

A Garbage Detection and Classification

Method Based on Yolov9-e

There is need for Garbage Bin

- Garbage classification using deep learning offers a solution for automating waste sorting processes, leading to more efficient recycling efforts and reduced environmental impact.

YOLOV9

- YOLOv9 is the latest iteration of the YOLO series by Chien-Yao Wang. Released on 21 February 2024.
- YOLOv9 introduces two innovative techniques, Programmable Gradient Information (PGI) and the Generalized Efficient Layer Aggregation Network (GELAN), to tackle the information bottleneck problem directly and improve the accuracy and efficiency of object detection.
- This combination addresses the challenges of information bottleneck and gradient reliability, enabling the model to learn more efficiently and accurately from complex data patterns without losing any information.

Reversible Network Architecture

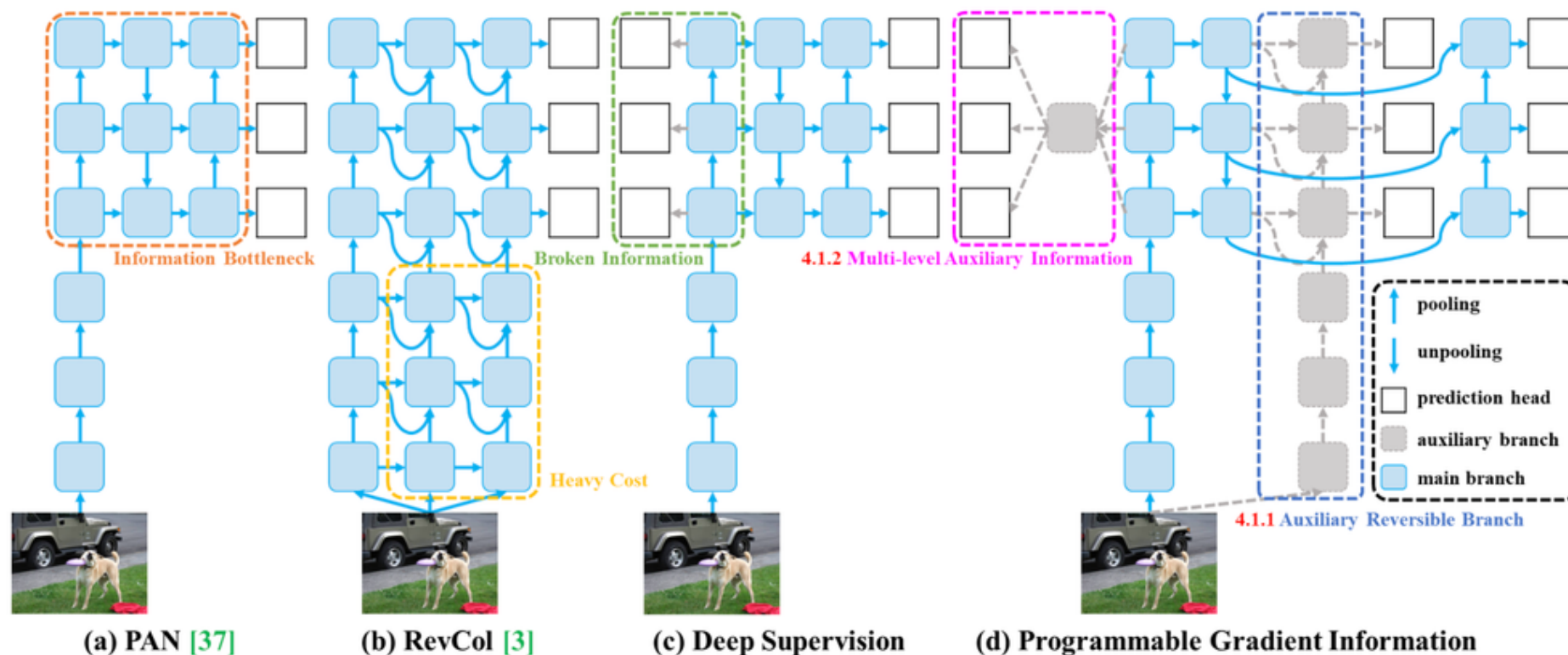


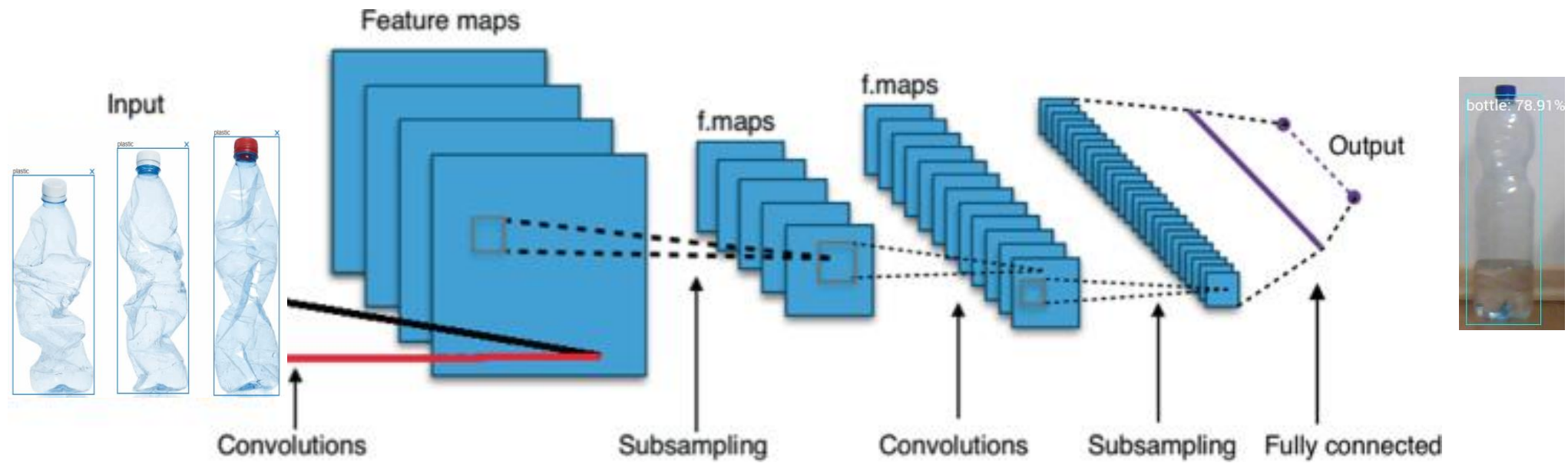
Figure 3: PGI and related network architectures and methods. (a) Path Aggregation Network (PAN) [37], (b) Reversible Columns (RevCol) [3], (c) conventional deep supervision, and (d) our proposed Programmable Gradient Information (PGI). PGI is mainly composed of three components: (1) main branch: architecture used for inference, (2) auxiliary reversible branch: generate reliable gradients to supply main branch for backward transmission, and (3) multi-level auxiliary information: control main branch learning plannable multi-level of semantic information.

Range of YOLOv9 Models

Model	#PARAM. (M)	FLOPs (G)	$AP_{50:95}^{val}(\%)$	$AP_{50}^{val}(\%)$	$AP_{75}^{val}(\%)$	$AP_S^{val}(\%)$	$AP_M^{val}(\%)$	$AP_L^{val}(\%)$
YOLOv9-S (Ours)	7.2	26.7	46.8	63.4	50.7	26.6	56.0	64.5
YOLOv9-M (Ours)	20.1	76.8	51.4	68.1	56.1	33.6	57.0	68.0
YOLOv9-C (Ours)	25.5	102.8	53.0	70.2	57.8	36.2	58.5	69.3
YOLOv9-E (Ours)	58.1	192.5	55.6	72.8	60.6	40.2	60.0	71.4

YOLOv9 Working Principle

Convolutional Neural Network



Dataset information

Source: Roboflow

Class	Train (%80)	Test (%20)	Total (%100)
Aluminum can	1600	278	1878
Cardboard	400	262	662
Organic	493	200	693
Glass bottles	452	100	552
plastic bag	693	200	893
plastic bottles	900	357	1257
Container for household chemicals	154	200	354
Total	4692	1597	6289

Picture Representation for Datasets



Aluminum can



Cardboard



Organic



Glass bottles



**Container
for household chemicals**




plastic bag




plastic bottles

Roboflow Annotation Tool

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waste classification

Object Detection

Overview

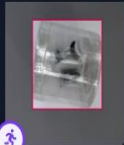
Images1566


Dataset1

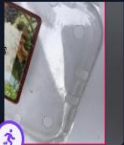
Model


API Docs


Health Check

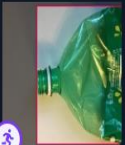

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metal282.jpg

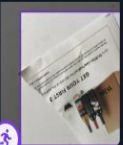

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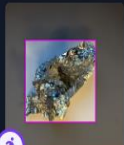

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metal2.jpg



plastic391.jpg



metal296.jpg



paper320.jpg

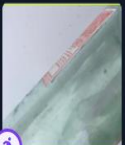

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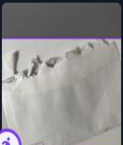

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paper137.jpg



plastic179.jpg

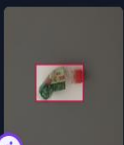

metal335.jpg



glass364.jpg



paper321.jpg



paper490.jpg



plastic63.jpg

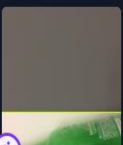

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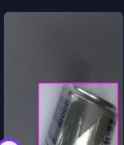

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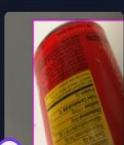

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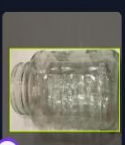

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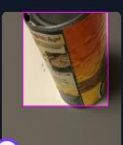

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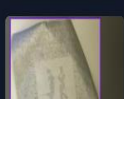

glass166.jpg



plastic88.jpg



glass39.jpg

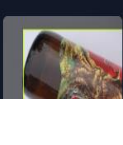

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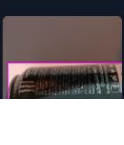

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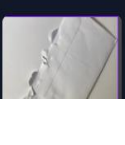

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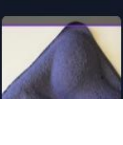

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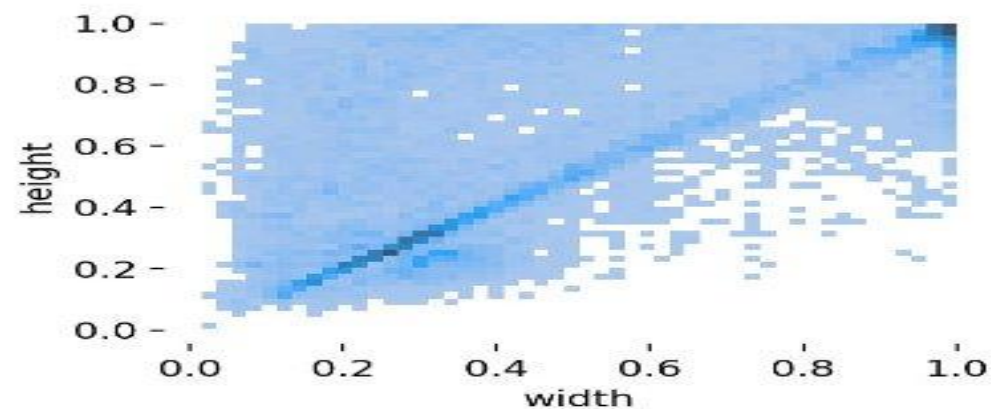
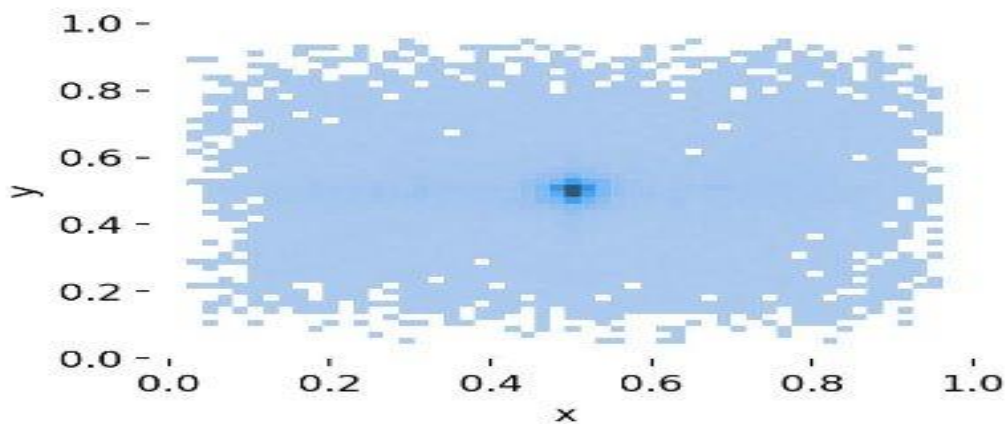
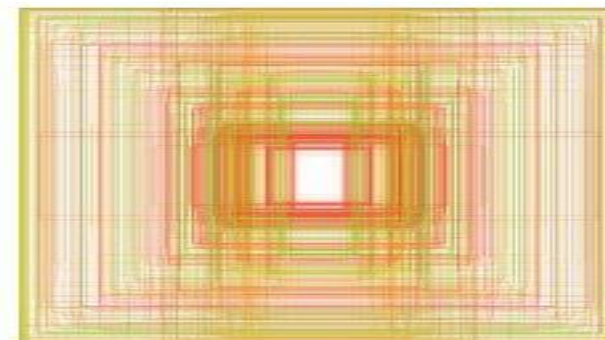
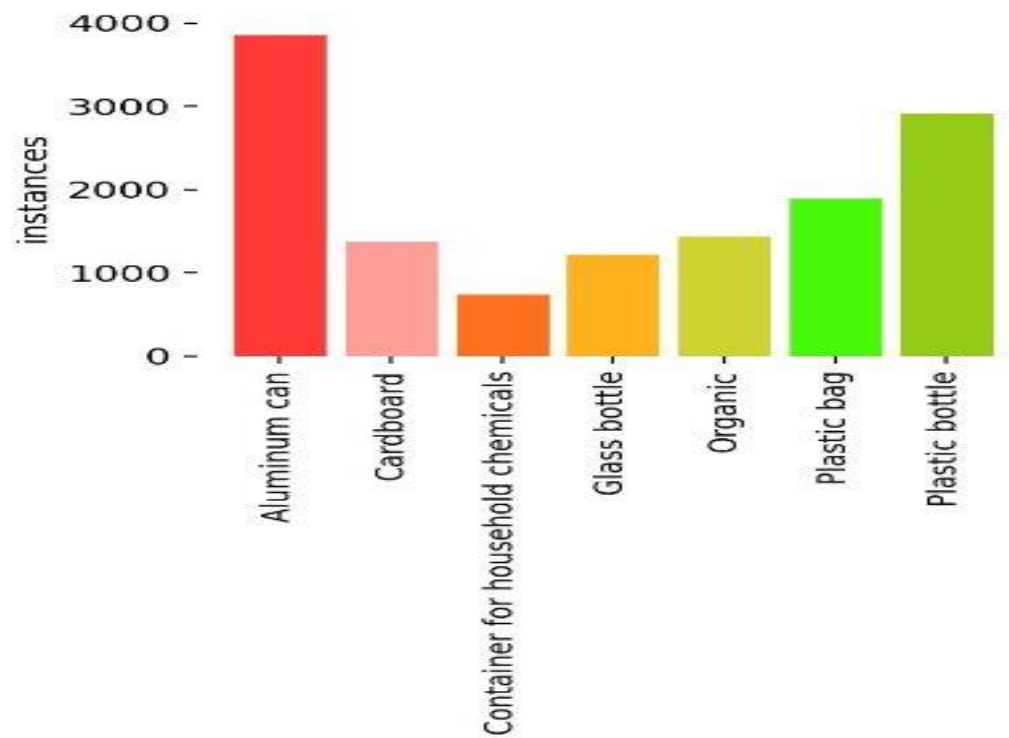

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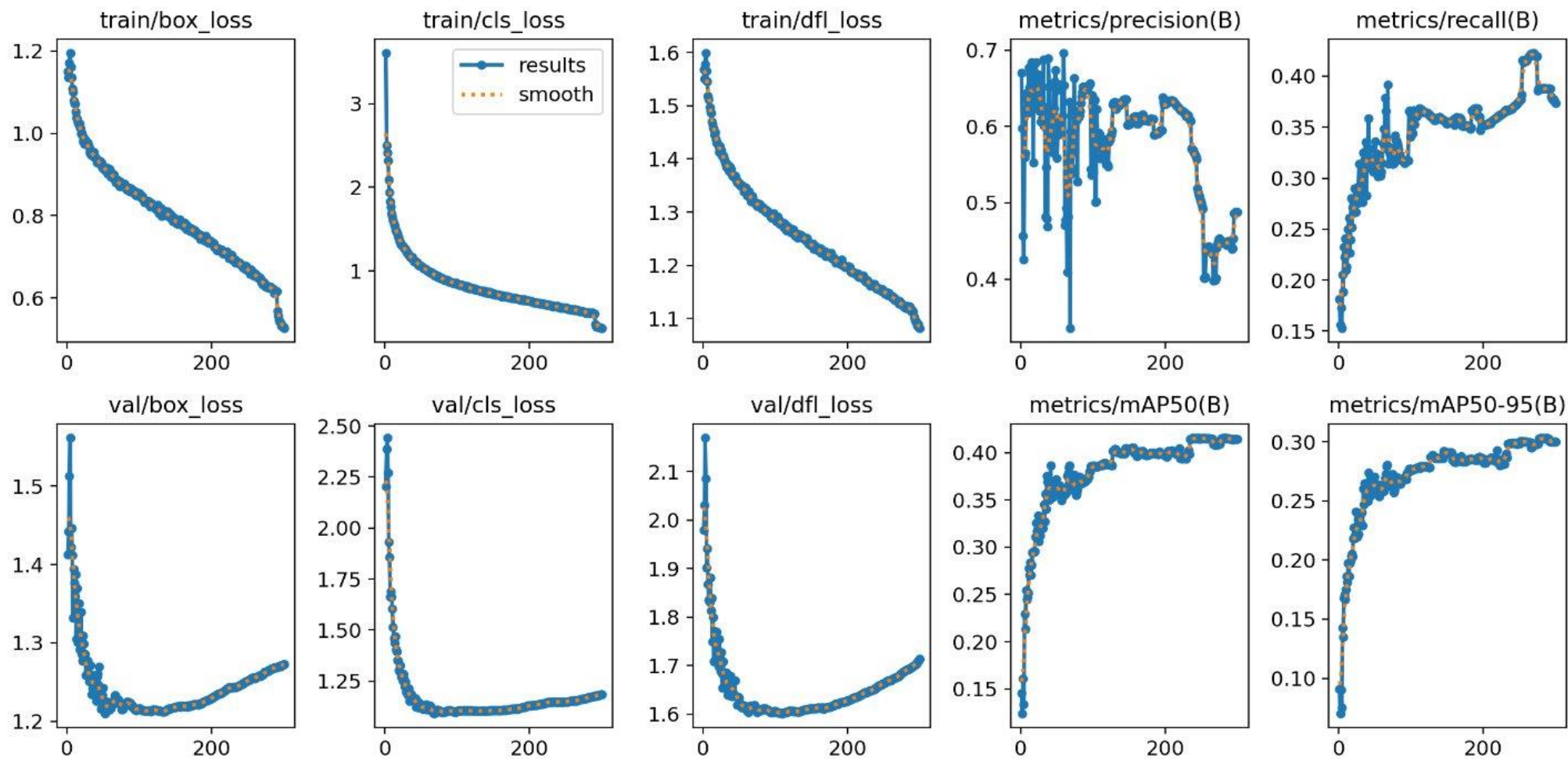

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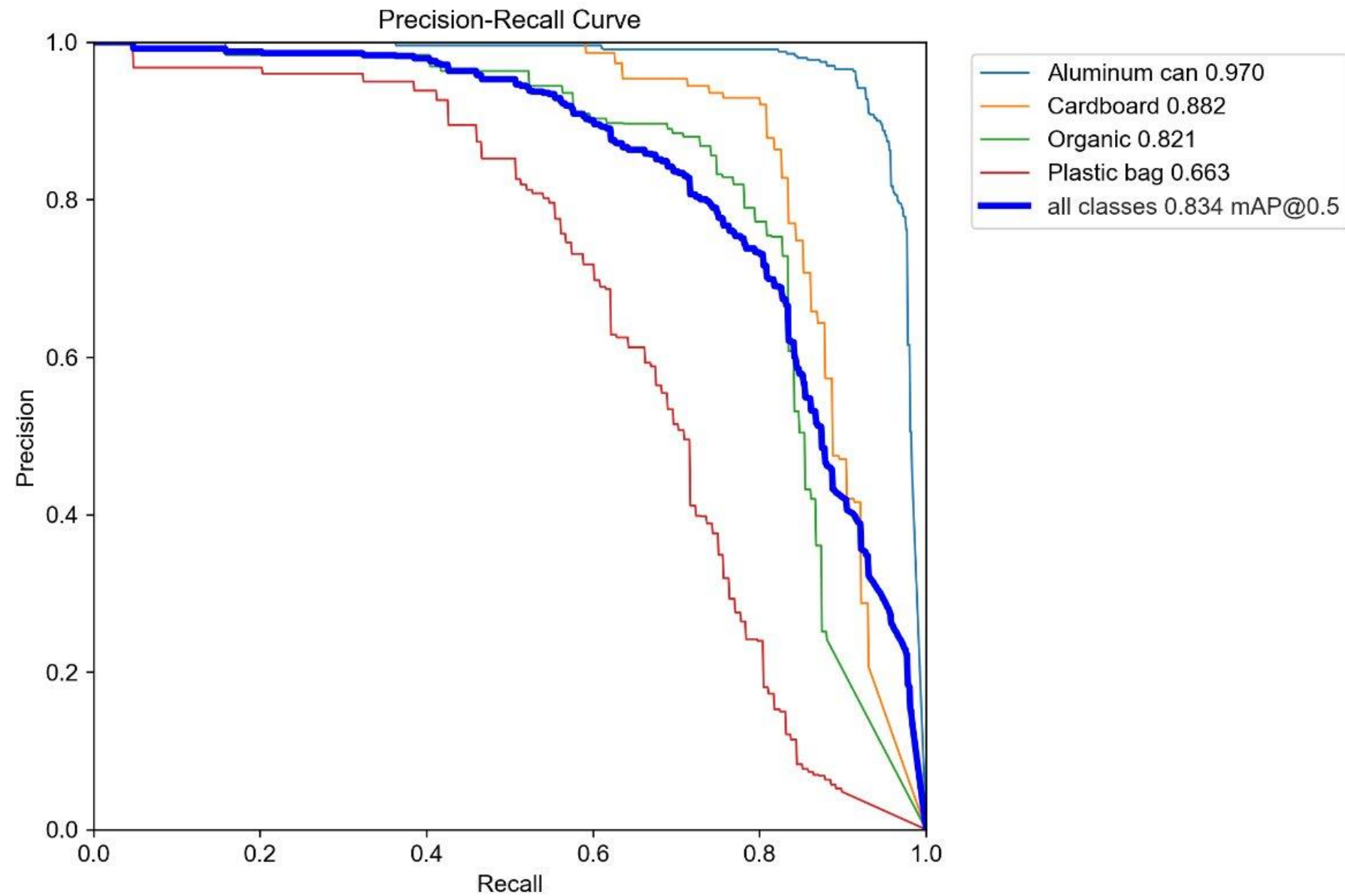
Labels



Training results for YOLOv9-e model



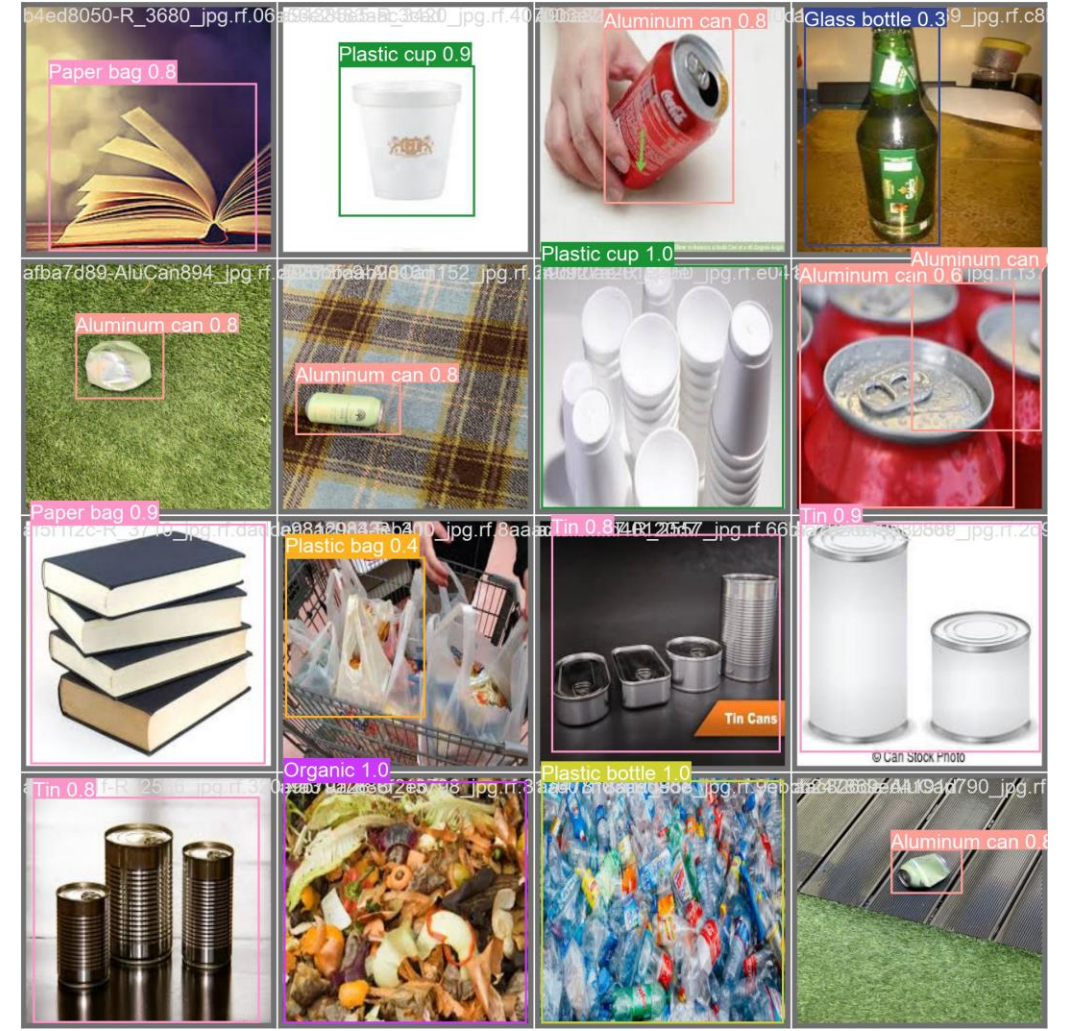
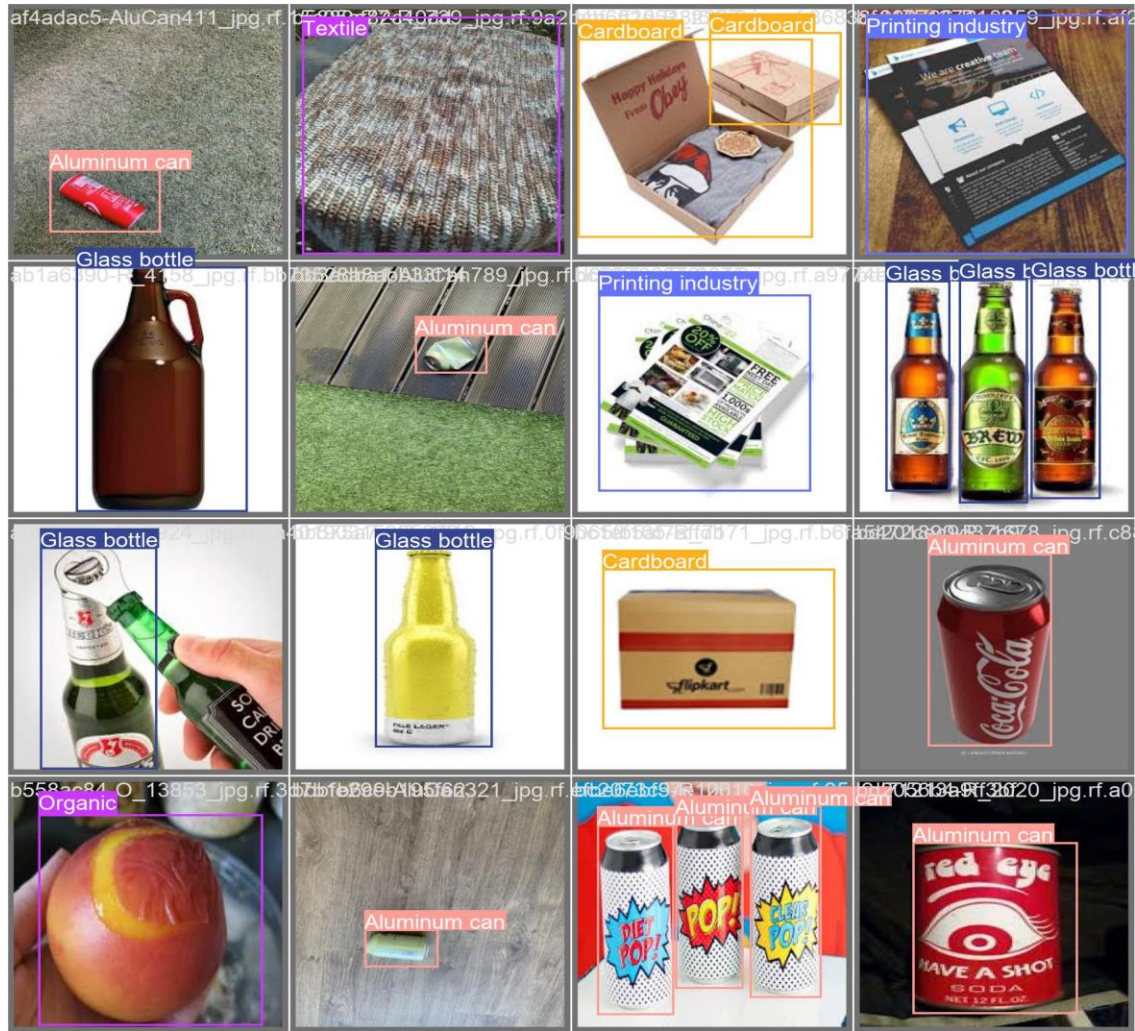
Precision-Recall Curve



Confusion Matrix



Test Images



Future Plan

- To adjust the model's parameters, use repeated experimentation and optimization.
- Research different neural network architectures, such as self-attention-based model of the Vision Transformer.