

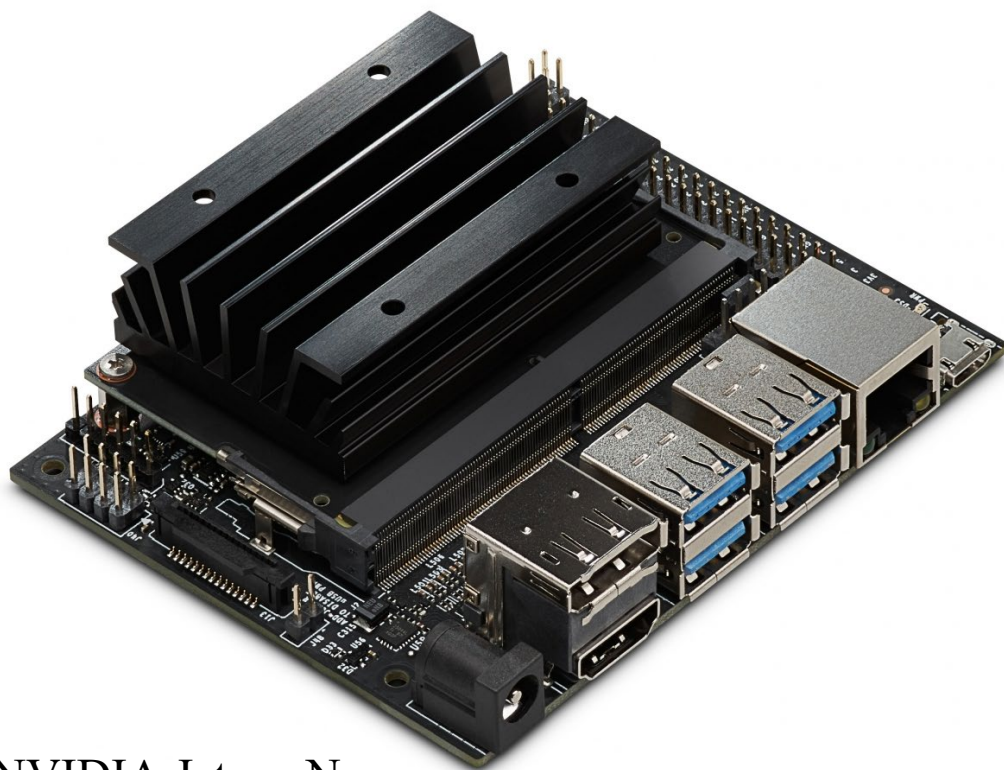
即時垃圾偵測系統

組別：22

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硬體設備



NVIDIA Jetson Nano

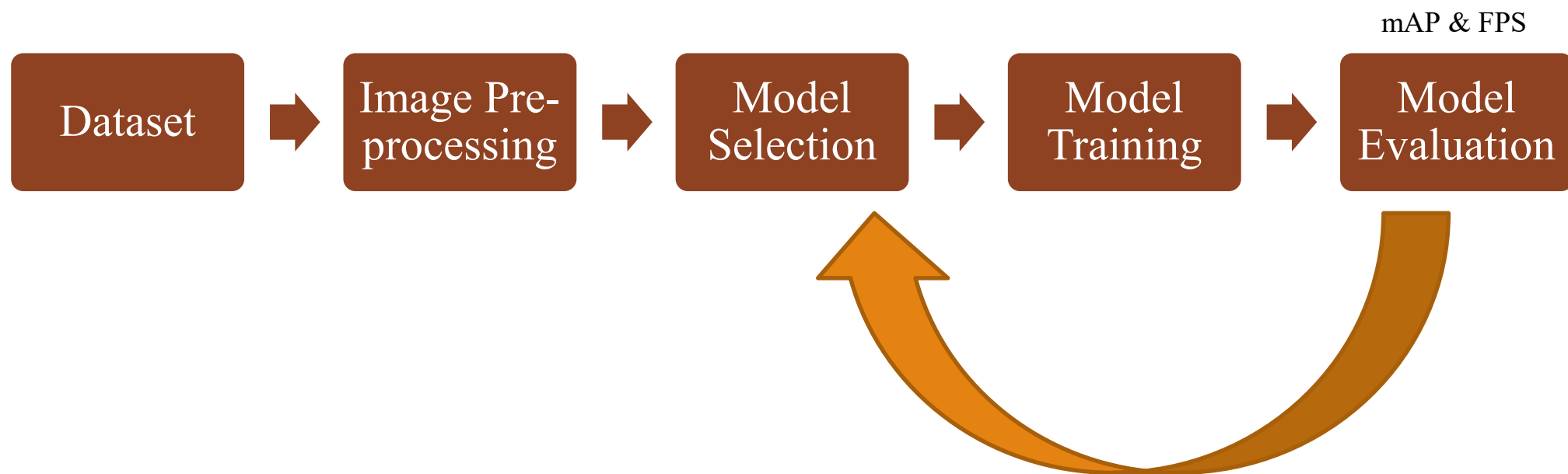


Logitech C270

架構



流程



目錄

- ◆ 動機
- ◆ 目標
- ◆ 研究方法
- ◆ 成果
- ◆ 參考資料

動機

雖然現今生活機能方便，清潔工具也日新月異，但卻因為產品的過度包裝，導致垃圾的產生越來越多，公共環境也變得髒亂，改善方法除了自主減少垃圾的增加之外，還有將以產生的垃圾做更完善的分類使垃圾能更有效率的回收再利用，因此，**我們想利用所學，開發出即時垃圾影像分類系統。**

目標

- 選擇TACO dataset以及華為雲大賽的資料集做比較
- 使用被廣泛應用的YOLO物件偵測演算法，比較各版本YOLO的效果。
- 部署在Jetson Nano上，實現即時垃圾偵測系統。

評估標準

Average Precision (AP):

AP % AP at IoU=.50:.05:.95 (primary challenge metric)
AP^{IoU=.50} % AP at IoU=.50 (PASCAL VOC metric)
AP^{IoU=.75} % AP at IoU=.75 (strict metric)

AP Across Scales:

AP^{small} % AP for small objects: area < 32²
AP^{medium} % AP for medium objects: 32² < area < 96²
AP^{large} % AP for large objects: area > 96²

Average Recall (AR):

AR^{max=1} % AR given 1 detection per image
AR^{max=10} % AR given 10 detections per image
AR^{max=100} % AR given 100 detections per image

AR Across Scales:

AR^{small} % AR for small objects: area < 32²
AR^{medium} % AR for medium objects: 32² < area < 96²
AR^{large} % AR for large objects: area > 96²

$$\text{mAP}@_{\alpha} = \frac{1}{n} \sum_{i=1}^n \text{AP}_i \quad \text{for } n \text{ classes.}$$

“华为云杯” 2020深圳开放数据应用创新大赛·生活垃圾图片分类

已结束

“华为云杯” 2020深圳开放数据应用创新大赛，大赛以“数聚粤港澳，智汇大湾区”为主题，面向全球征集基于开放数据的创新应用解决方案及优秀算法代码。

举办方：深圳市政务服务数据管理局、南山区人民政府、南山区政务数据管理局、华为技术有限公司

奖金：¥180,000

912
团队数

4388
报名人数

决赛B榜截止时间：2020/07/10

大赛介绍

赛题说明

开发环境

排行榜

交流互动

初赛A榜 初赛B榜 决赛A榜 决赛B榜

排名更新时间：2020-07-11 03:15:59

排名	团队名	得分	作品提交时间
1	江流儿	0.7885	2020/07/09
2	Augmentation	0.7884	2020/07/10
3	hw63745443	0.7746	2020/07/10
4	nene)冲鸭队	0.7725	2020/07/09
5	华中科技大学	0.7717	2020/07/09
6	黎明的那道光会越过黑暗	0.7712	2020/07/10
7	黑暗大法师	0.7699	2020/07/09
8	不要聊了，不要聊了	0.7676	2020/07/08
9	hiahia	0.767	2020/07/10
10	还来得及吗	0.764	2020/07/09

0.7885

TACO dataset AP retrieved from Proença, P. F., & Simões, P. (2020).

Let the class probabilities, given by this head, be $P = \{p_1, p_2, \dots, p_{N+1}\}$ where N is the number of classes and p_{N+1} is the probability of being background

$$Score = \begin{cases} \max_i p_i, & class_score \\ 1 - p_{N+1}, & litter_score \\ \frac{\max_i p_i}{p_{N+1} + \epsilon}, & ratio_score \end{cases}$$

Dataset	Class score	Litter score	Ratio score
TACO_1	15.9 ± 1.0	26.2 ± 1.0	26.1 ± 1.0
TACO_10	17.6 ± 1.6	18.4 ± 1.5	19.4 ± 1.5

class_score is the established score, ratio_score expresses both the confidence on a class and the confidence on being litter, where ϵ is just a small scalar to avoid NaN. That is, ratio_score allows us to say "This model is ratio_score times more confident that given object is class X than not being litter."

研究方法

將dataset分割成train set和validation set = 8 : 2

	TACO dataset	HUAWEI dataset
Train	1189張圖片	9410張圖片
Validation	297張圖片	2349張圖片
Total dataset	1486張圖片	11759張圖片

研究方法

TACO資料的class名稱：

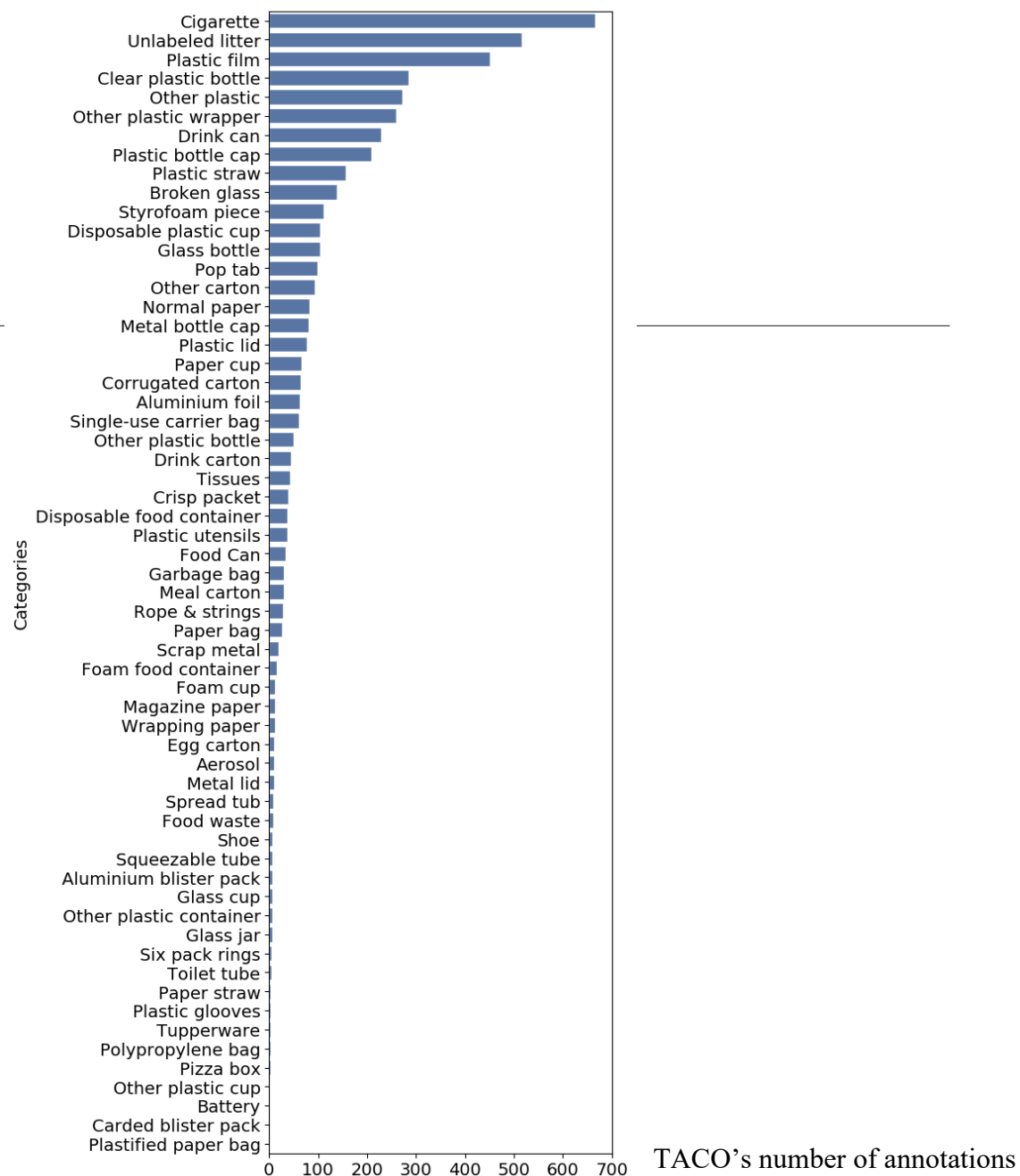
'Clear plastic bottle', 'Plastic bottle cap', 'Drink can', 'Other plastic',
'Plastic film', 'Other plastic wrapper', 'Unlabeled litter', 'Cigarette'

TACO資料的class中文名稱：

“透明塑料瓶”，“塑料瓶蓋”，“飲料罐”，“其他塑料”，
“塑料薄膜”，“其他塑料包裝材料”，“無標籤垃圾”，“香煙”

只選擇**此8種**的class作為dataset的原因在於各類別annotation數量分布較不均勻

研究方法



研究方法

Huawei資料的class名稱：

'Disposable Fast Food Box','Book Paper','Power Bank','Leftovers','Package','Trash Can','Plastic Utensils','Plastic Toys',

'Plastic Hangers',"Big Bones","Dry Battery","Express Paper Bag", "Plug Wire", "Old Clothes", "Can", "Pillow",

"Peel and Pulp", "Stuffed Toy", "Defiled Plastic", "Contaminated paper","Toilet care products", "Cigarette butts",

"Toothpicks", "Glassware","Baffle", "Chopsticks", "Carton box", "Flower pot", "Tea residue", "Cai Bang Cai Ye",

"Egg Shell", "Sauce Bottle", "Ointment", "Expired Medicine", "Wine Bottle", "Metal Kitchenware", "Metal Utensils",

"Metal Food Cans", "Pots", "Ceramic utensils", "shoes", "edible oil drums", "drink bottles", "fish bones"

研究方法

Huawei資料的class中文名稱：

’一次性快餐盒’，’書籍紙張’，’充電寶’，’剩飯剩菜’，’包’，’垃圾桶’，’塑料器皿’，’塑料玩具’，’塑料衣架’，’大骨頭’，’乾電池’，

’快遞紙袋’，’插頭電線’，’舊衣服’，’易拉罐’，’枕頭’，’果皮果肉’，’毛絨玩具’，’污損塑料’，’污損用紙’，’洗護用品’，’煙蒂’，

’牙簽’，’玻璃器皿’，’砧板’，’筷子’，’紙盒紙箱’，’花盆’，’茶葉渣’，’菜幫菜葉’，’蛋殼’，’調料瓶’，’軟膏’，’過期藥物’，

’酒瓶’，’金屬廚具’，’金屬器皿’，’金屬食品罐’，’鍋’，’陶瓷器皿’，’鞋’，’食用油桶’，’飲料瓶’，’魚骨’

研究方法

使用aiForge環境上的V100 GPU進行訓練

- ◆ **YOLOv3-tiny (416x416) :**

Darknet C語言版本程式碼、max_batches = 50000、init learning rate: 0.00261、input size =416x416、pre-trained weight: yolov3-tiny.conv.15

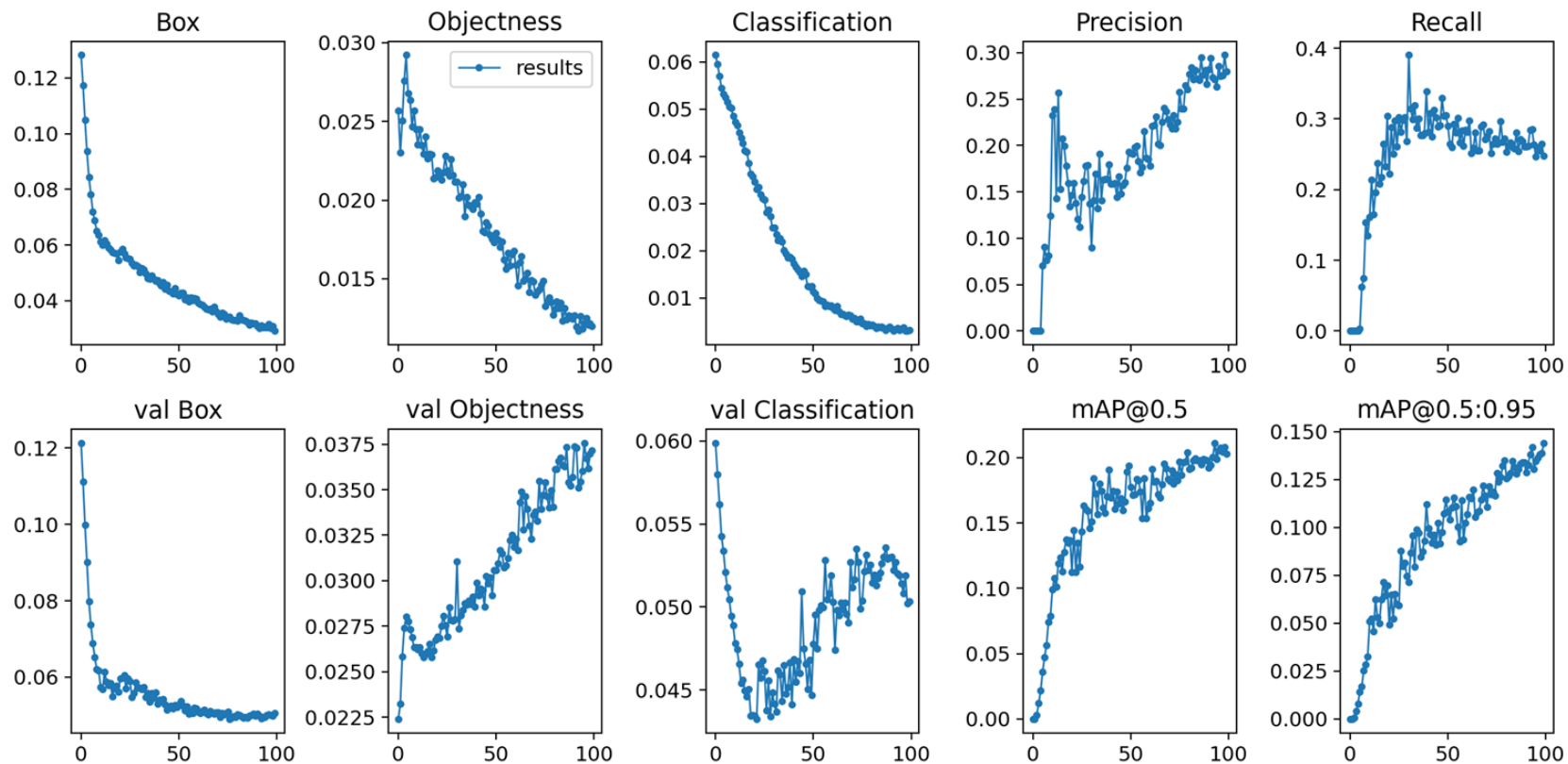
- ◆ **YOLOv4-tiny (416x416) :**

Darknet C語言版本程式碼、max_batches = 50000、init learning rate: 0.00261、input size =416x416、pre-trained weight: yolov4-tiny.conv.29

- ◆ **YOLOv5s (416x416) :**

PyTorch版本程式碼、Epochs = 300、init learning rate: 1e-5、input size = 416x416、pre-trained weight: yolov5s.pt

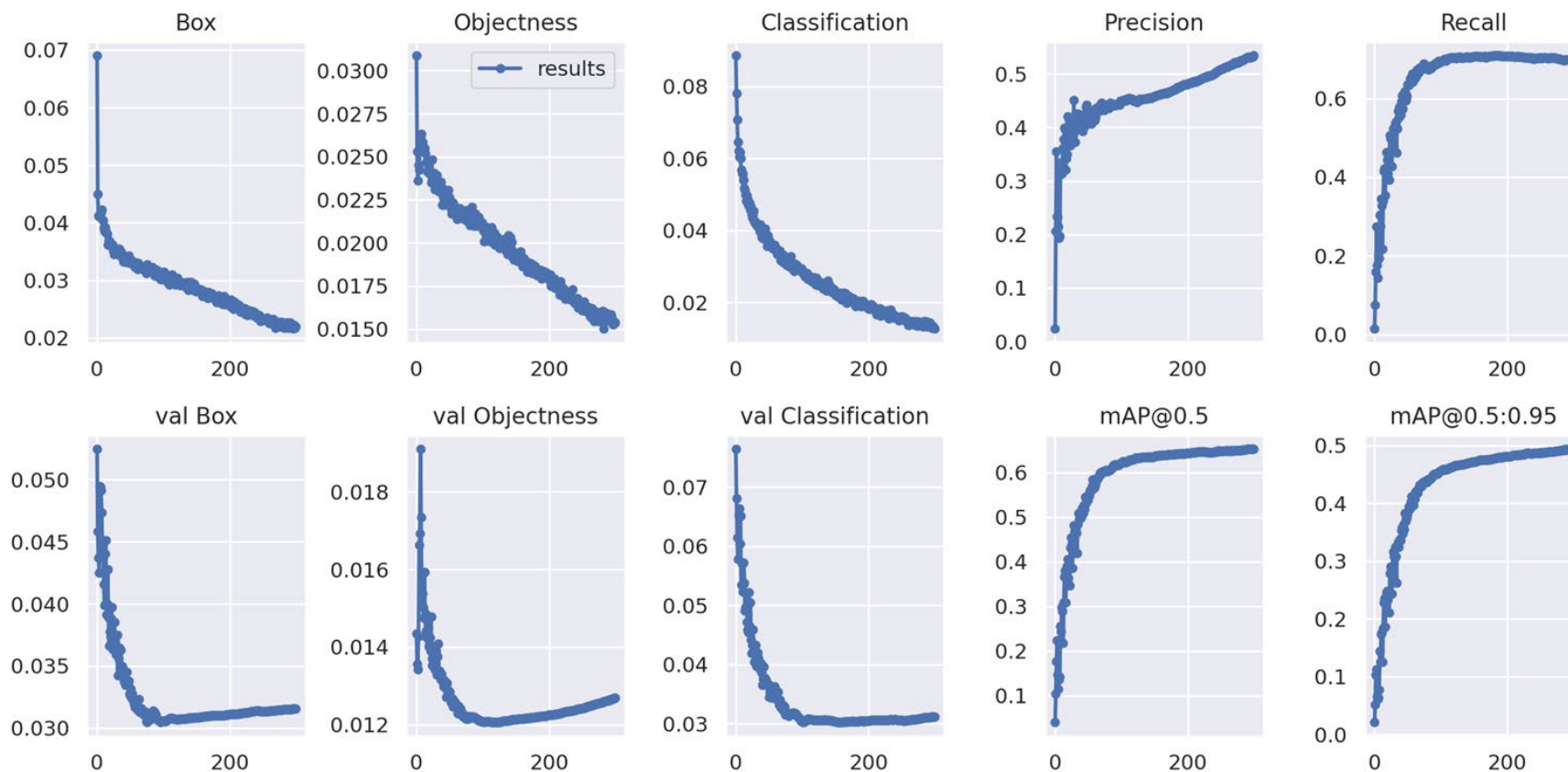
訓練結果(TACO)



訓練結果(TACO)

Model (640x640)	mAP@0.5
yolov5s	0.247
yolov5m	0.252
yolov5l	0.274
yolov5x	0.271
Yolov4s-mish(pretrained weight)	0.129
Yolov4s-mish(from scratch)	0.115
Yolov4m-mish	0.121
Yolov4l-mish	0.147
yolov4x-mish	0.138

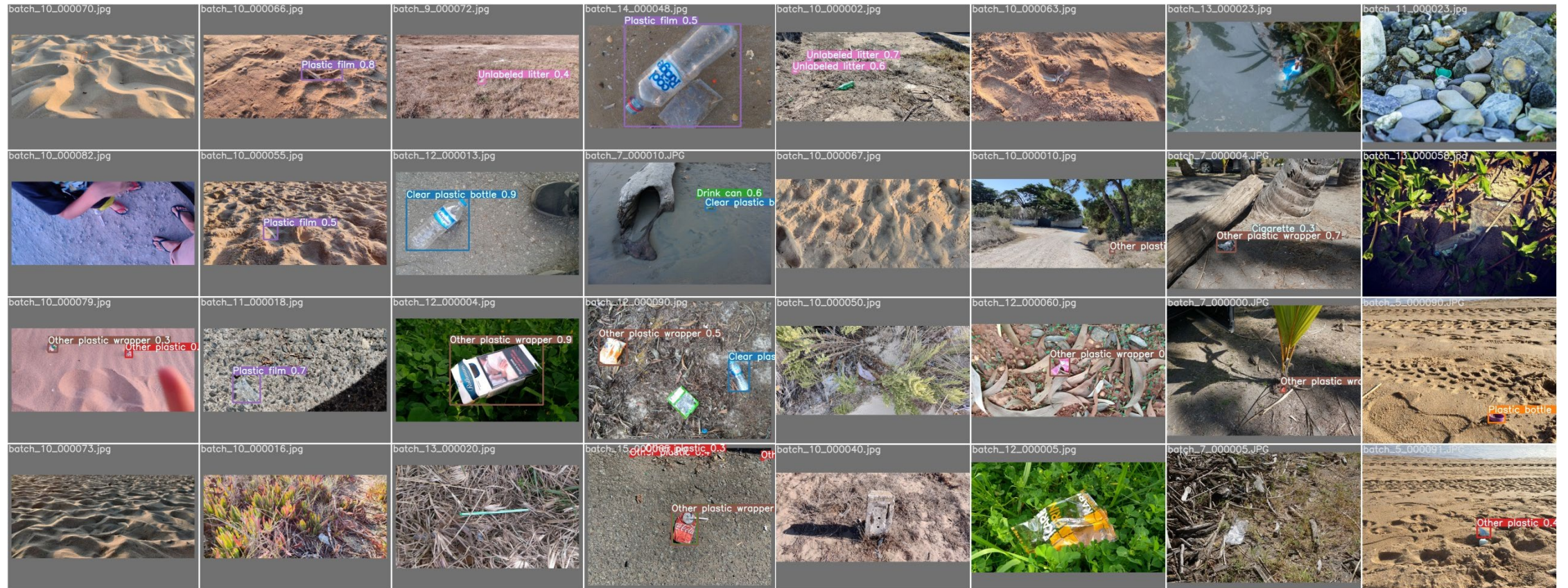
訓練結果(HUAWEI)



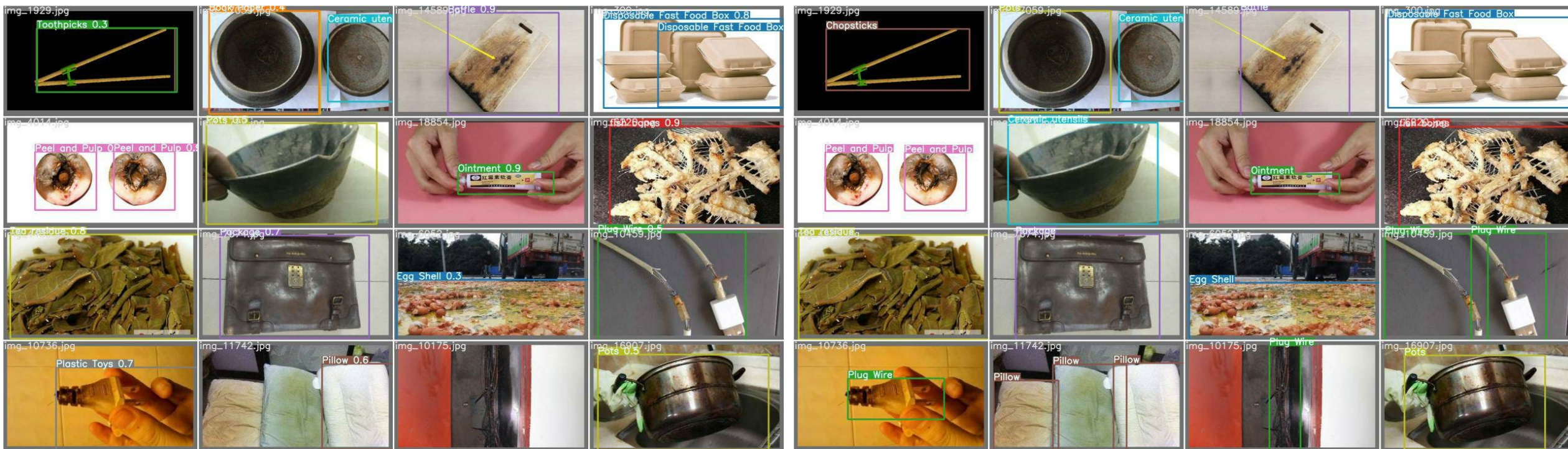
訓練結果(HUAWEI)

Model	mAP@0.5	F1 Score	AVG FPS
YOLOv3-tiny (416x416)	0.4698	0.44	6.2
YOLOv4-tiny (416x416)	0.5803	0.60	12.3
YOLOv5s (416x416)	0.68	0.623	5.6

訓練結果(TACO)



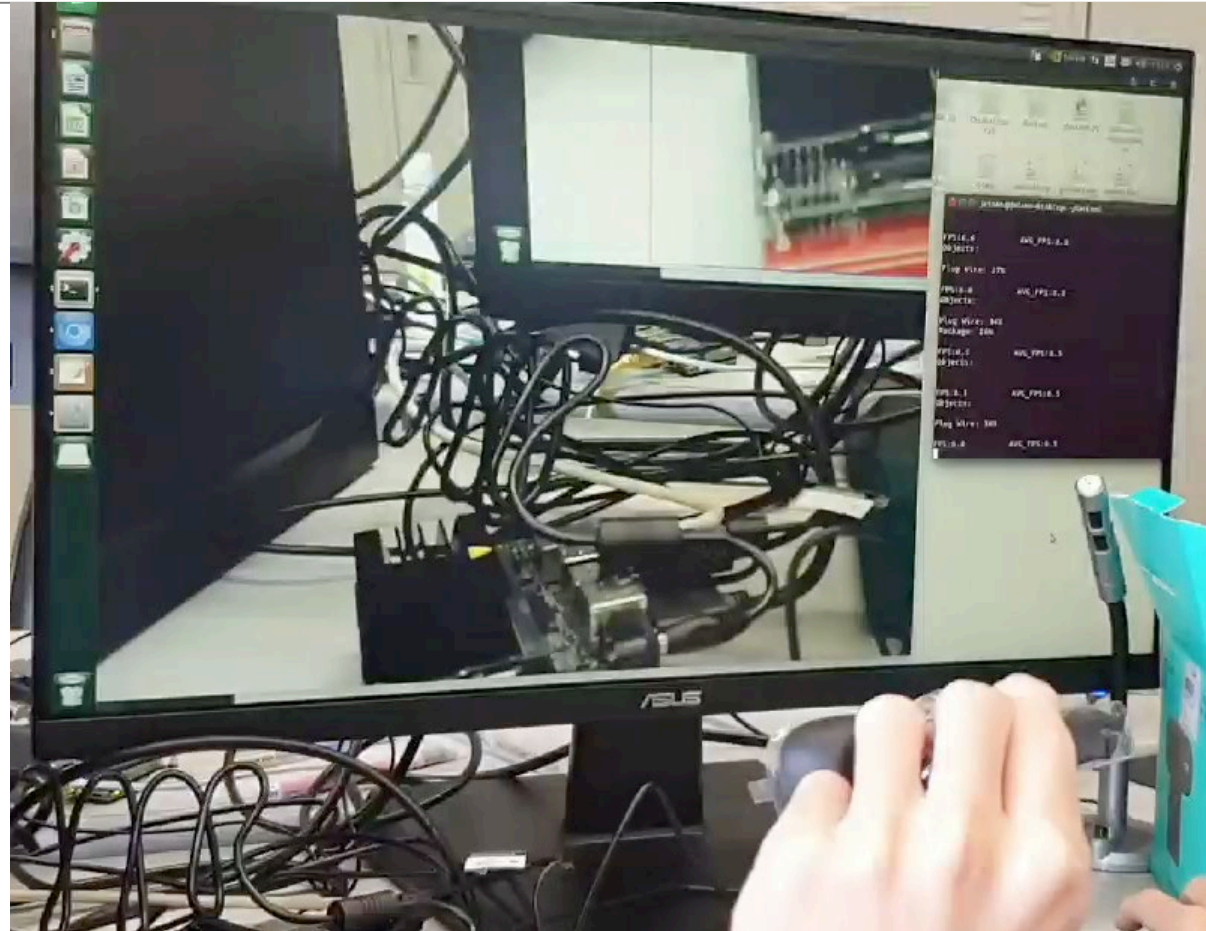
訓練結果(Huawei)



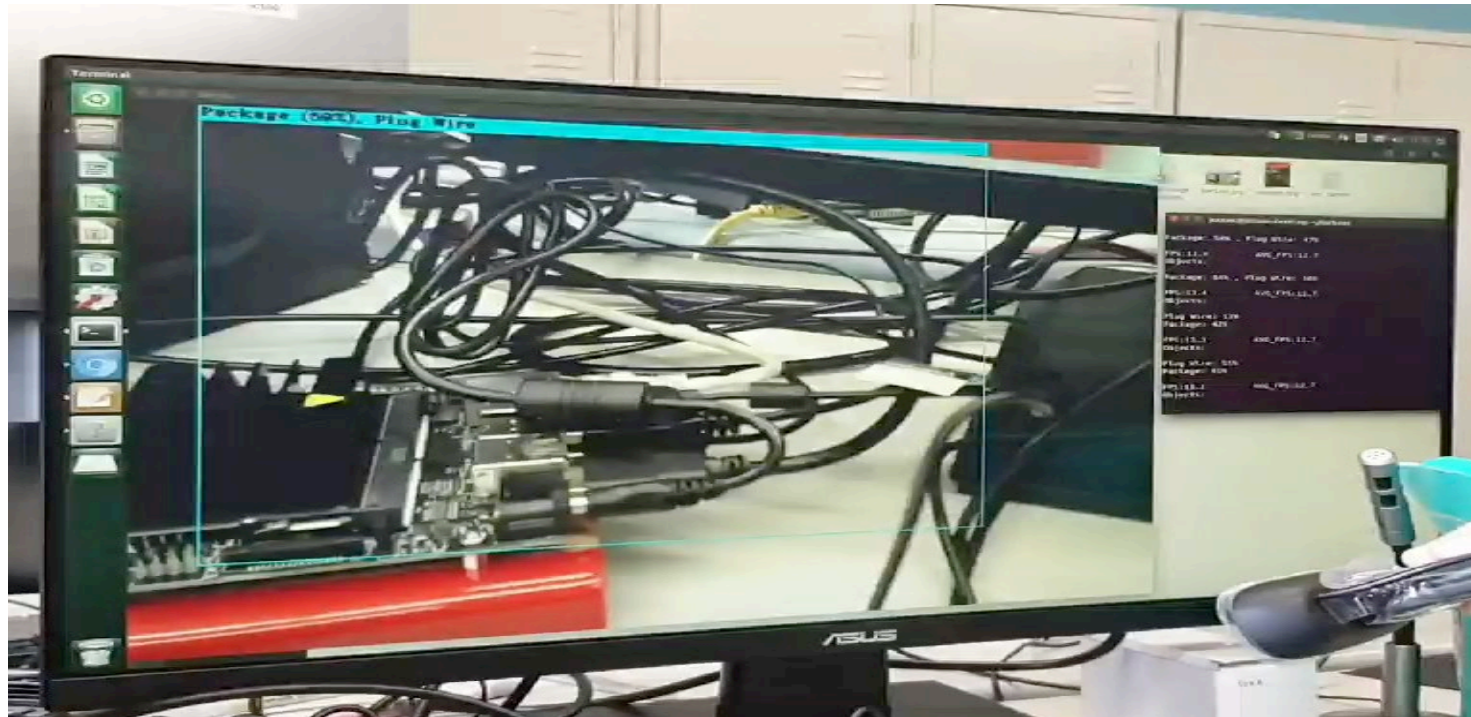
結論

1. 基於mAP比較結果，我們選擇Huawei dataset訓練出來的結果做為最終部署到Jetson Nano的模型
2. 在mAP表現上，YOLOv5s > YOLOv4-tiny > YOLOv3-tiny
在FPS表現上，YOLOv4-tiny > YOLOv3-tiny > YOLOv5s
3. 由於TACO dataset訓練出來的表現遠低於Huawei dataset，推論是TACO圖片中的原先標記的Ground-Truth bounding box較小、dataset圖片數量較少之緣故
4. 即時垃圾偵測系統部署在Jetson Nano上為可行之方案

Jetson-Nano實作 YOLOv3-TINY



Jetson-Nano實作 YOLOv4-TINY



Jetson-Nano實作 YOLOv5s



未來展望

將生活環境中人為垃圾偵測出來，減少清理環境所需耗費的人力

應用在掃地機器人的視覺辨識

垃圾子母車自動偵測垃圾，判斷人類分類是否正確

TACO完整專案

<https://github.com/e96031413/TACO-Trash-Detection-YOLOv5>

e96031413 / TACO-Trash-Detection-YOLOv5

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Commit history:

e96031413	Update README.md	9e73c14	23 days ago	14 commits	
100epochs_yolov5s_tras...	training result for trash detection	17.46 MB	2 months ago		
LICENSE	Initial commit	1.04 KB	2 months ago		
README.md	Update README.md	608 Bytes	23 days ago		
taco.yaml	Update taco.yaml	1.53 KB	2 months ago		
test.jpg	Add files via upload	207.66 KB	2 months ago		
trash_detection.ipynb	Add files via upload	7.63 KB	2 months ago		

About

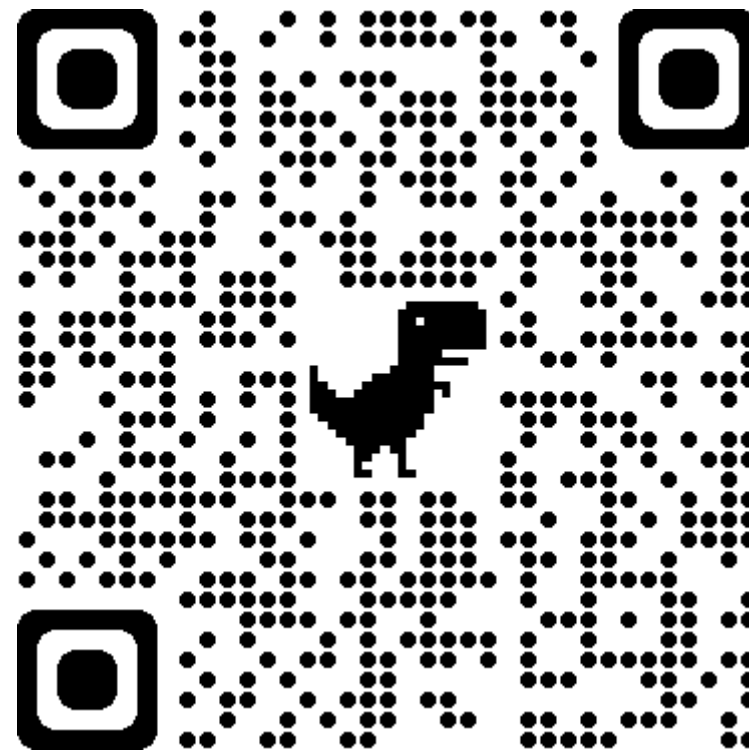
AI Module Course Term Project, detect trash with YOLOv5 on TACO dataset

17.68 MB

MIT License

Languages

Jupyter Notebook 100.0%



Huawei完整專案

<https://github.com/e96031413/HUAWEI-Trash-Detection-YOLOv5>

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↓

e96031413 Update README.md

55a112c 11 days ago 29 commits

README.md	Update README.md	5.93 KB	🔗	11 days ago
huawei-trash.data	Update huawei-trash.data	383 Bytes	🔗	12 days ago
huawei-trash.names	Add files via upload	560 Bytes	🔗	19 days ago
trash-中文.yaml	Add files via upload	1.1 KB	🔗	26 days ago
trash.yaml	Update trash.yaml	1.18 KB	🔗	26 days ago
yolov3-tiny-huawei.cfg	Add files via upload	2.04 KB	🔗	12 days ago
yolov4-tiny-huawei.cfg	Add files via upload	2.95 KB	🔗	12 days ago

About

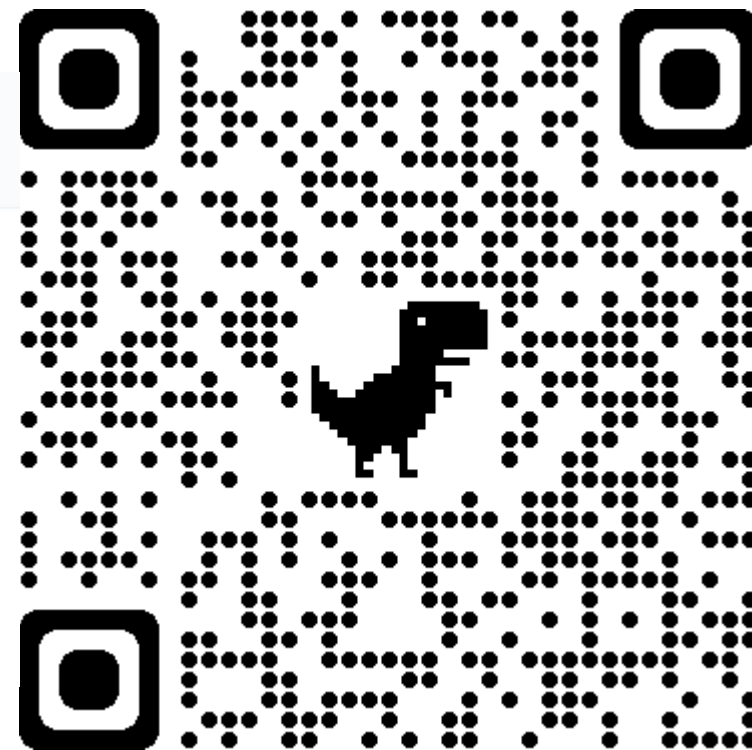
Training dataset from Huawei Cloud competition 2020

64 KB

Releases

No releases published

Create a new release



參考資料

- [1] Proença, P. F., & Simões, P. (2020). TACO: Trash Annotations in Context for Litter Detection. arXiv preprint arXiv:2003.06975.
- [2] Redmon, J., & Farhadi, A. (2018). Yolov3: An incremental improvement. arXiv preprint arXiv:1804.02767.
- [3] Bochkovskiy, A., Wang, C. Y., & Liao, H. Y. M. (2020). YOLOv4: Optimal Speed and Accuracy of Object Detection. arXiv preprint arXiv:2004.10934.
- [4] Richard Kuo, “TACO-8 train & detect using YOLOv5.”
<https://www.kaggle.com/rkuo2000/yolov5-taco>, 2020.
- [5] <https://github.com/e96031413/HUAWEI-Trash-Detection-YOLOv5>
- [6] <https://cocodataset.org/#detection-eval>

Q&A

