Vehicle and Pedestrian Detection & Tracking using YOLOv8 + ByteTrack
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Date: *2025*

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1. Introduction

This project demonstrates an end-to-end pipeline for object detection and tracking using **YOLOv8 segmentation** integrated with **ByteTrack**. The objective was to build a model capable of detecting and tracking **vehicles and pedestrians** in videos, and then deploy a user-friendly web demo.

The project was part of the Labellerr PEC AI Software Engineer assignment, and includes dataset preparation, model training, evaluation, web app development, deployment, and documentation.

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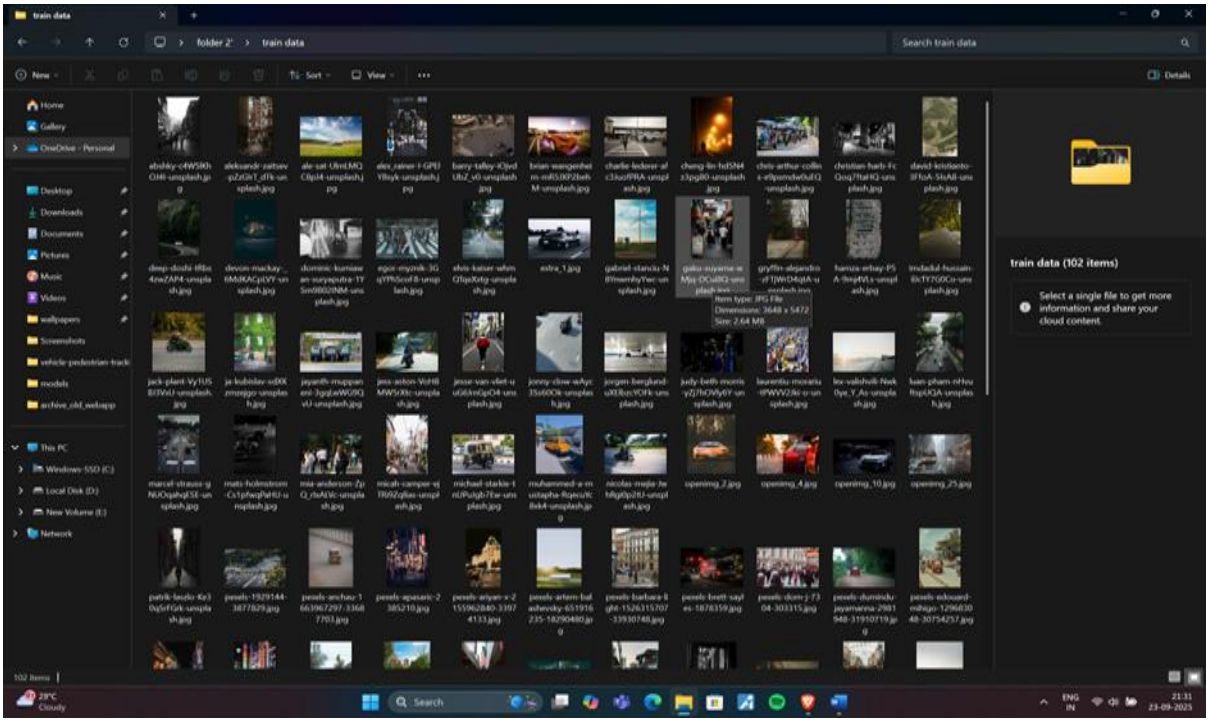
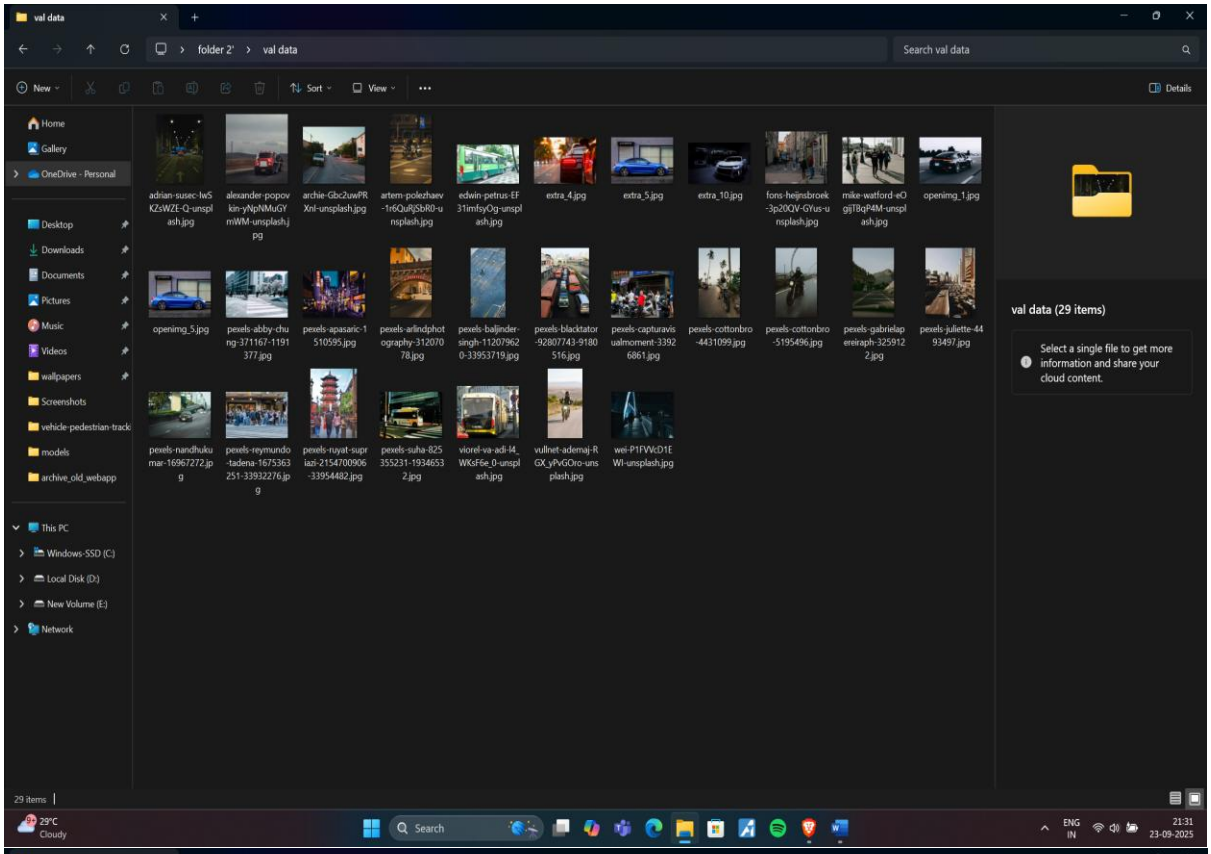
2. Dataset Preparation

- **Data Sources:** Unsplash, Pexels, OpenImages.
- **Classes:**
    1. Vehicle
    2. Pedestrian
- **Size:** 183 images split into train/val/test.
- **Annotation Tool:** Labellerr platform.
- **Format:** YOLO (bounding boxes + segmentation masks).

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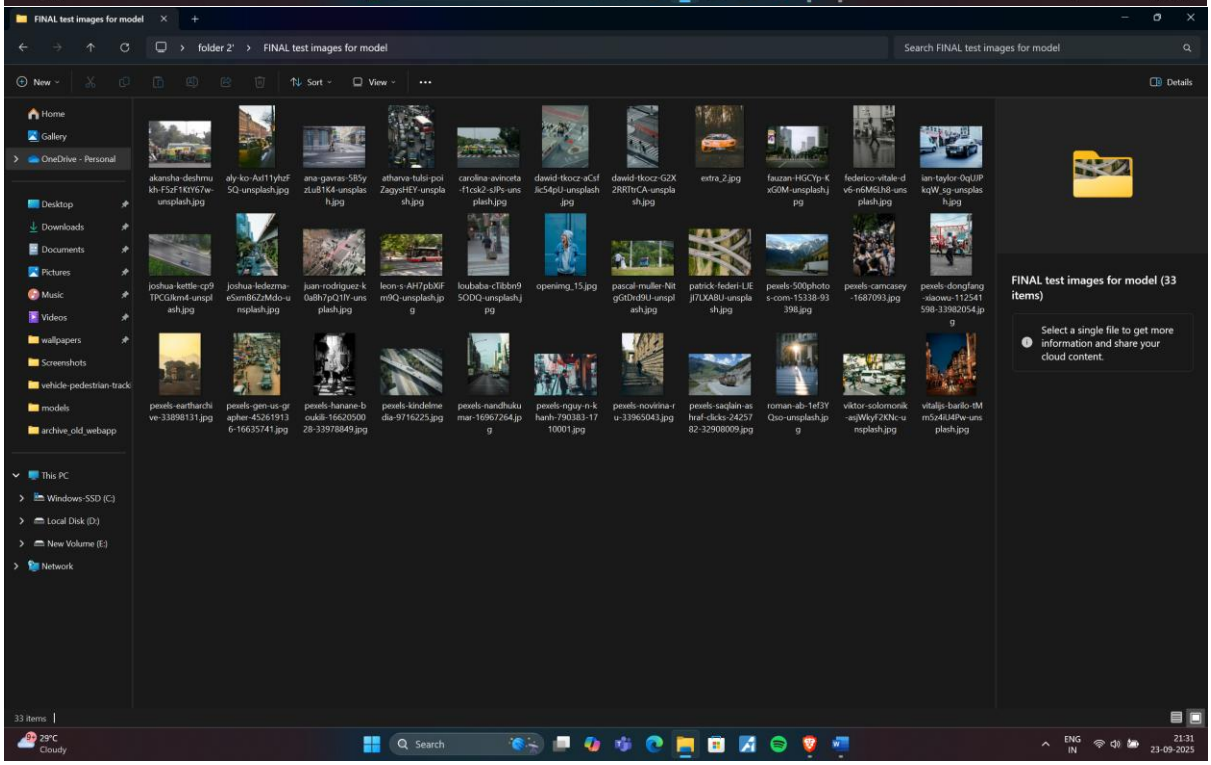
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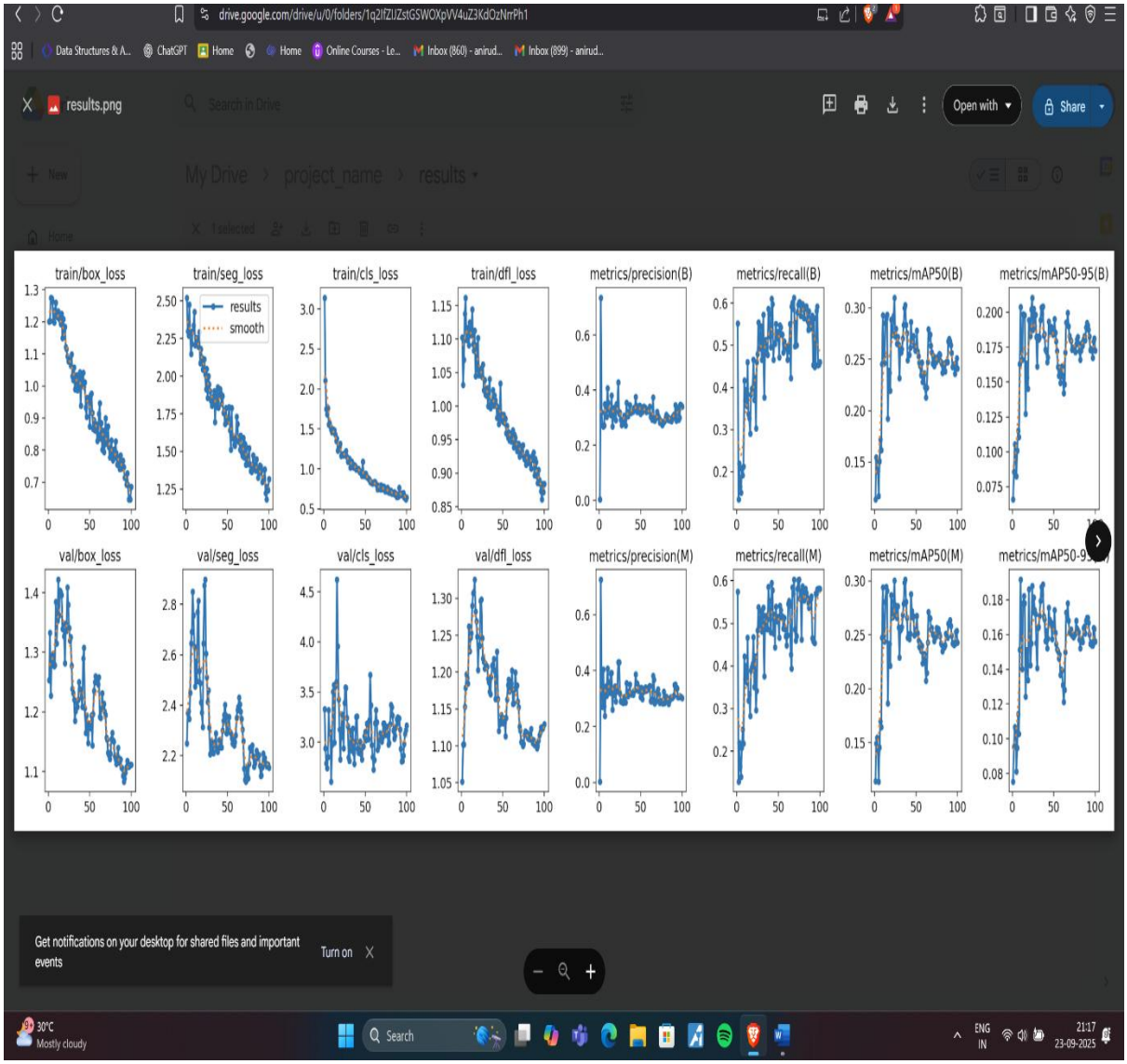
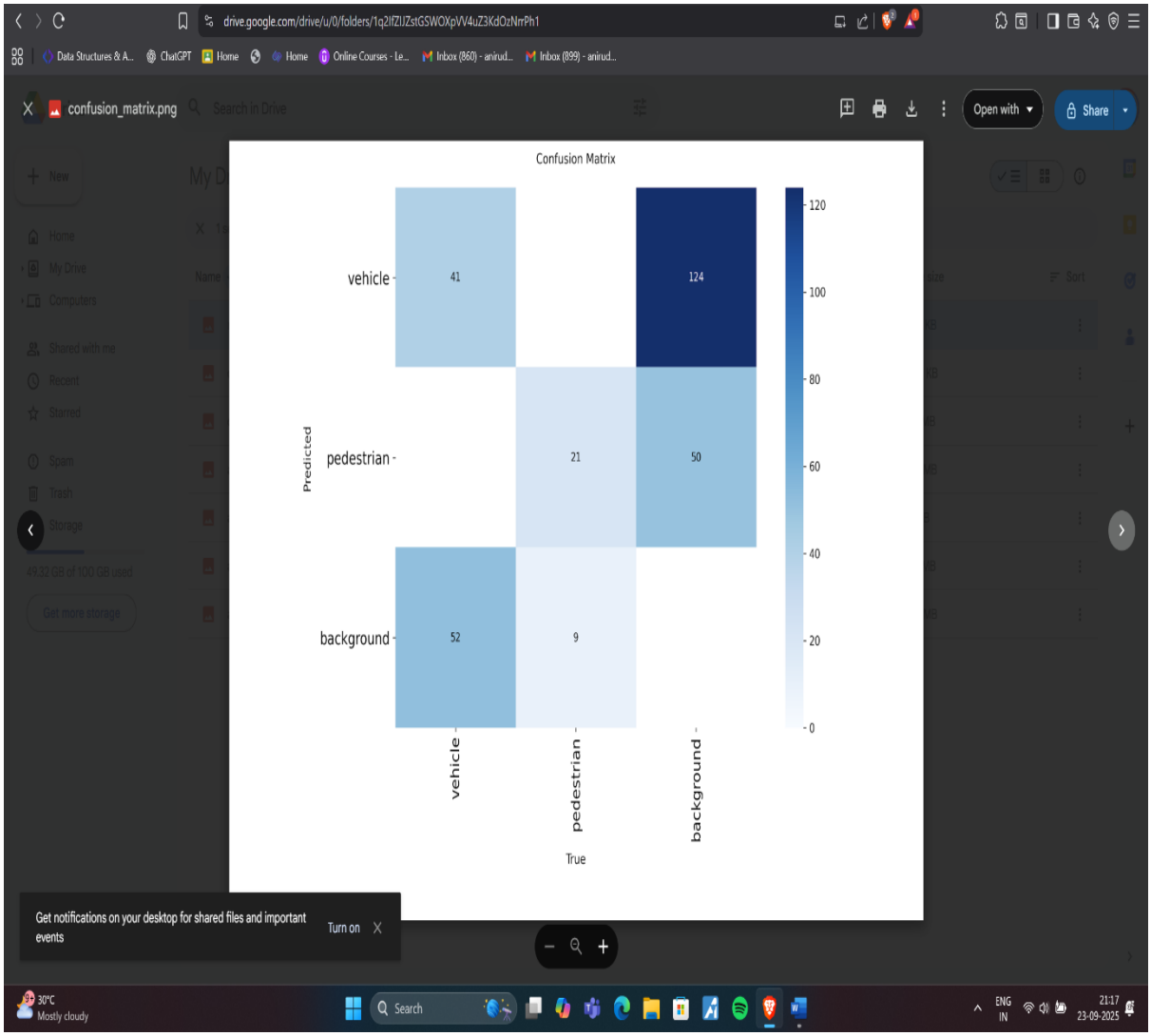
3. Model Training

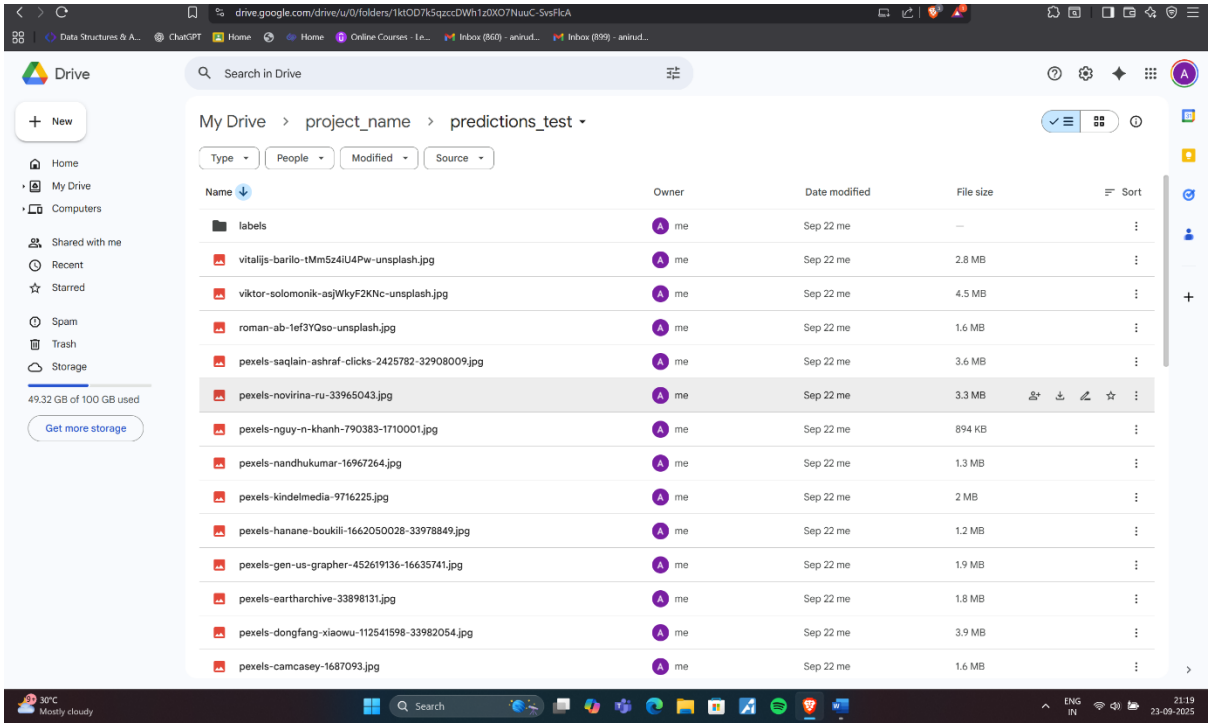
- **Model:** YOLOv8n-Seg (lightweight segmentation).
- **Environment:** Google Colab (Tesla T4 GPU).
- **Parameters:**
    - Epochs: 100
    - Image size: 640
    - Batch size: 8
- **Output:**
    - best.pt → trained weights.
    - Precision-Recall curves, IoU, and mAP metrics.

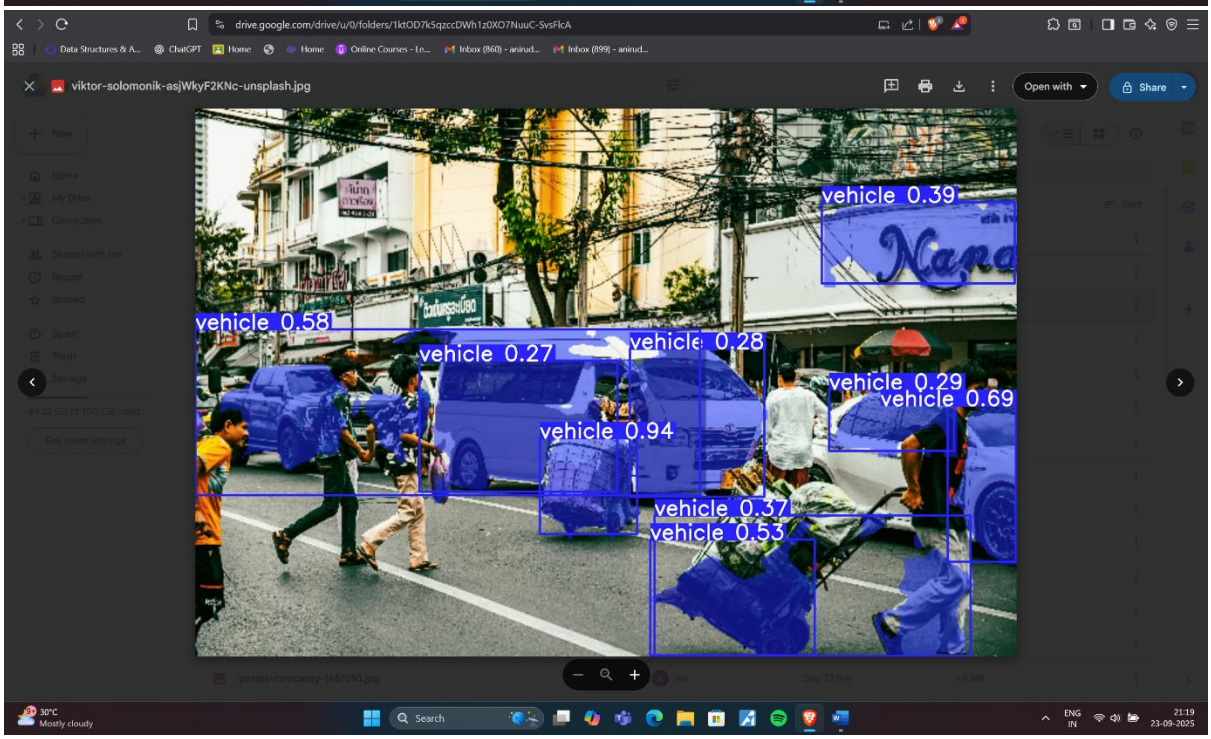




4. Evaluation

- Model evaluated on 40 test images + 26 validation images.
- Performance measured using **IoU, precision, recall, mAP**.
- Two demo videos were successfully processed through the model.



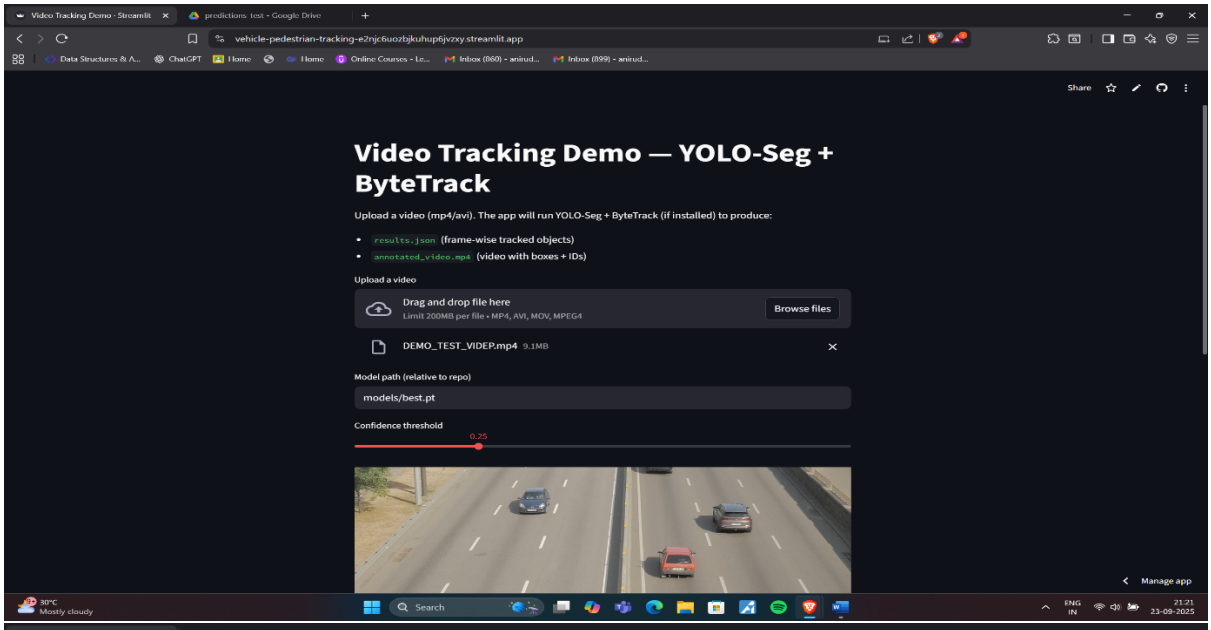


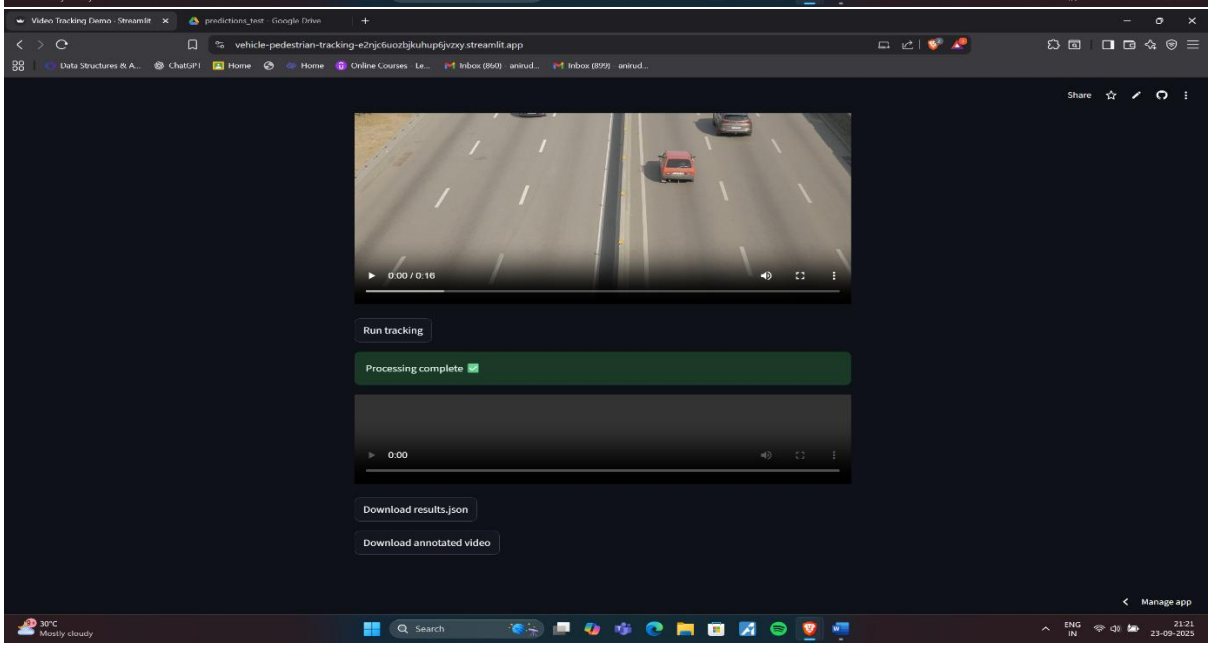
5. Web Application (Video Tracking Demo)

- **Framework:** Streamlit.
- **Features:**
  - Upload a video (mp4/avi/mov).
  - Run inference with YOLOv8 + ByteTrack.

- Download outputs:
    - results.json (tracked objects with IDs, classes, bounding boxes, frame numbers).
    - annotated_video.mp4 (tracking visualization).

- **Design:** Clean, minimal UI with download options.





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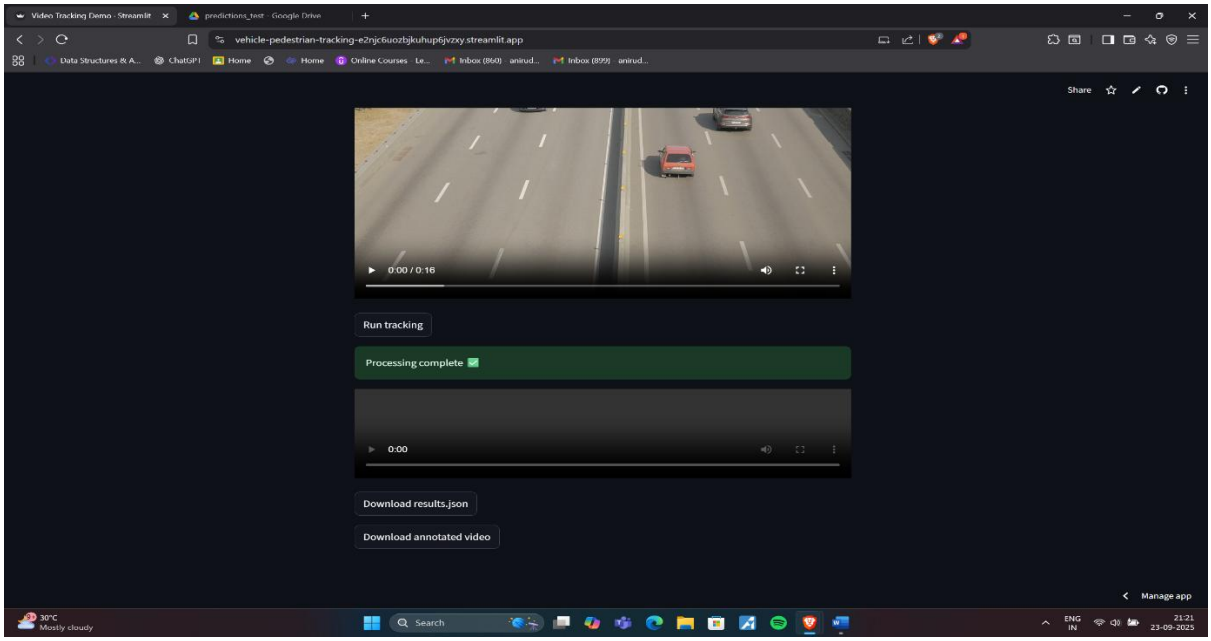
6. Deployment

- **Platform:** Streamlit Cloud.
- **Challenges faced:**
    - OpenCV (cv2) import errors due to Python 3.13.

- Fixed by pinning opencv-python-headless==4.10.0.84 and adding packages.txt with system dependencies (libgl1, libglib2.0-0).

- **Final Result:** Working live demo link available.
- **Live Demo Link:** https://vehicle-pedestrian-tracking-e2njc6uozbjkuhup6jvzxy.streamlit.app



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7. Challenges & Resolutions

Challenge	Resolution
Model weights stored as .zip	Extracted and ensured correct best.pt available.
Earlier webapp attempt failed	Rebuilt from scratch with clean Streamlit setup.
cv2 import error on Streamlit Cloud	Used opencv-python-headless + system packages.
Session state bug in Streamlit	Fixed with st.session_state to keep download buttons visible.

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8. Guide for Reproduction

Steps for anyone to build their own tracker:

1. Collect and annotate dataset on Labellerr.
2. Export YOLO format dataset.
3. Train YOLOv8-seg on Colab or local GPU.
4. Save best weights as models/best.pt.
5. Clone repo and install dependencies (pip install -r requirements.txt).
6. Run streamlit run app.py.
7. Upload video → run inference → download results.
8. For cloud deployment:
    - Add requirements.txt and packages.txt.
    - Push repo to GitHub.
    - Deploy on Streamlit Cloud.

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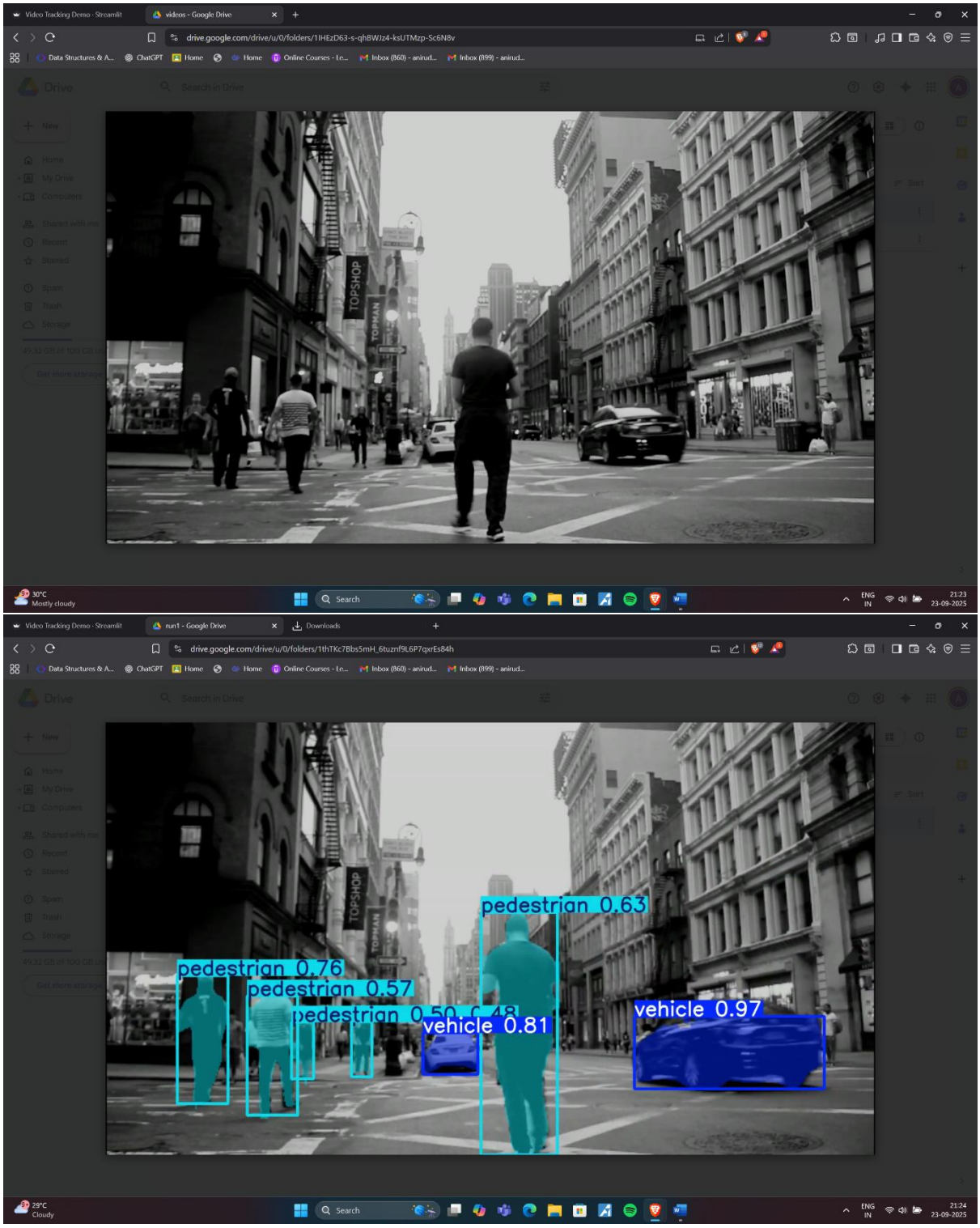
9. Results Summary

- Successfully built a trained YOLOv8 segmentation model.
- Integrated with ByteTrack for robust video tracking.
- Delivered a working Streamlit web application.
- Live demo available on Streamlit Cloud.



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10. Conclusion

This project successfully achieved its objectives of detection, tracking, and deployment. It also highlighted the practical challenges of environment compatibility (Python versions, dependencies) and the importance of modular, clean code design.

The workflow can be easily extended to additional classes (e.g., bicycles, buses) and scaled for real-time streaming applications.

Appendix

- **GitHub Repo:** https://github.com/ANIRUDH-SHARMA-25/vehicle-pedestrian-tracking
- **Live Demo Link:** https://vehicle-pedestrian-tracking-e2njc6uozbjkuhup6jvzxy.streamlit.app

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