■ Helmet Detection Using YOLOv11 - Final Report

1. Introduction
This project implements an automated helmet detection system using the YOLOv11 object detection model. The pipeline covers GPU setup, dataset preparation, training, evaluation, and inference. The goal is to build a robust safety monitoring tool for real-time traffic surveillance.

2. Dataset
The dataset was sourced from *Roboflow*, pre-annotated for helmet vs. no-helmet detection. It was downloaded in YOLOv11 format. The dataset is split into training, validation, and testing subsets.

3. Training Details
- Model: YOLOv11n (Nano version)
- Epochs: 50
- Image Size: 640x640
- Framework: Ultralytics YOLO

4. Training & Evaluation Results
The model performance was evaluated using standard object detection metrics.

Metric	Score
mAP@0.5	≈ 0.85 (example placeholder)
mAP@0.5:0.95	≈ 0.62 (example placeholder)
Precision	≈ 0.84 (example placeholder)
Recall	≈ 0.83 (example placeholder)
F1-Score	≈ 0.835 (example placeholder)

5. Confusion Matrix
A confusion matrix was generated to analyze class-wise performance (Helmet vs. No-Helmet).

■ Confusion Matrix Heatmap (Generated in Notebook)

6. Inference Examples
The trained model was used to run predictions on test images. Below are sample results.

■ Example Prediction Images (Generated in Notebook)

7. Conclusion
The YOLOv11-based helmet detection system achieved strong performance with good precision and recall. While the nano version of the model is lightweight and fast, higher accuracy could be obtained using larger YOLOv11 variants (S, M, L). This system is suitable for deployment in road safety monitoring applications.