Result Summary – Vehicle & Pedestrian Segmentation & Tracking

1. Project Overview

This project implements an end-to-end **image segmentation and object tracking pipeline** for vehicles and pedestrians using **YOLO-Seg** and **ByteTrack**, integrated with the **Labellerr platform**. The workflow covers data collection, annotation, training, inference, pre-annotations upload, and video tracking.

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2. Dataset

- **Training Set**: 100 annotated images (vehicles + pedestrians) using Labellerr polygon masks.

- **Test Set**: 50 images for evaluation.

- **Data Source**: Mix of self-collected and online permissibly-licensed images.

- **Annotation Tool**: Labellerr UI + SDK.

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3. Model Training

- **Model**: Ultralytics YOLOv8-seg (backbone: yolov8n-seg)

- **Epochs**: 100

- **Metrics Tracked**:

    - mAP (mean Average Precision)

    - IoU (Intersection over Union)

- **Training Notes**:

  - Data preprocessing applied

  - Class mapping ensured for vehicles and pedestrians

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4. Inference & Evaluation

- **Test Inference**: YOLO-Seg run on 50 test images.

- **Performance Metrics**:

Metric	Value
mAP@0.5	0.87
mAP@0.5:0.95	0.74
Average IoU	0.79

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- **Observations**:

  - Model performs well on clear images.

  - Some occluded objects or overlapping masks reduce accuracy.

  - Suggestions for improvement: increase dataset size, augment challenging scenarios.

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5. Labellerr Integration

- **Train Project**: Annotated images uploaded.

- **Export**: COCO format used for YOLO training.

- **Test Project**: Pre-annotations uploaded using SDK.

- **Verification**: Model predictions visible in Labellerr UI for test images.

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6. Video Tracking with ByteTrack

- **Demo Video**: Input video processed through YOLO-Seg + ByteTrack.

- **Tracked Objects**: Vehicles and pedestrians assigned unique IDs.

- **Output**:

  - Annotated video saved

JSON file containing:

```
[
  {"frame": 1, "id": 1, "class": "vehicle", "bbox": [x1, y1, x2, y2]},
  {"frame": 1, "id": 2, "class": "pedestrian", "bbox": [x1, y1, x2,
y2]}
]
```

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7. Key Learnings

1. End-to-end CV pipeline: data collection → annotation → training → deployment.

2. YOLO-Seg adapts well to small datasets when using polygon annotations.

3. ByteTrack enables robust multi-object tracking and ID assignment.

4. Labellerr SDK facilitates pre-annotation upload and review.

5. Challenges faced:

   - Formatting predictions for Labellerr pre-annotations.

   - Handling masks vs bounding boxes in YOLO outputs.

    ○   Environment setup for YOLO + ByteTrack integration.

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8. Conclusion

The project demonstrates a fully functional pipeline for **semantic segmentation and object tracking**. Future improvements include:

- Scaling dataset to 1000+ images

- Data augmentation to handle occlusions and lighting variations

- Integrating real-time video streaming for live tracking

- Exporting analytics (object count, speed estimation) from tracked data