1. Challenge Description

Title: AI-Driven Waste Collection Tracking for Smart Cities

Challenge Overview: Participants are tasked with developing an AI-based solution to detect and count the number of waste bins collected using a provided dataset of videos from real-world waste collection operations. The AI system should analyze the videos, identify different types of waste bins, and accurately track each bin as it's handled by the waste collection vehicles.

This solution will contribute significantly to improving waste collection processes by providing municipalities and waste management companies with actionable data. The collected data can help optimize waste collection routes, monitor recycling efforts, and facilitate the implementation of a "Pay-As-You-Throw" system, where citizens are charged based on the waste they produce. The primary goals are to increase operational efficiency, reduce environmental impact, and promote sustainable waste management practices.

Participants must ensure that their AI solution is:

- **Accurate**: The system should correctly identify and count waste bins.
- **Scalable**: It must handle a large number of video streams and detect bins in various settings.
- **Robust**: The AI should perform well under real-world conditions such as changes in lighting, weather, or bin placement.

Using the following data:

- **AI model YOLO v8 Nano** (see specifications in section 2)
- **A set of videos**

Task Requirements:

- Correctly identify the number of distinct objects (waste bins) detected by the AI model.
    - o For each identified object, provide the time stamps marking the start and end of its presence.
    - o Key real-world challenges include:
        - **Partial visibility**: The object may be partially obstructed or overlapped with another object.
        - **Proximity to the frame**: The object may appear very close to the camera and then move away.

- **Re-entry into the frame**: The object may leave the frame and later re-enter.

• Ensure **minimal processing time** to make real-time analysis feasible.

2. AI Model Specifications

The AI model used in this challenge is part of the **YOLO v8** family, specifically the **Nano** version.

Model details:

- The model was trained using images with a resolution of **640 x 640** pixels.
- It was trained to detect a single class: **1100 L residual waste bins**.
- The model is not perfect and has some shortcomings in exceptional cases.
- **Object tracking**: The waste bins exhibit two main behaviors:

    1. Variable speed and trajectory.

    2. Vertical oscillation, where the object changes size on the screen until it covers the camera.

3. Judging Criteria

No.	Criterion Description	Result	Percentage
1	**Accuracy of detection and tracking of containers**	Total number of containers detected	**50%**
2	**Running performance. Disk size of the model used. Teams will be graded proportionally based on the number of applicants**	Smallest model vs largest model	**30%**
3	**Maintaining track ID for containers entering and exiting the frame**	Unique number of containers	**10%**
4	**Detection of containers different from those provided by the trained model** (e.g., recyclable, biodegradable, paper-cardboard)	Total number of detected containers	**10%**
TOTAL			**100%**

Detailed Explanation of Each Criterion:

1. **Accuracy of Detection and Tracking of Containers** (50%):

   o The focus is on how accurately the AI system can detect and track the containers in the video. The number of successfully detected containers will heavily influence the final score.

2. **Running Performance & Model Size** (30%):

   o This criterion evaluates the performance of the AI model in terms of speed and efficiency, including how much disk space the model occupies. Teams will be scored based on how compact their model is, with a comparison between the smallest and largest models to determine the range of performance.

3. **Maintaining Track IDs for Containers Entering and Exiting the Frame** (10%):

   o The ability to assign a consistent track ID to containers that leave and re-enter the frame. This ensures that each container is uniquely identified even if it is temporarily out of view.

4. **Detection of Additional Container Types** (10%):

   o Teams are also scored on their ability to detect container types that differ from the training set. This includes containers for recyclable, biodegradable, and paper/cardboard waste. The total number of such containers successfully detected will count toward this score.

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4. Deliverables

Each team must provide the jury with the following:

- An **Excel file** with the following columns:

  o Object Type
  o Track ID
  o Start time of the bin's presence
  o End time of the bin's presence

- A **15-minute video** (provided in advance) annotated with all container detections.

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5. Award

A prize of 6,000 RON per team will be awarded to the winning team.