# AI-POWERED WASTE VIOLATION DETECTION USING YOLO AND DEEPSORT

## Problem Statement

Illegal waste disposal from vehicles onto public roads has become a major environmental and civic issue, contributing to pollution, road hazards, and increased municipal cleaning costs. Traditional surveillance relies on human operators monitoring CCTV footage, which is inefficient, labor-intensive, and error-prone. Most existing AI-based methods focus only on detecting litter or vehicles, without establishing a clear link between the waste object and the vehicle responsible. This gap prevents actionable evidence generation and reduces the applicability of such systems in law enforcement and smart city waste management.

## Existing Work

1. Public litter datasets such as TACO and pLitterStreet primarily focus on static waste detection, not waste emerging from vehicles.  
2. Current YOLO-based models are effective for object detection but struggle with small object visibility, occlusion, and motion blur in real traffic scenarios.  
3. Research in illegal dump detection has been explored in aerial or static imagery, but dynamic action-based waste violations remain underexplored.  
4. Existing systems lack tracking and association mechanisms, resulting in ambiguity about which vehicle is responsible for waste disposal.

## Proposed Solution

The proposed system integrates YOLOv8 for object detection with DeepSORT for real-time multi-object tracking to detect waste violations from traffic surveillance videos.  
  
- Detection Module: YOLOv8 fine-tuned to detect `car` and `waste` classes.  
- Tracking Module: DeepSORT assigns persistent IDs to vehicles and waste objects across frames.  
- Association Logic: IoU and trajectory-based analysis determine if a waste object originated from a specific vehicle.  
- Violation Logging: System generates an event log with timestamp, vehicle ID, waste ID, and cropped evidence images for reporting.

## Dataset

- Custom dataset created by extracting frames from traffic surveillance videos and annotating `car` and `waste` objects in YOLO format.  
- Supplemented with open datasets such as TACO (Trash Annotations in Context) and pLitterStreet for robustness.  
- Preprocessing pipeline includes frame extraction (2–5 fps) and dataset balancing for waste vs. vehicle classes.

## Evaluation

- Detection Performance: Precision, Recall, and mAP@0.5 for waste and vehicle detection.  
- Tracking Performance: MOTA (Multiple Object Tracking Accuracy), ID-switch rate.  
- Association Accuracy: Correct Vehicle Attribution Rate (CVAR) and False Positive Violations (FPV).

## Expected Results

- Reliable real-time detection of waste disposal from vehicles in traffic scenes.  
- High-confidence association between waste objects and responsible vehicles.  
- Automated logging of violation evidence for potential integration into smart city surveillance systems.  
- Improved scalability and reduced dependency on manual monitoring, enabling municipalities to act against violators more effectively.