Uncertainty detection and data sampling using class-wise thresholding method

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Introduction

Introduction

In active learning models, data uncertainty is assessed, and labeling is carried out when the model's predicted probability falls below a predefined threshold, known as "**Confidence Thresholding**"

Image source: https://kr.freepik.com/search?format=search&query=%EB%A1%9C%EB%B4%87%20%EA%B3%A0%EB%AF%BC&type=photo

Introduction

This method has a limitation in that it doesn't consider varying probability distributions among different classes. For example, when one class has a low average prediction probability and another class has a high average prediction probability, using a single threshold can lead to misinterpretation of data from the low-probability class.

Image source: https://thestreetspirit.org/2015/07/09/blockading-the-white-train-of-death-2/

Introduction

Aim to effectively enhance the Confidence Thresholding technique for various real-world applications by proposing suitable thresholds for prediction probabilities.

Image source: https://clomag.co.kr/article/3138

Related works

Related works

Object classification

- Object classification is a crucial topic in the field of computer vision. It entails researchin g and developing techniques to identify and categorize objects within a given image.

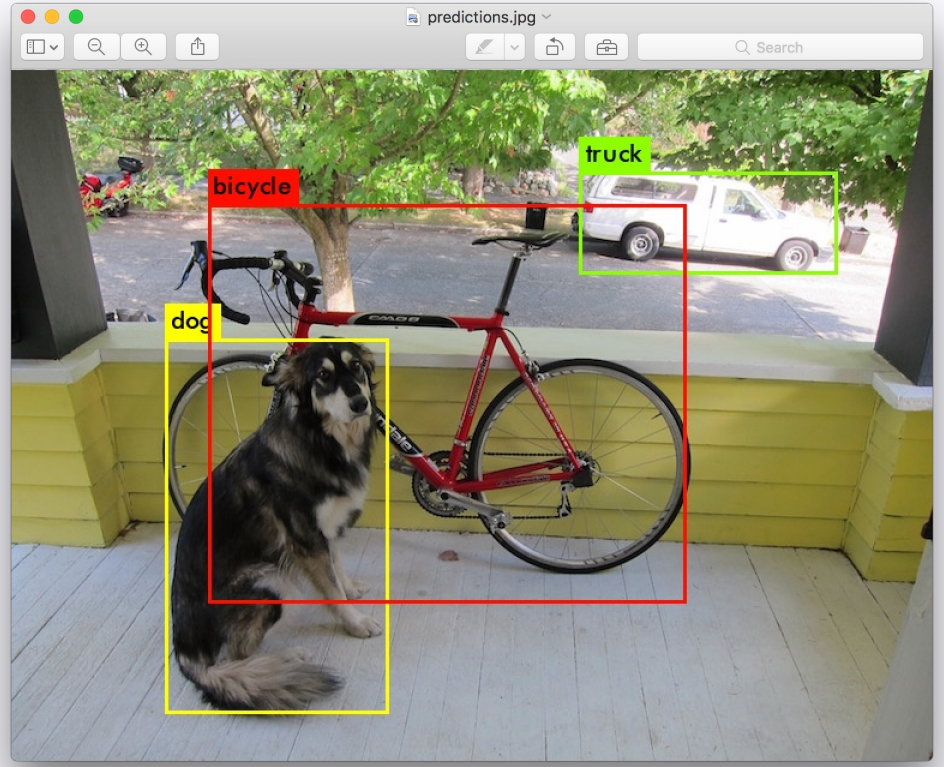


Image source: https://pjreddie.com/darknet/yolo/

Active learning

- Active learning reduces data labeling time and costs by involving human annotators to obtain data labels in machine learning algorithms.

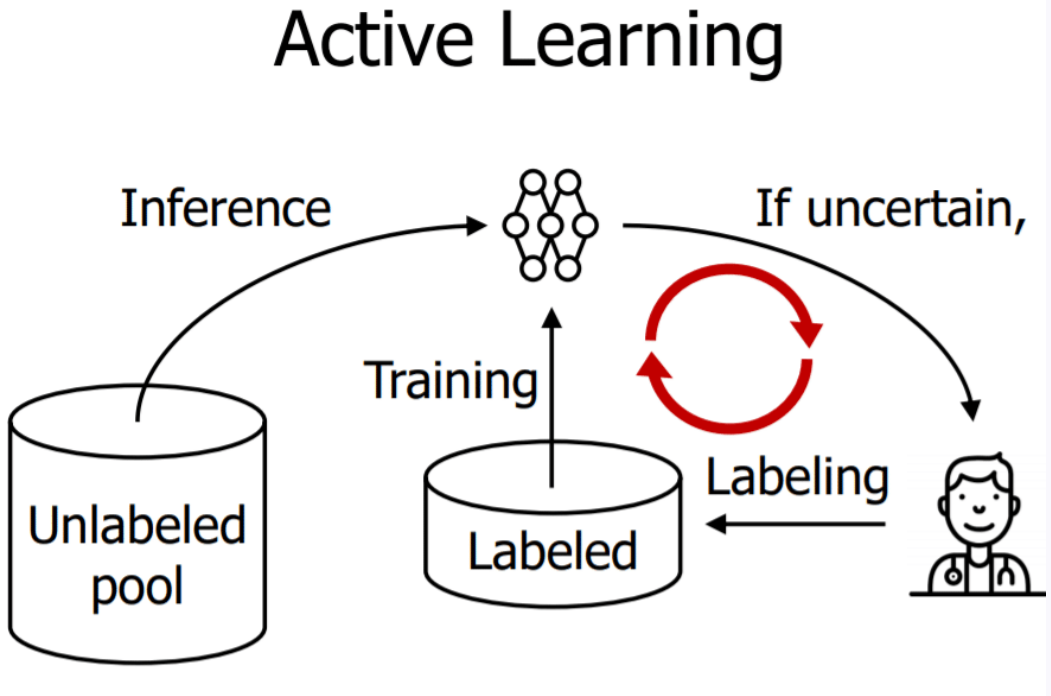


Image source: https://smilegate.ai/2021/06/23/learning-loss-for-active-learning/

Active learning

Application of Active Learning to Computer Vision

1

Objecet Detection

Improve the performance of object detection detection models. Better results can be achieved even with a small number of labeled data.

2

Image Segmentation

Can be used through collaboration between between artificial intelligence models and and human workers to obtain accurate accurate labeling in shape segmentation segmentation tasks.

3

Optical Character Recognition (OCR) (OCR)

Reduce recognition errors and improve accuracy in character recognition tasks.

Active learning

Benefits of Active Learning

1 Efficient data labeling

Save money and time by reducing the number of data required for labeling.

2 Improve model performance

Even with a small amount of labeled data, a more accurate model can be created.

3 Time-saving for professionals

Improves work efficiency by being able to use expert time efficiently.

Active learning

Active Learning algorithm and method

Uncertainty sampling

Sampling the highest uncertainty examples, the model learns from the images it's least confident about.

Diversity sampling

Selecting the most diverse images encourages models to learn more. It involves choosing samples that require labels from different classification groups.

Query by Committee

When multiple models exhibit increased uncertainty for a given image, it prompts a request for labeling from a human annotator.

Active learning

Data labeling methods

Core image labeling

To enhance the model's performance, the focus is placed on labeling crucial images.

Error case labeling

Labeling is conducted for specific cases where the model struggles, thereby securing data for model improvement.

Select discriminatory data

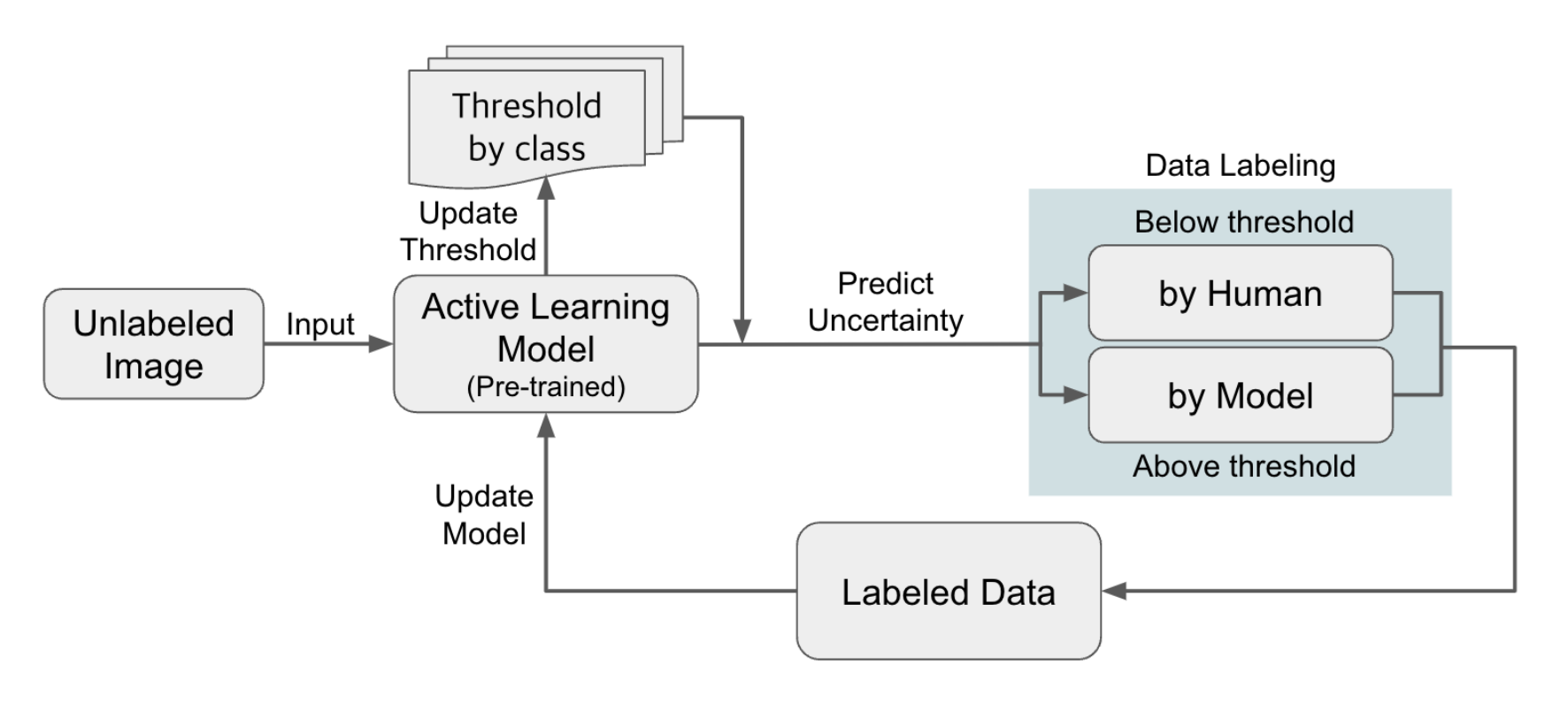
During training, diverse image samples requiring various classes and labels are selected.

Consider model uncertainty

Using active learning algorithms, the model requests labeling for uncertain samples.

Experiment & Results

Proposed Model Architecture



The process of deriving class-wise uncertainty measure method

Train YOLO model

Extract bounding boxes, classes, confidence

Quantify confidence distribution by class

Uncertainty-based data sampling test

Experiment & Results

Model used

YOLO v5 small

Dataset

COCO 2017 train/val

Setting

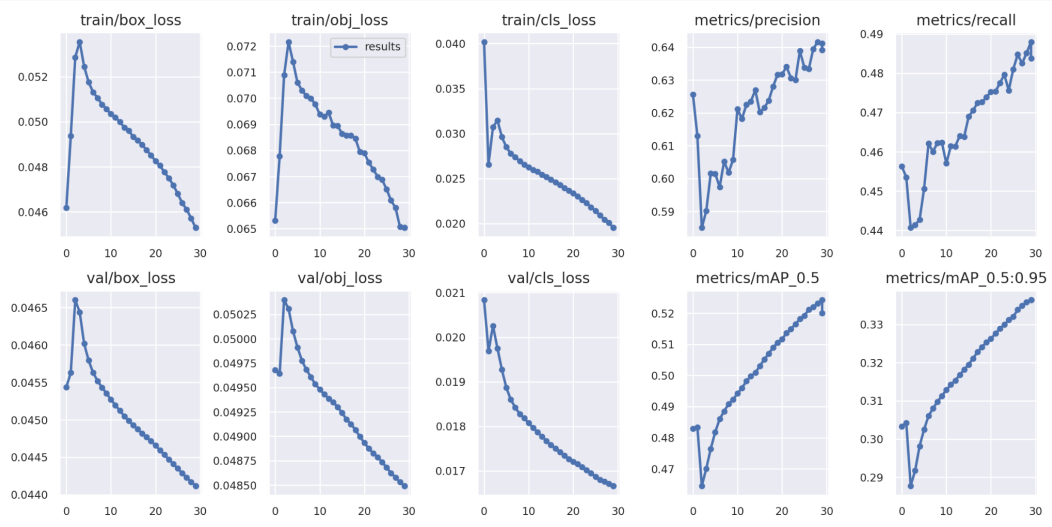
64bs, 100epoch, 0.01lr (60hr)

Weight(Pre-trained)

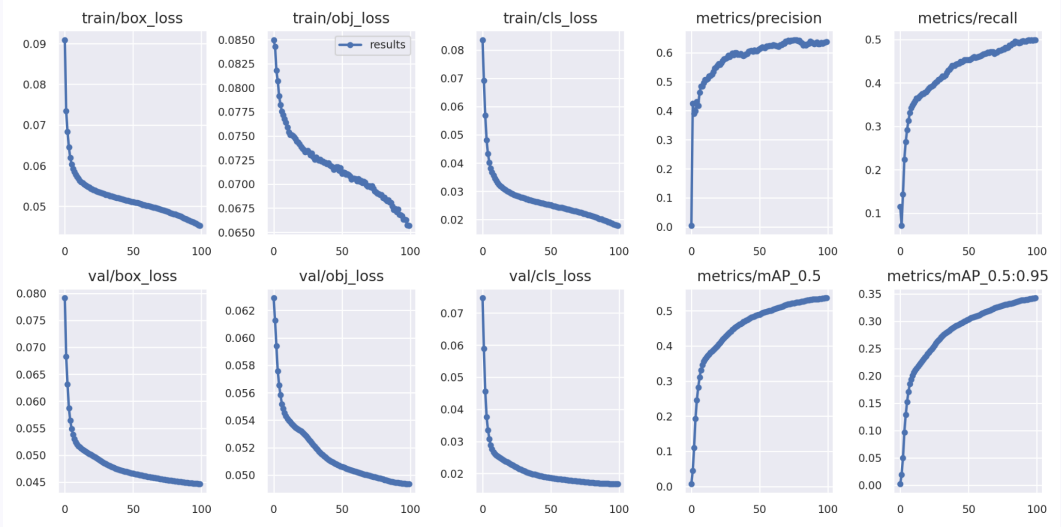
None

Train result

- Compare with/without pre-trained model
- Reliable learning by removing initial weights



w pre-trained model



w/o pre-trained model

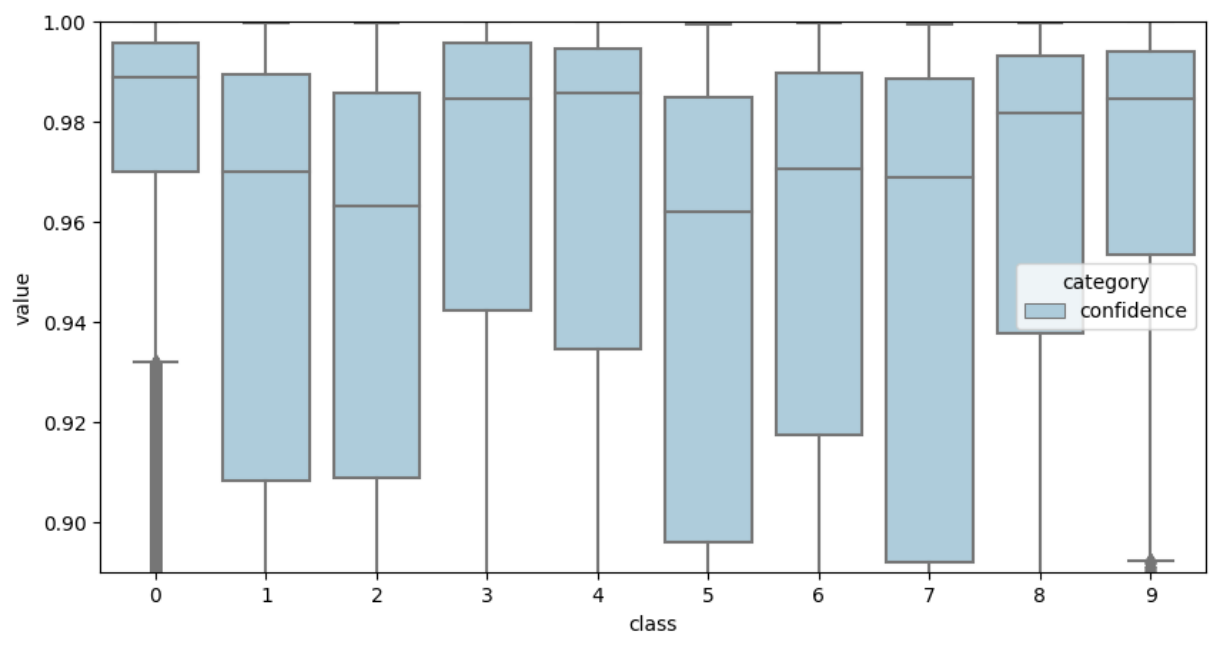
Train result

Compared with the performance of yolo 5, there was no significant difference, so it can be said that the learning went well

	mAP 0.5	mAP 0.5-0.95
YOLOv5s	56.8	37.4
Train result	53.6	34.2

Confidence distribution visualization

Using multiple box plot graphs, it is possible to compare confidence distribution values for different classes and confirm the presence of significant differences in the distributions.



Comparison of confidence distributions by class (class 0~9)

Uncertainty-based data sampling test

Test data

- 80 data from images not utilized for model learning (bounding box)
- 10 data per class (5 correct predictions, 5 false positives(FP))

Evaluation

- Evaluate recall and precision when true and false are divided by class-wise thresholds

Test results

Compared to the method of applying the same threshold value to all classes, recall and precision could be improved simultaneously

threshold	recall(avg)	precision(avg)
0.90	0.175	1
0.80	0.550	0.969
0.70	0.675	0.888
Q1	0.875	0.571
mean	0.700	0.671
median	0.700	0.675

Thank you