-tuned these models to accurately detect and track vehicles in the campus environment.
  + **Time-Series Analysis:**
    - Used Python libraries such as Pandas and NumPy to conduct time-series analysis, identifying peak traffic hours, congestion points, and patterns in vehicle movements.
    - Visualized movement patterns using Matplotlib and Seaborn to generate actionable insights for campus traffic management.
* **Edge Case Handling Tests**

To ensure the robustness and reliability of the machine learning models and analysis, several edge cases were identified and handled:

1. **Variable Lighting Conditions:**
   * **Test:** Evaluated model performance under different lighting conditions, including day, night, and varying weather conditions.
   * **Solution:** Applied data augmentation techniques and adaptive image preprocessing to enhance model robustness against lighting variations.
2. **Partial Occlusions:**
   * **Test:** Tested model accuracy with vehicles partially occluded by other objects or vehicles.
   * **Solution:** Augmented training data with synthetic occlusions and used robust object detection algorithms to improve detection accuracy under occlusions.
3. **High-Density Traffic:**
   * **Test:** Assessed model performance in scenarios with high vehicle density.
   * **Solution:** Implemented non-maximum suppression techniques to accurately detect and differentiate closely packed vehicles.
4. **Different Vehicle Types:**
   * **Test:** Ensured models could accurately detect and classify a variety of vehicle types, including cars, bikes, and buses.
   * **Solution:** Included diverse vehicle types in the training dataset and used transfer learning to adapt models to the specific vehicle mix on campus.
5. **Real-Time Processing:**
   * **Test:** Validated model inference speed and accuracy in real-time scenarios.
   * **Solution:** Optimized models for real-time deployment by reducing complexity without compromising accuracy.

**Evaluation and Question Handling**

During evaluation, I am prepared to answer questions related to the following aspects of my contribution:

1. **Model Selection and Training:**
   * Justification for choosing specific models (YOLO, SSD, Faster R-CNN) and frameworks (TensorFlow, PyTorch, Keras).
   * Explanation of the training process, including dataset selection, transfer learning, and hyperparameter tuning.
2. **Vehicle Movement Pattern Analysis:**
   * Detailed explanation of methods used for analyzing vehicle movement patterns and identifying congestion points.
   * Visualization techniques and tools used to present movement patterns and insights.
3. **Edge Case Handling:**
   * Identification of potential edge cases and the specific solutions implemented to handle them.
   * Impact of these solutions on overall model performance and reliability.
4. **Challenges and Solutions:**
   * Key challenges faced during model training and analysis.
   * How these challenges were addressed to ensure accurate and reliable vehicle detection and movement analysis.