Technical Summary – Traffic Flow Analysis

Approach:
The project uses YOLOv8n (pre-trained on COCO) for real-time vehicle detection (classes: car, bus, truck, motorcycle).
Three polygonal lane boundaries were defined to classify each detected vehicle into a specific lane.
A ByteTrack-based tracker was used to assign persistent IDs across frames, ensuring that each vehicle is counted only once.

During processing:
- Each frame is analyzed for vehicle detections.
- Detected objects are filtered by class and checked against lane polygons.
- A counter is incremented when a new vehicle ID enters a lane's detection zone.
- All events are logged to output_events.csv containing: VehicleID, Lane, Frame, Timestamp.
- The output video (output_annotated.mp4) includes lane overlays and real-time counts.

Challenges:
1. Lane Boundary Accuracy – Vehicles near lane borders could be misclassified.
2. Processing Speed – Full-frame YOLO inference on every frame was time-consuming for long videos.
3. Duplicate Counting – Without proper tracking, the same vehicle could be counted multiple times.

Solutions:
- Manual Lane Calibration – Lane polygons were carefully drawn using coordinate inspection to ensure correct assignment.
- Frame Skipping Optimization – YOLO detection was run every 2–3 frames while the tracker updated positions in between, reducing processing time without sacrificing accuracy.
- Persistent Tracking (ByteTrack) – Provided robust ID assignment, preventing duplicate counts for the same vehicle across frames.