YOLO와 SAM을 활용한 해양 쓰레기 탐지 및 Pseudo Segmentation

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김상수, 김지훈, 송인섭, 윤서환

광운대학교 정보융합학부

광운대학교 KwangWoon University AI 인공지능서비스 연구실 http://sites.google.com/view/aiaas

Outline

1. Introduction
2. Method
3. Experiments
4. Results

Introduction

- **Background**

해양쓰레기 문제, 얼마나 심각하며 어떻게 해결할 수 있을까

[인터뷰] 김경신 한국해양수산개발원 연구원

2021.06.28 | 정책브리핑 김차경

[사설] 늘어나는 해양 폐기물을 방치하면 안되는 이유

울산매일 | 승인 2024.05.15 18:22 | 15면

환경·자연

"전세계 바다에 떠다니는 미세플라스틱 무려 230만톤"

2023.03.09 17:25

Introduction

- **Background**

해양 생태계

- 서식지 파괴
- 종의 감소

생물의 다양성 감소

경제

- 관광업의 경제적 비용 증가
- 수산업 생산의 비효율성

경제적 손실

Introduction

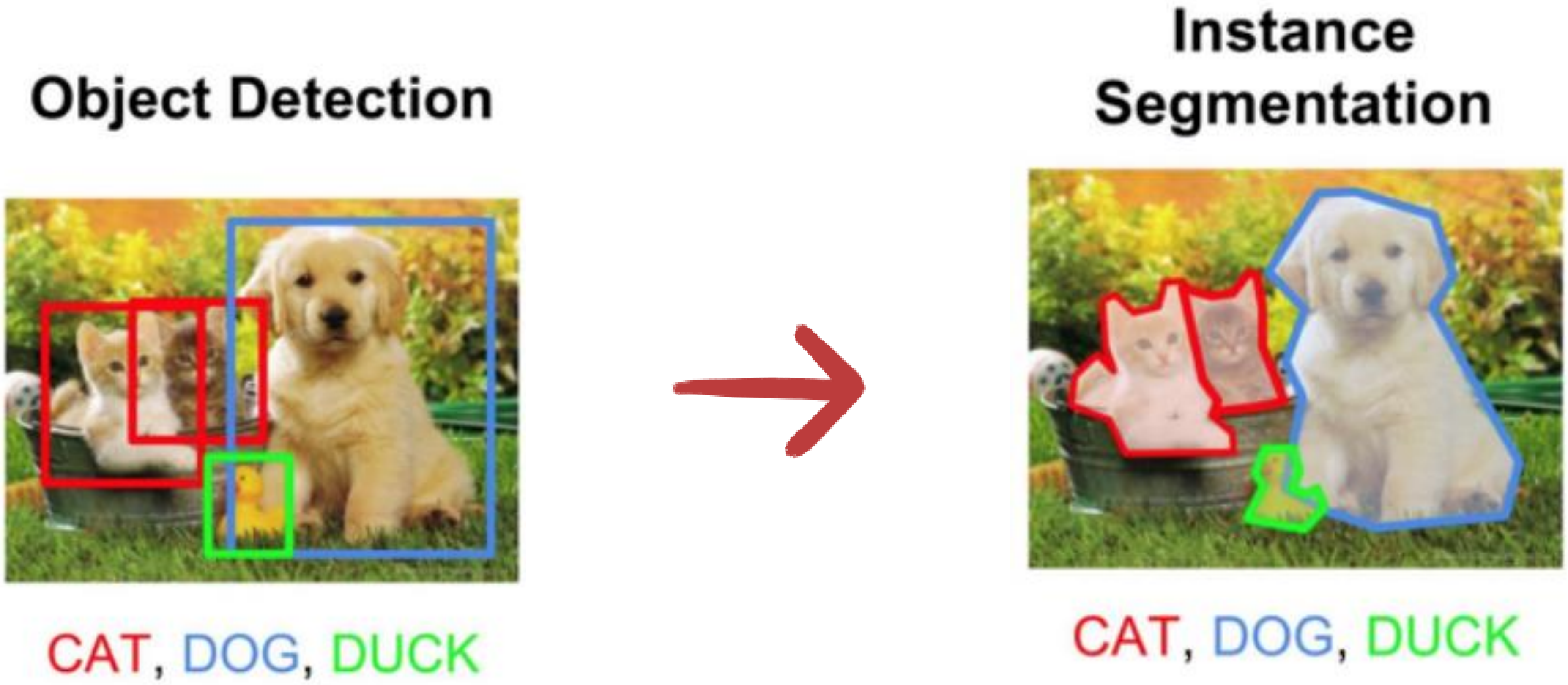
- **Background**

직접 탐지에 한계점

- 넓은 해양지역
- 조도가 낮은 심해환경

Introduction

- **Background**



Introduction

- **Background**

이미지

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    </object>
```


XML label

Introduction

- **Background**

	등급 1 (첫 50,000개) **1000개당 가격**	등급 2 (다음 950,000개) **1000개당 가격**
bounding box	63$	49$
segmentation	870$	850$

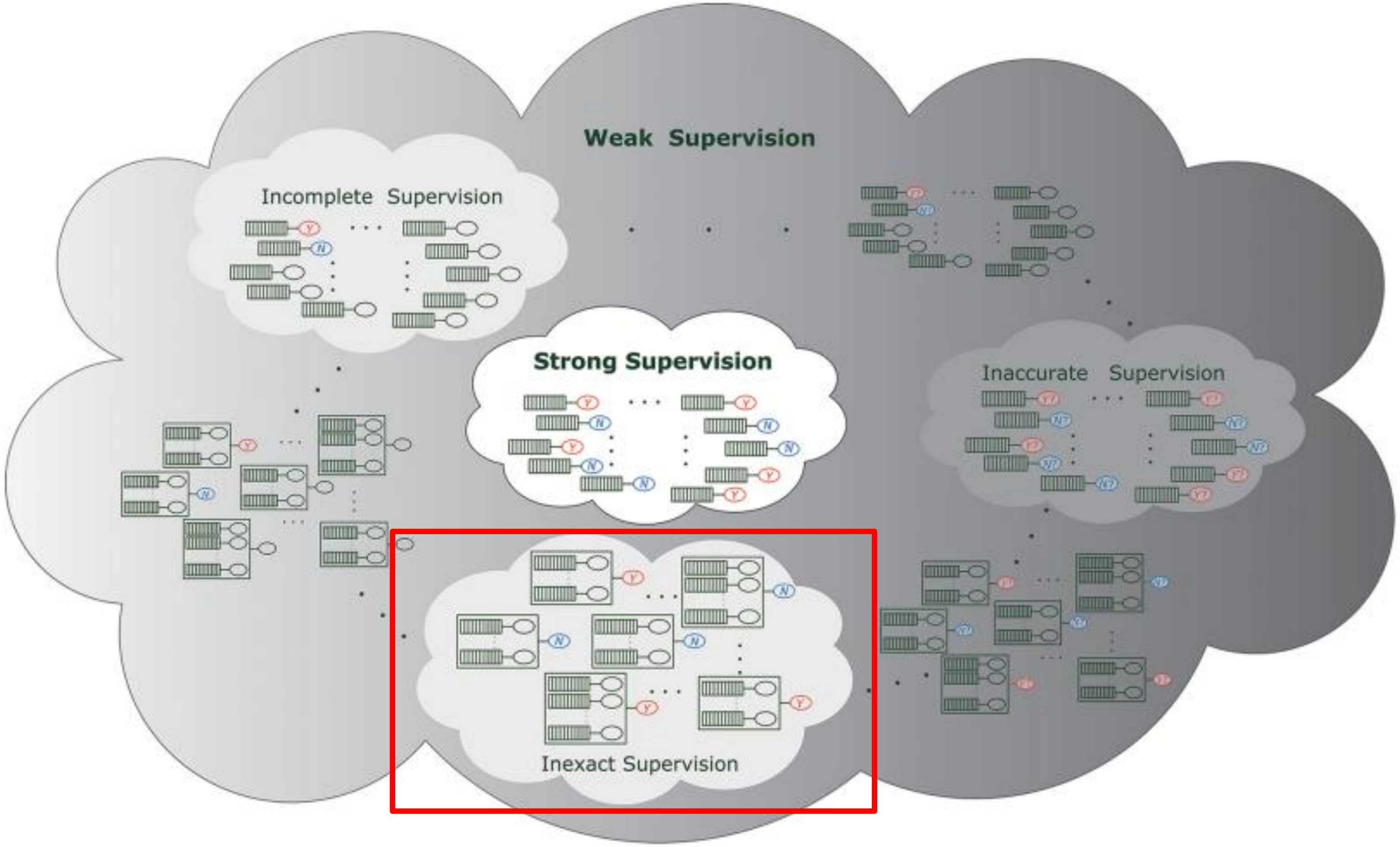
구글 AI Platform

	Label당 제안되는 요금
bounding box	0.036$
segmentation	0.84$

아마존

Introduction

- **Background**



Weakly supervised learning

Zhou, Zhi-Hua. "A brief introduction to weakly supervised learning." *National science review* 5.1 (2018): 44-53.

Introduction

- **Background**

Object Detection

YOLO(You Only Look Once)

Segmentation

SAM(Segment Anything Model)

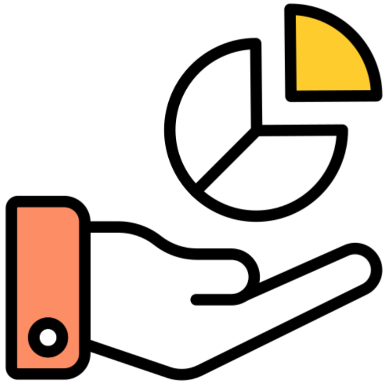
Introduction

- Research Objectives

해양 쓰레기 탐지 모니터링

데이터 구축 비용 절감

Weakly supervised learning 기여



Outline

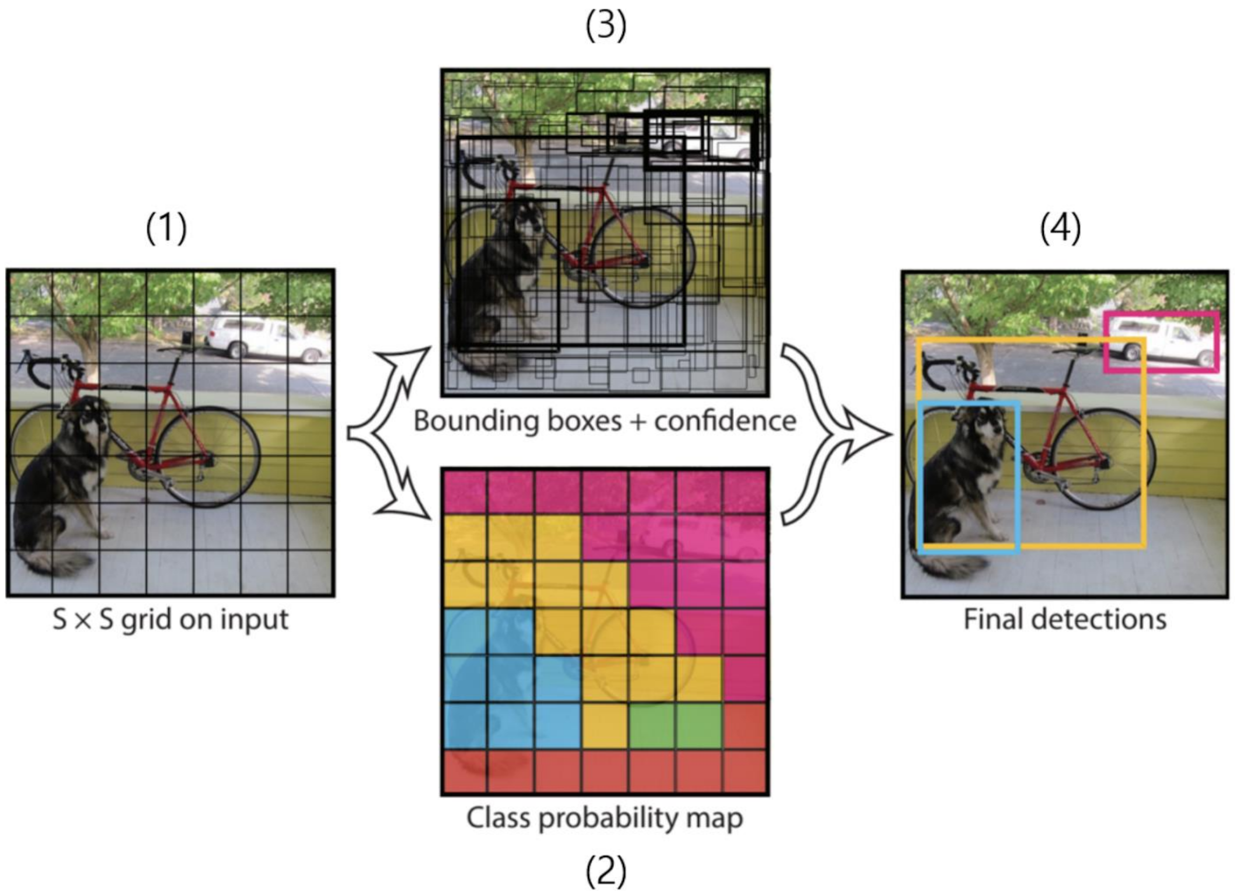
1. **Introduction**
2. **Method**
3. **Experiments**
4. **Results**

Method

- **Deep Learning Technologies Used**
  - YOLO(You Only Look Once)
  - SAM(Segment Anything Model)
  - Sea-thru

Method

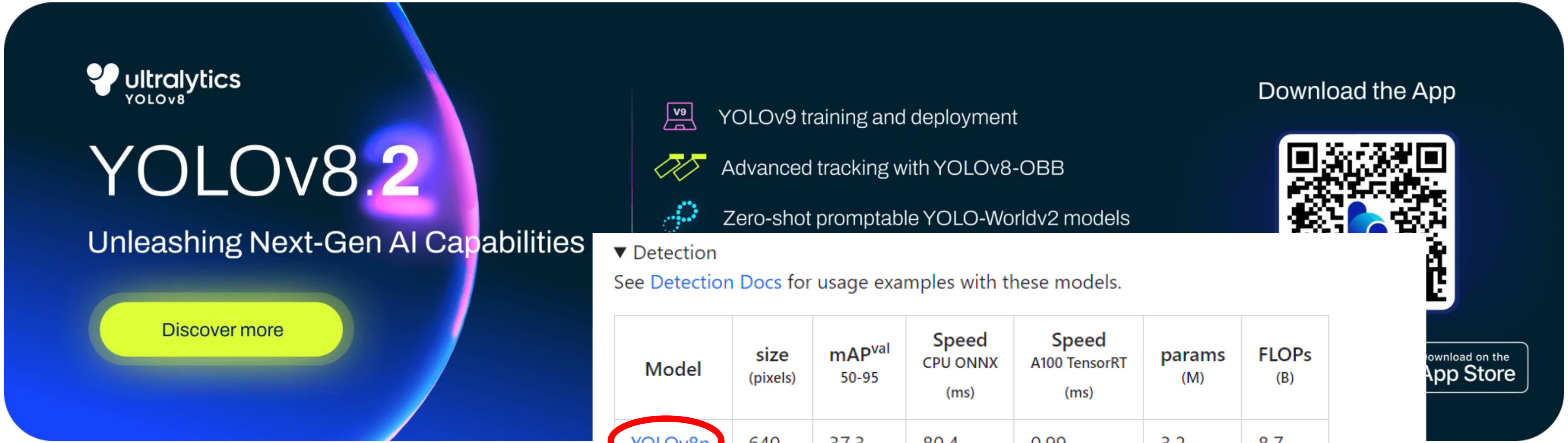
- **YOLO(You Only Look Once)**



https://velog.io/@dlwns97/%EC%BB%B4%ED%93%A8%ED%84%B0%EB%B9%84%EC%A0%84-Object-Detection-YOLO

Method

- **YOLO(You Only Look Once)**



▼ Detection

See Detection Docs for usage examples with these models.

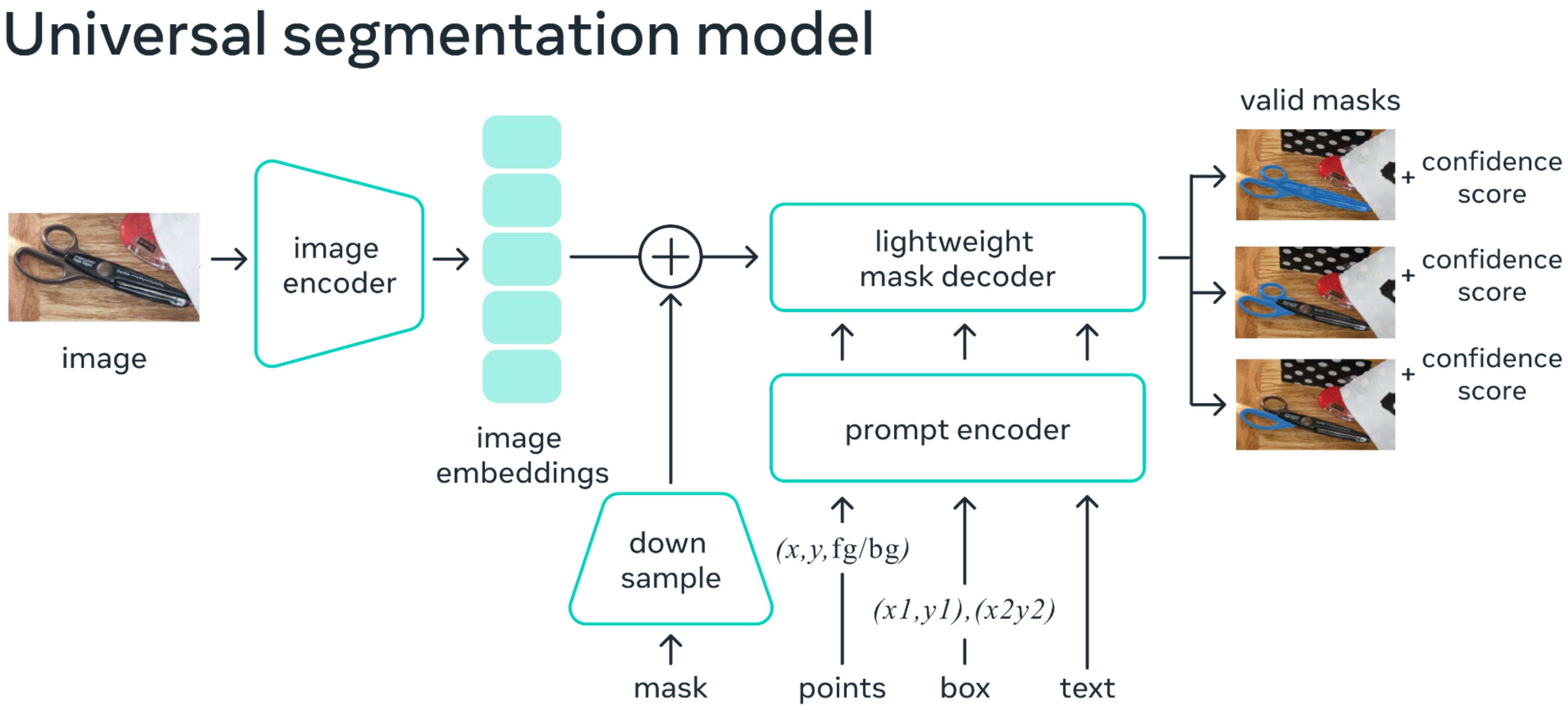
Model	size (pixels)	mAP^{val} 50-95	Speed CPU ONNX (ms)	Speed A100 TensorRT (ms)	params (M)	FLOPs (B)
YOLOv8n	640	37.3	80.4	0.99	3.2	8.7
YOLOv8s	640	44.9	128.4	1.20	11.2	28.6
YOLOv8m	640	50.2	234.7	1.83	25.9	78.9
YOLOv8l	640	52.9	375.2	2.39	43.7	165.2
YOLOv8x	640	53.9	479.1	3.53	68.2	257.8

Method

- **SAM(Segment Anything Model)**

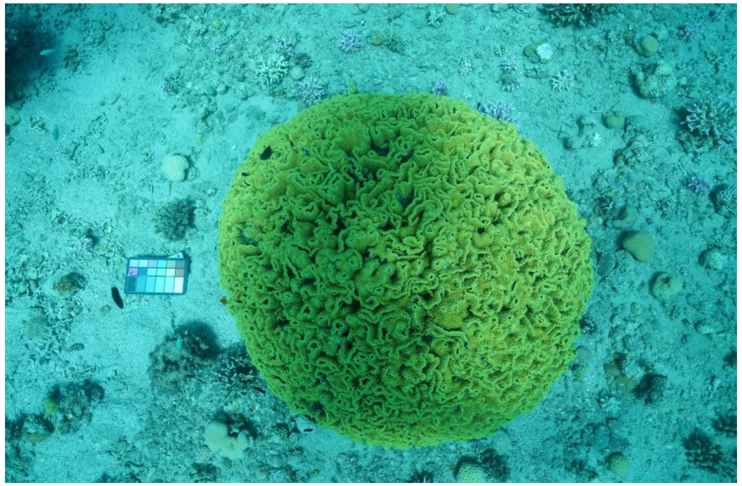
Method

- **SAM(Segment Anything Model)**



Method

- **Sea-thru**



Original

Sea-thru

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Experiments

- **Dataset**
  - AI-Hub 해양 침적 쓰레기 이미지
  - 소나 이미지 46,000장, 수중 촬영 이미지 18,000장
  - 객체 여러 개 또는 미존재 제거 → 12,000장 사용
  - Train, val, test = 7:1:2

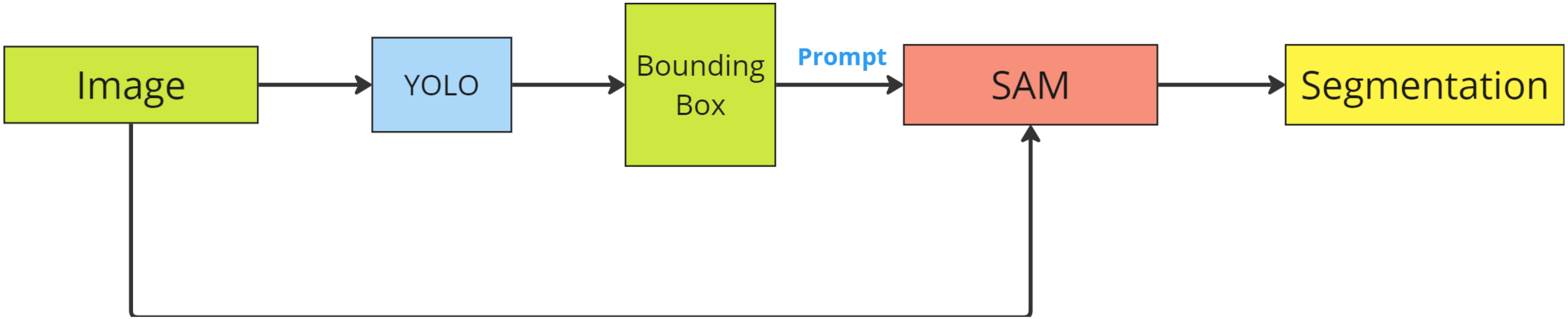
Experiments

- **YOLO**
  - COCO pre-trained YOLOv8n
  - Batch size : 128, Input size : 512
  - AdamW(lr : 0.001111, momentum : 0.9), epoch : 50

- **SAM**
  - Pre-trained ViT-H
  - Input size : 512
  - Prompt : bounding box

Experiments

- **Pipeline**



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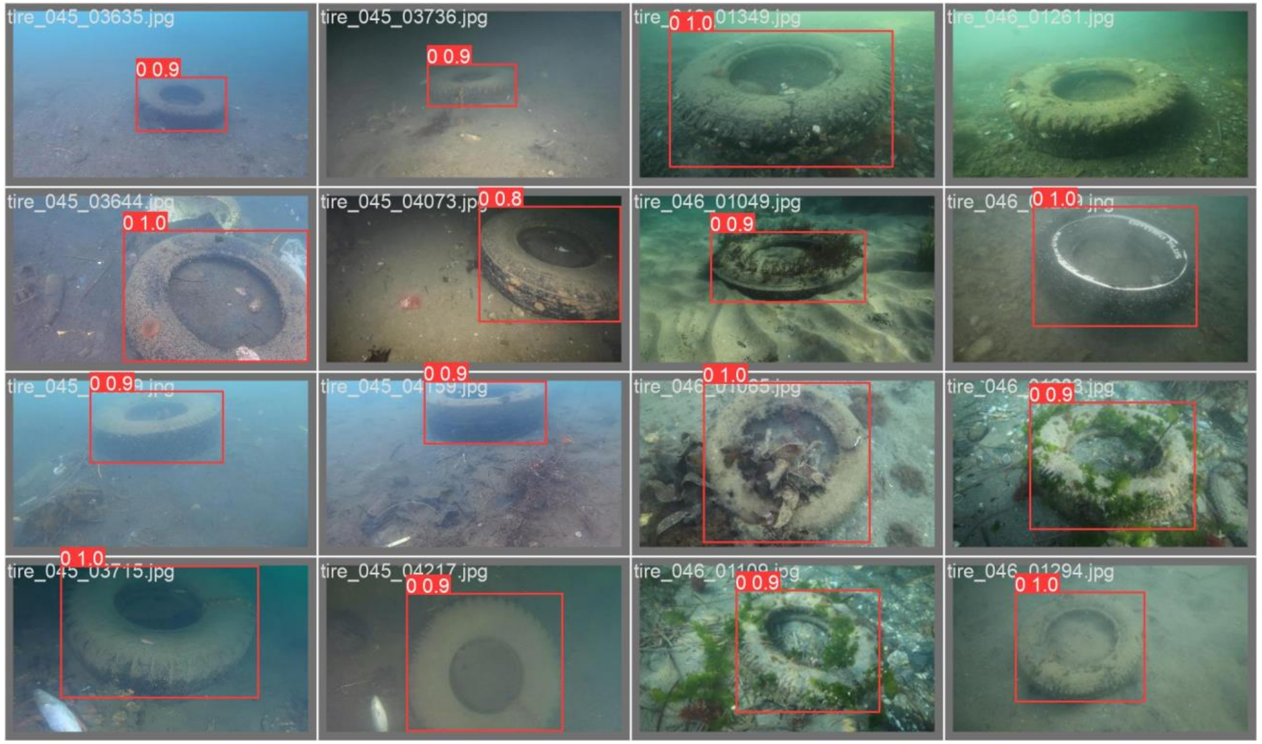
Results

- **YOLO**
  - Train보다 test 성능 우수
  - Overfitting x, 일반화 성능

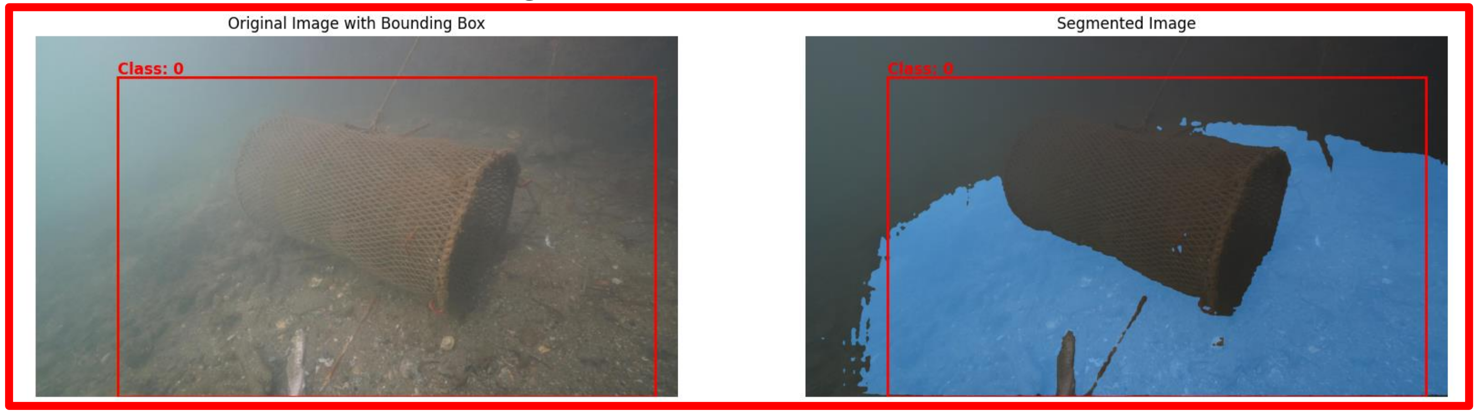
	precision	recall	f1	mAP50	mAP50-95
train	0.86	0.68	**0.74**	0.73	0.61
test	**0.91**	**0.69**	0.73	**0.76**	**0.62**



KWANGWOON UNIVERSITY AI as a Service

Results

- **SAM**
  - Ground Truth bbox, prediction bbox 비교
  - Prediciton에서 더 좋은 segmentation



Ground Truth

Prediction

Results

- **Pseudo label**
  - SAM Inference time : 0.05s
  - 수작업 labeling : 10~30m
  - 약 10,000배 시간 단축

```
Average Inference Time: 0.0532 seconds
```

Labeling cost & time 감소

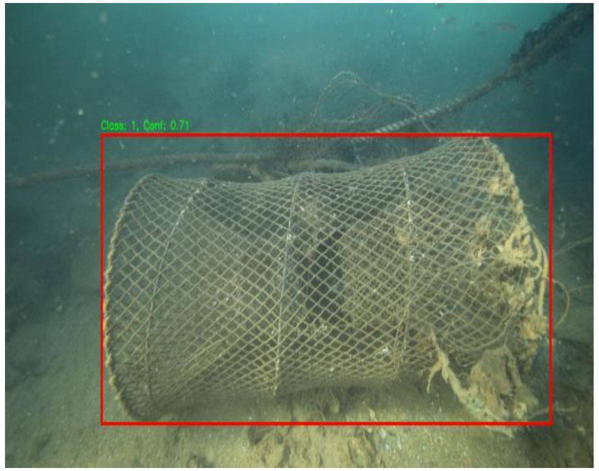
Results

- **기대 효과 – 해양 환경 보호**
  - YOLO, SAM을 통한 해저 쓰레기 탐지
  - 해양 생태계 유지 및 보호
  - Segmentation을 통한 쓰레기 크기, 밀도 추정 → 처리 우선순위, 수색 시간 감소

해양 쓰레기 탐지 모니터링

데이터 구축 비용 절감

Weakly supervised learning 기여



쓰레기 탐지

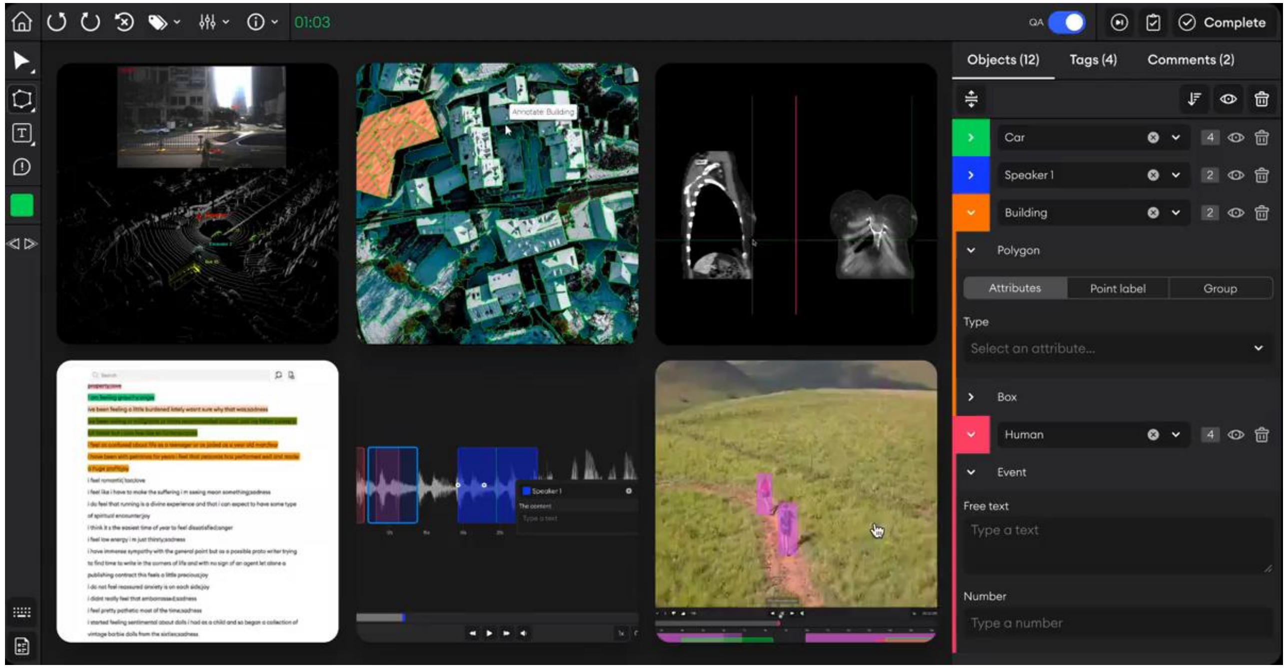
해양 생태계 보호

쓰레기 처리

https://www.ilyoweekly.co.kr/news/newsview.php?ncode=1065578186974349&dt=m
https://www.segye.com/newsView/20210707516074

Results

- **기대 효과 – 비용 절감**
  - AI 탐지 모델 → 인력 및 처리 비용 감소
  - Ground Truth보다 더 정확한 bbox label
  - Segmentation label 구축 비용 절감



Results

- **활용 분야**
  - **해양 쓰레기 탐지**
    - 공공기관 및 민간 기업 활용
    - 해당 과정에서 데이터 축적 → 고도화된 모델 및 기술 개발
  - **해양 쓰레기 연구**
    - 해양 쓰레기 종류와 분포 분석
    - 수질 오염 원인 및 쓰레기 처리 방법에 도움
    - Weakly supervise learning에 기여

해양 쓰레기 탐지 모니터링

데이터 구축 비용 절감

Weakly supervised learning 기여

Q & A

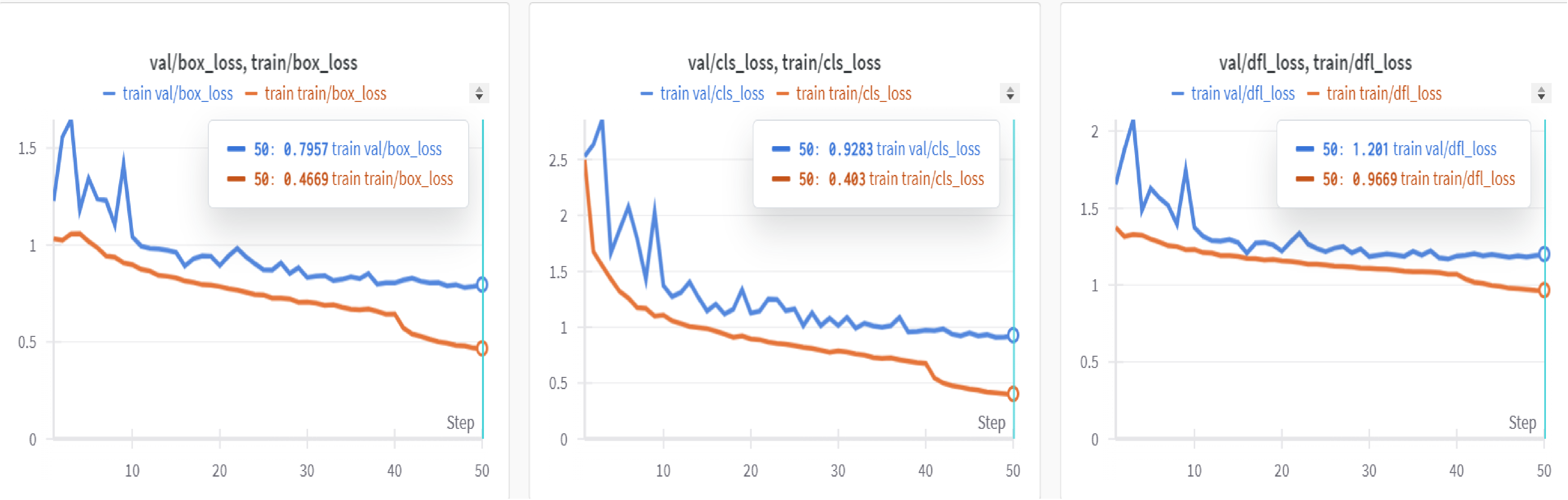
감사합니다 !

Appendix

- **Sea-thru**

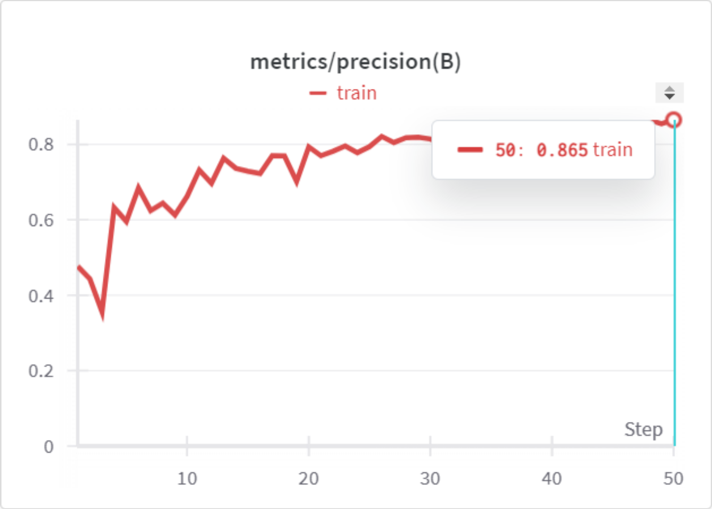
Appendix

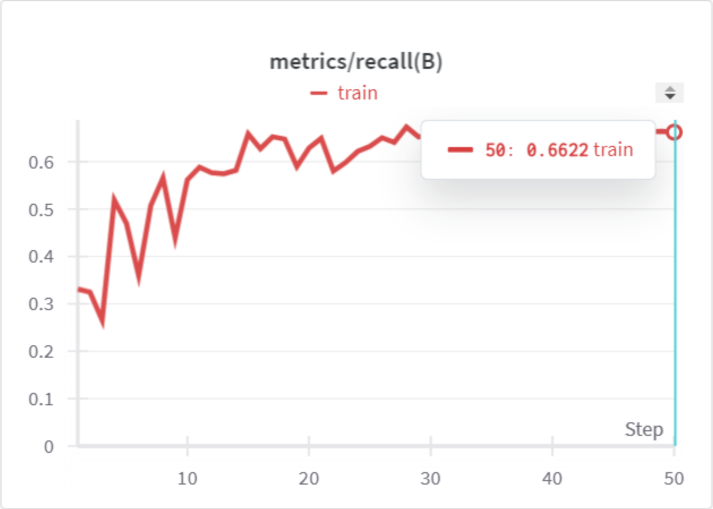
- **Train & validation loss**

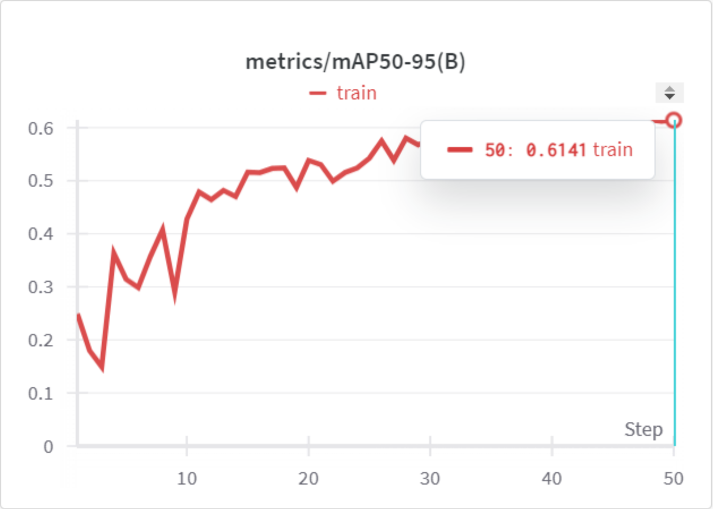


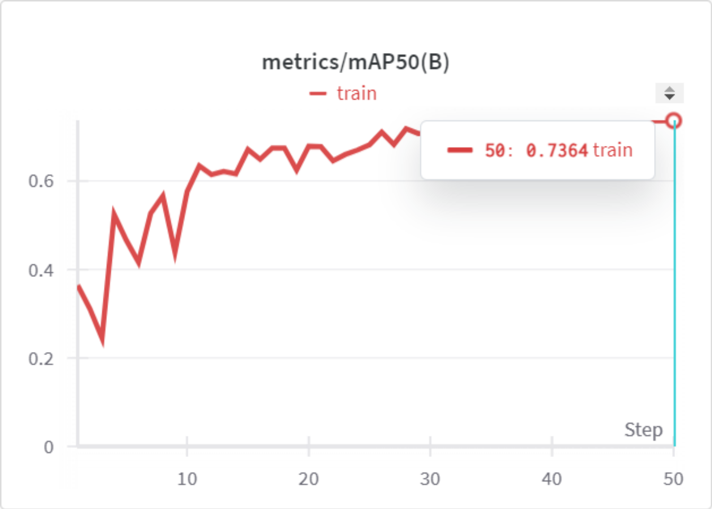
Appendix

- **Training metric**



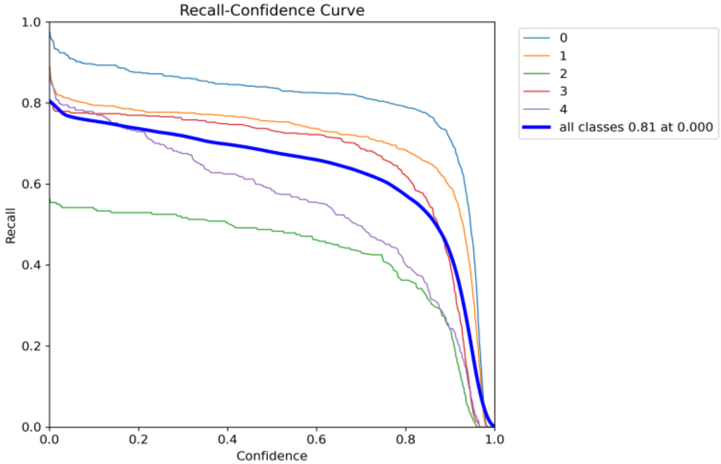




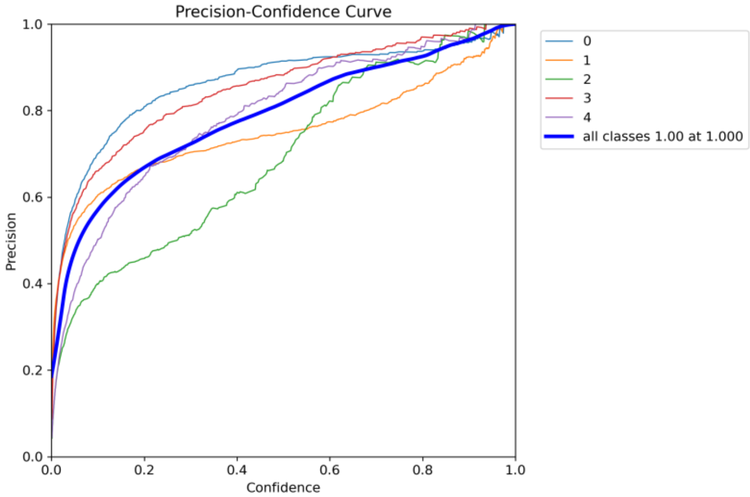


Appendix

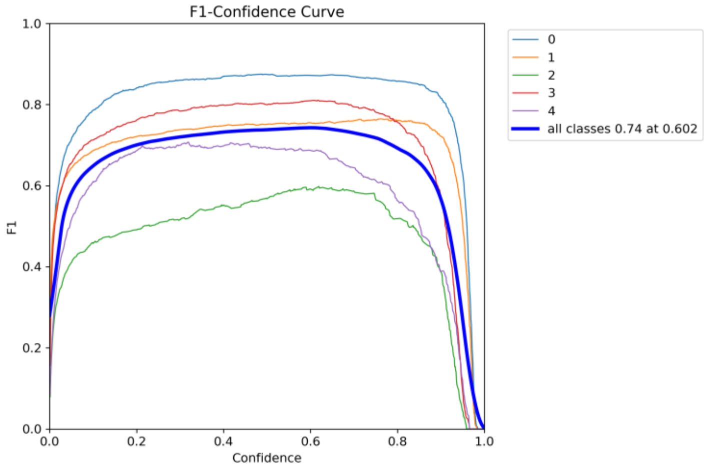
- **Training metric**



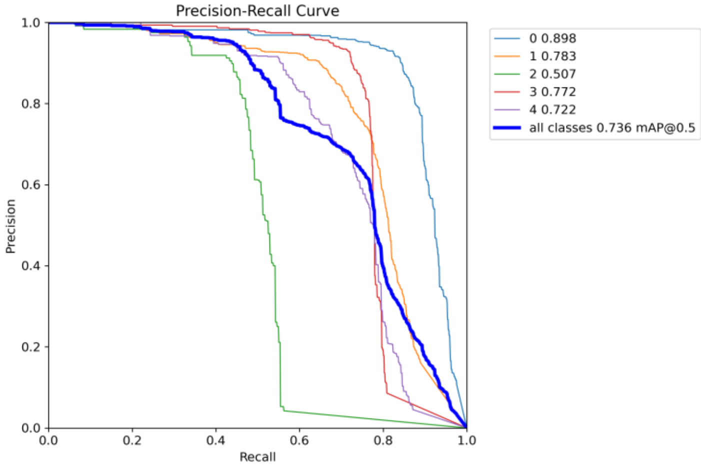
R_Curve



P_Curve



F1_Curve



PR_Curve

Appendix

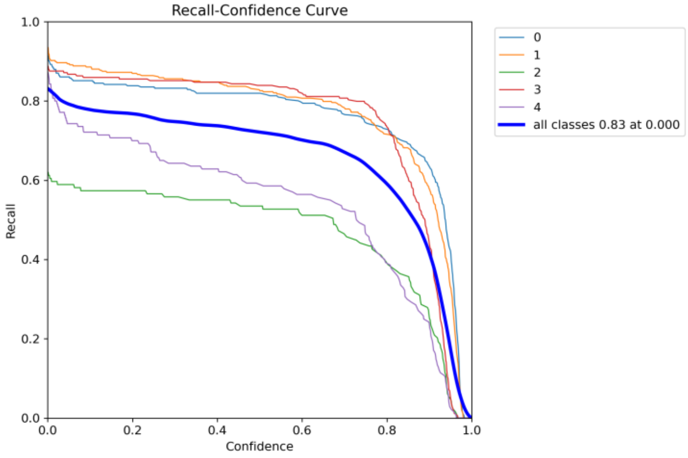
- **Validation batch**

Ground Thrth

prediction

Appendix

- **Test metric**



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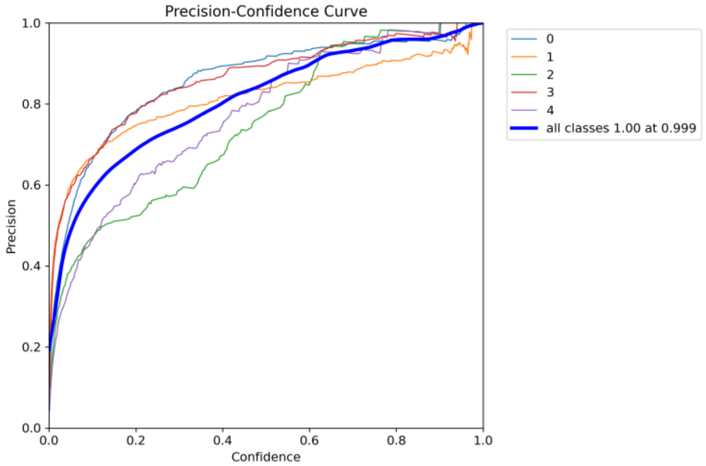

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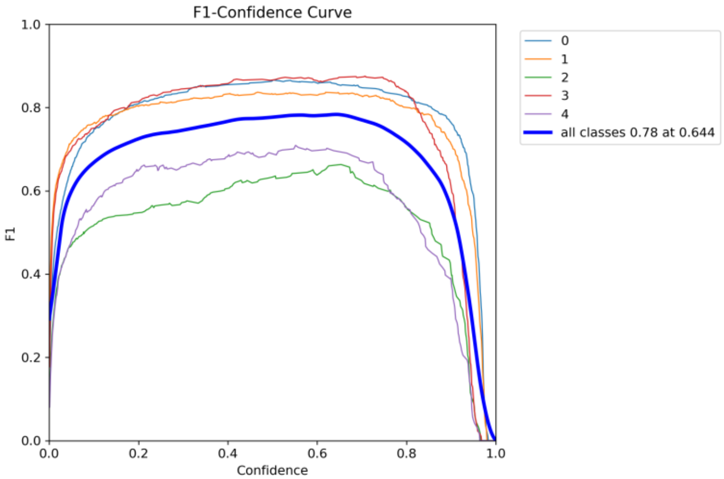
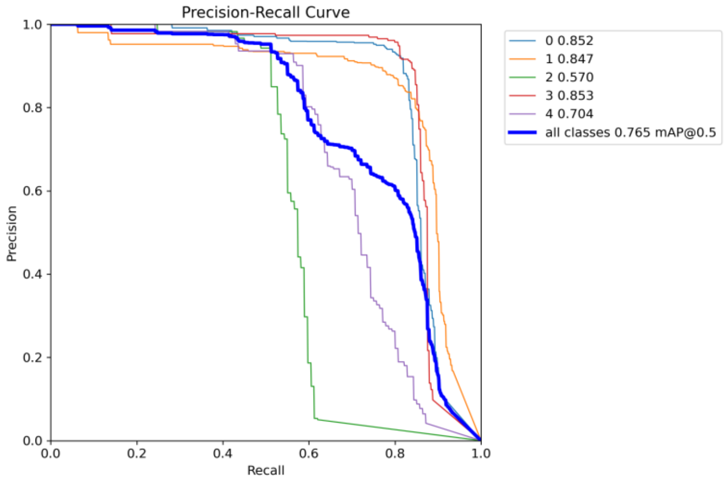


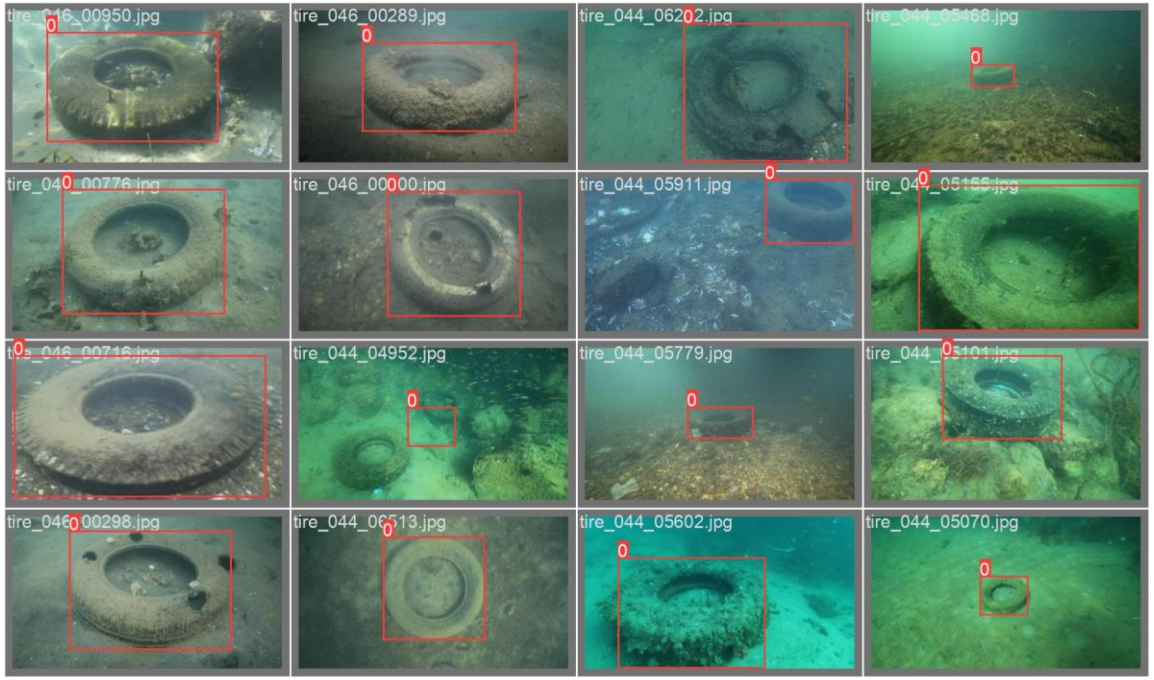
F1_Curve



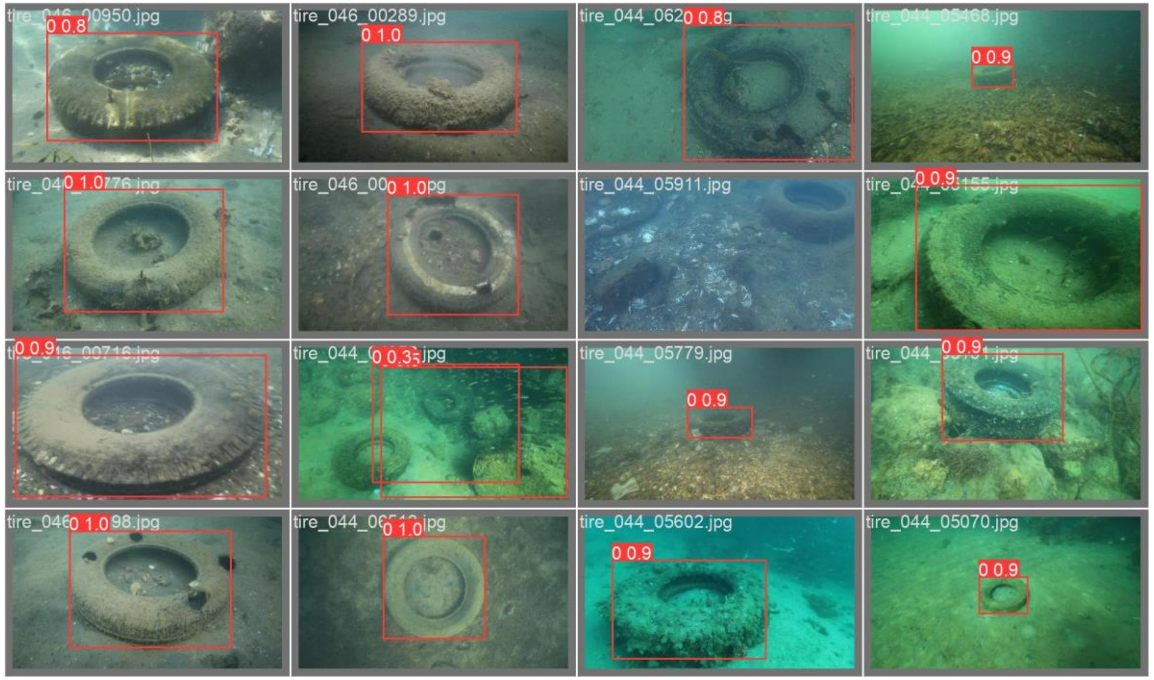
PR_Curve

Appendix

- **Test batch**



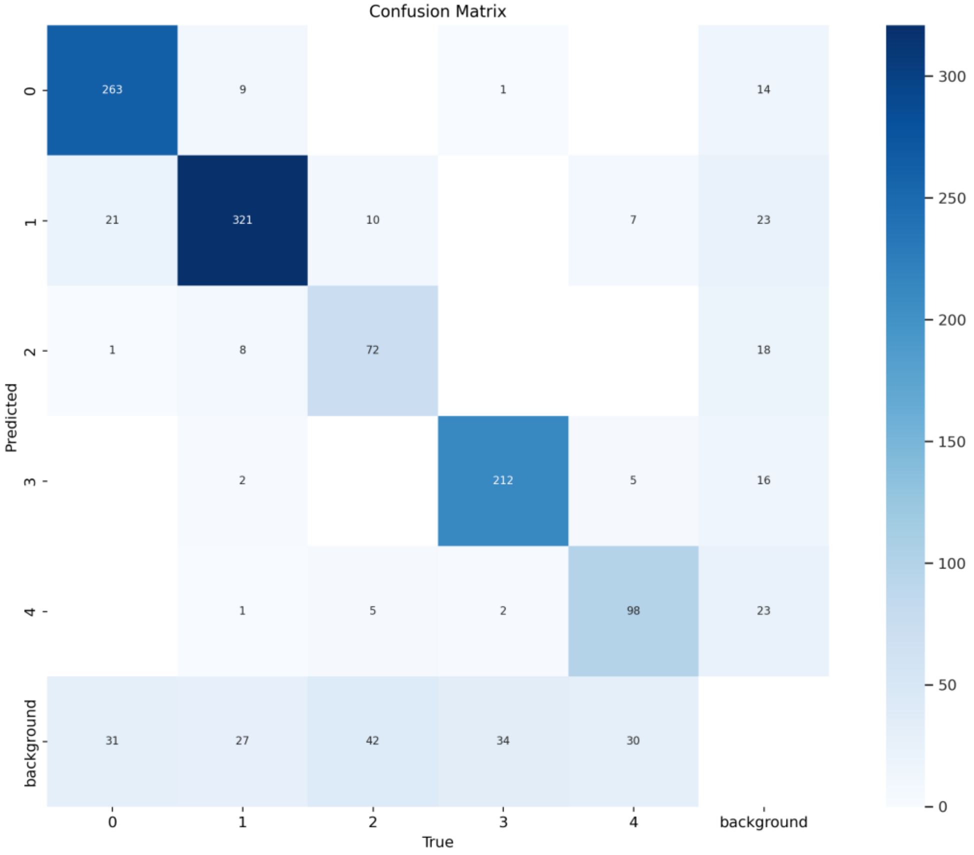
Ground Thrth



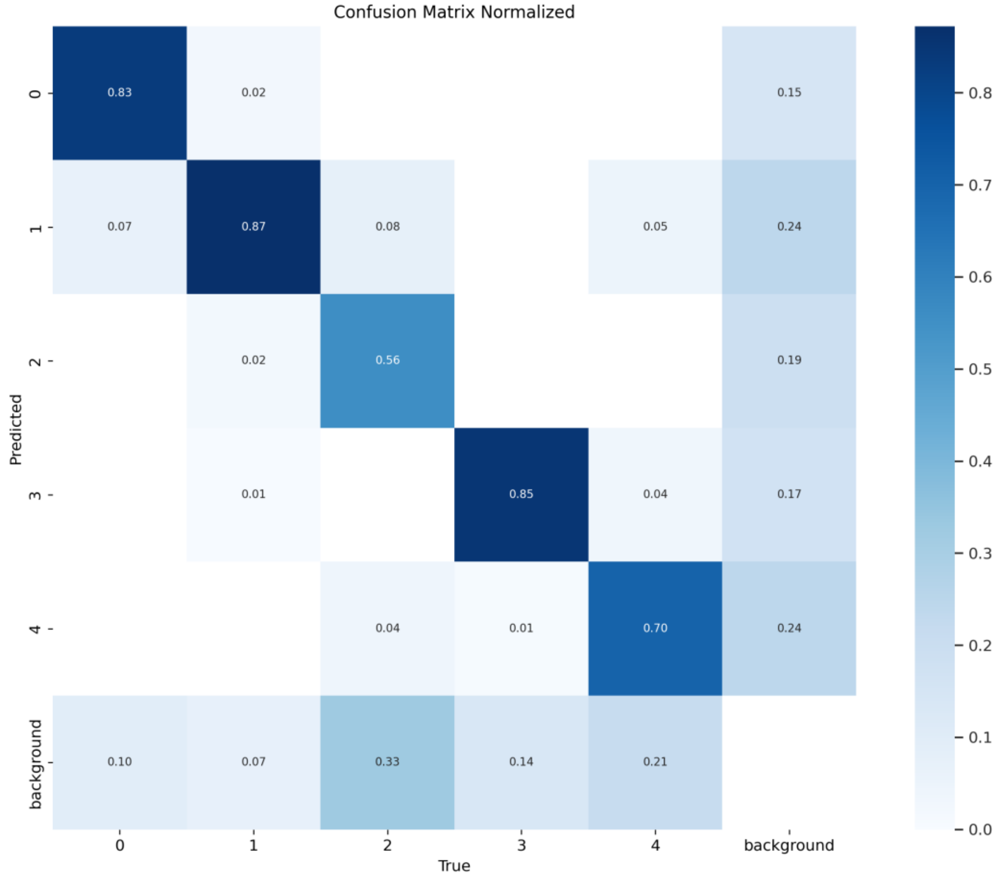
prediction

Appendix

- **Test confusion matrix**



Confusion matrix



Confusion matrix normalized

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