Object detection

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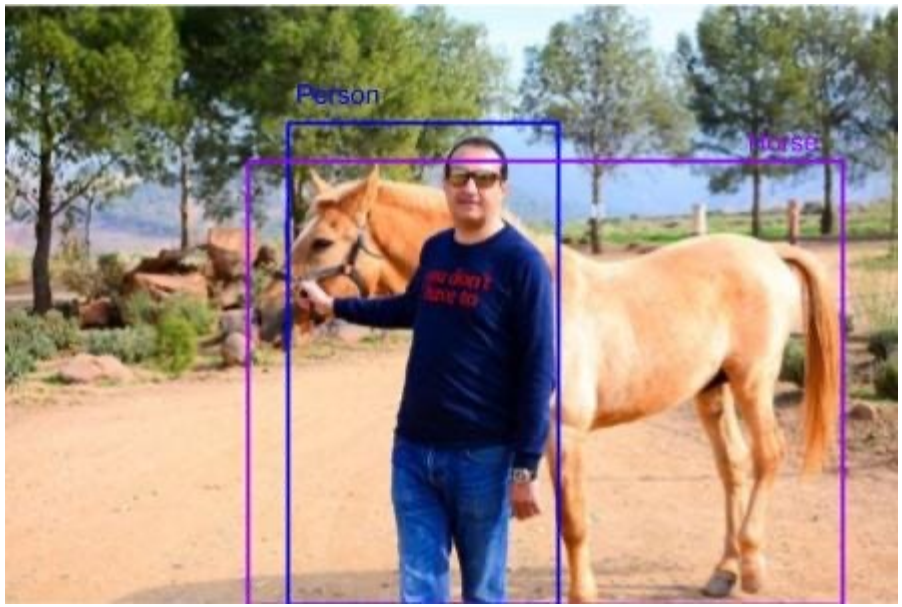
mAP (mean Average Precision)

주요 개념

- when $y_i \in \{positive, negative\}$
- Precision (정밀도)
  - 파지티브(네거티브)로 예측된 것들 중에서 실체 파지티브(네거티브)의 비중
- Recall (재현율)
  - 실제 파지티브(네거티브) 중에서 파지티브(네거티브)로 제대로 예측된 것들의 비중

주요 개념

- Object detection에서의 True positive, False positive, False negative, and True negative
  - 정답



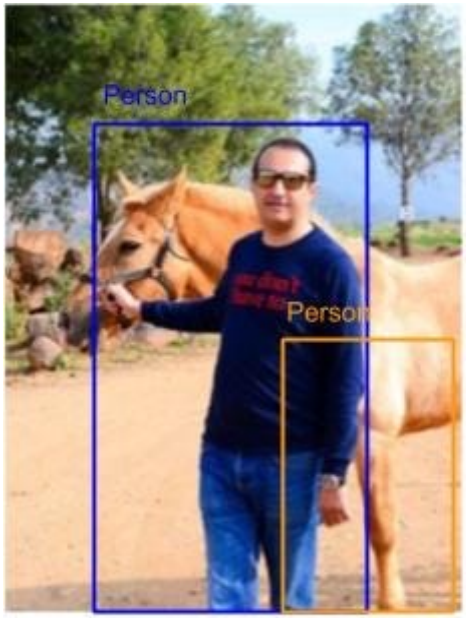
<source: https://towardsdatascience.com/breaking-down-mean-average-precision-map-ae462f623a52>

주요 개념

- True positive: 물체를 제대로 찾은 경우
  - 노란색이 예측된 Bounding box
  - 기준 IoU = 0.5 인 경우

주요 개념

- False positive: 제대로 찾지 못했는데 찾았다고 하는 경우



IoU < 0.5

Duplicate BB are considered as FP

No IoU

주요 개념

- False negative: 물체가 있는데 제대로 찾지 못하는 경우

물체가 있는데 없다고 하는 경우
즉, detection을 하지 못하는 경우

IoU > 0.5 인데 classification을
잘못한 경우

주요 개념

- True negative
  - Object detection 에서는 적용되지 않음
  - 이는 백그라운드를 정확하게 찾는 것을 의미 (이는 아무 것도 찾지 않는 것을 의미)

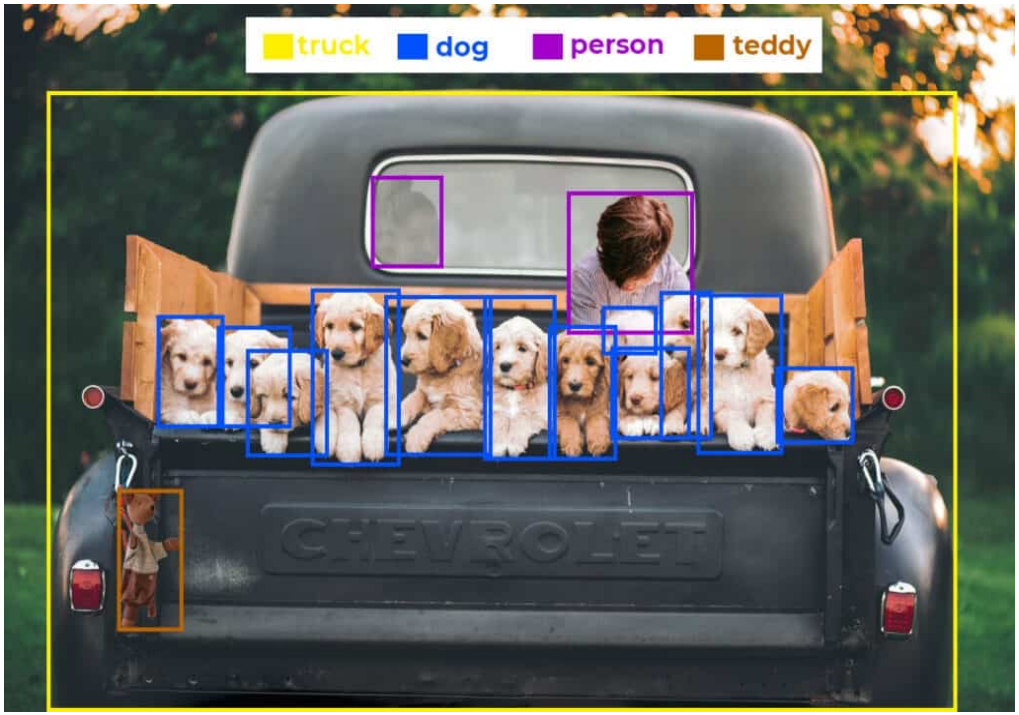
주요 개념

- Precision in OD
  - TP / total detections (or TP / total predictions)
  - 찾은 것들 (혹은 물체가 있다고 예측된 것들) 중에서 제대로 물체를 찾은 비중
  - 0 – 1
- Recall in OD
  - TP / total ground truths
  - 0 – 1

주요 개념

- Average Precision
  - It does mean the average of precision. For simplicity, we can say that it is the area under the precision-recall curve.
  - How to calculate AP?
  - Example
    - 2 persons, 12 dogs, 1 teddy, 1 truck
    - IoU threshold = 0.5

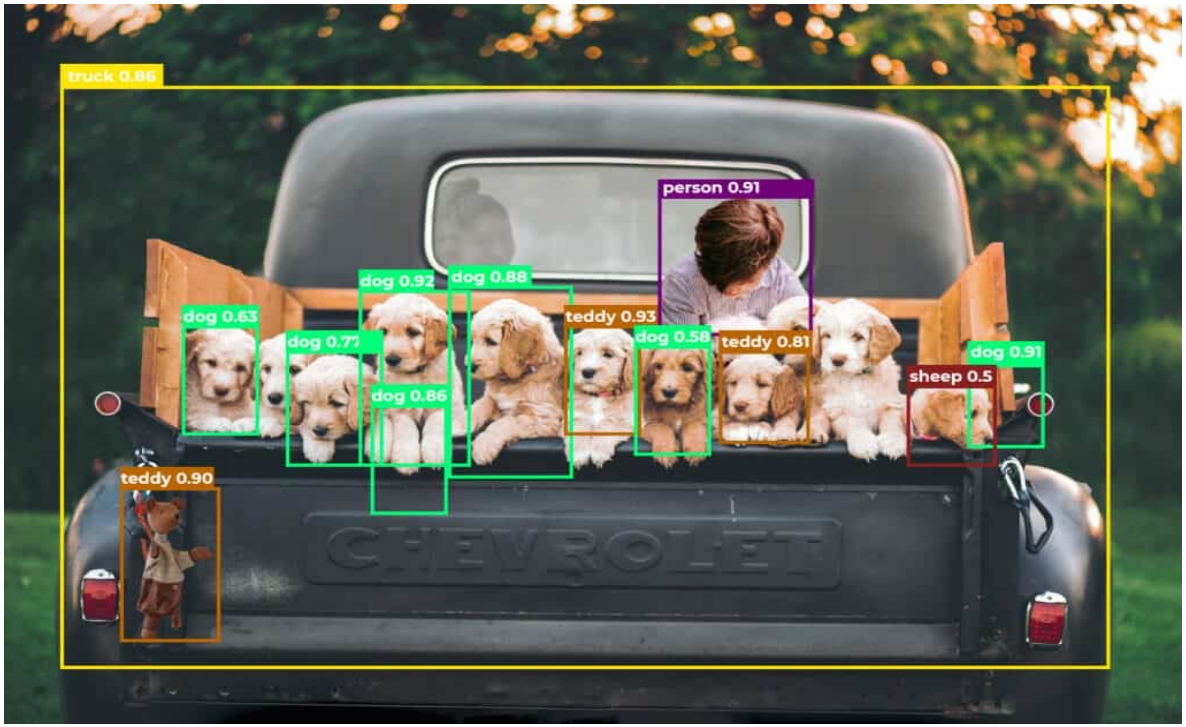
<Ground Truths>



<source: https://learnopencv.com/mean-average-precision-map-object-detection-model-evaluation-metric/>

주요 개념

- Average Precision
  - Predictions



주요 개념

- Average Precision
  - AP is calculated per class
    - In the case of the 'dog' class
      - 1) Record every Dog detection along with the Confidence score

'dog' 으로 예측되기는 했지만 예측된 BB의 IoU < 0.5 인 경우

Detections							
Conf.	0.63	0.77	0.92	0.86	0.88	0.58	0.91
Matches GT by IoU?	TP	TP	TP	FP	TP	TP	FP

주요 개념

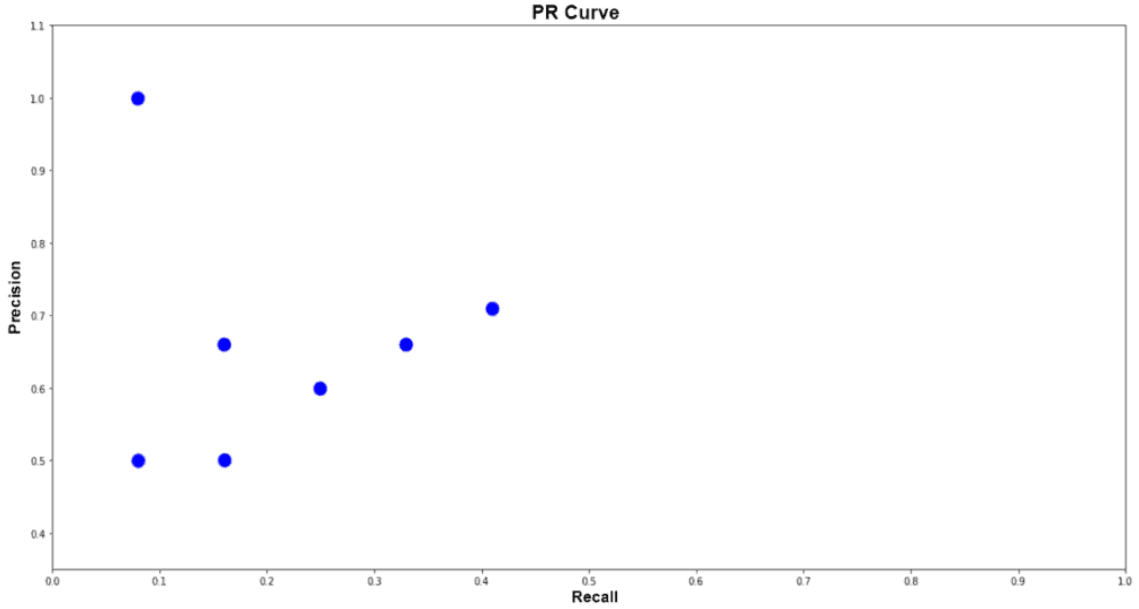
- AP: ‘dog’ class
  - 2) Calculate Precision and Recall (아래 순서를 따름)
    - 각 BB를 confidence score 내림차순으로 정렬
    - Tabulate cumulative TP and FP (Keep on adding the current value with the previous row).
    - Calculate row-wise Precision and Recall. Where,
      - Precision = Cumulative TP / (Cumulative TP + Cumulative FP)
      - Recall = Cumulative TP / Total Ground Truths

주요 개념

Preds.	Conf.	Matches	Cumulative TP	Cumulative FP	Precision	Recall
	0.92	TP	1	0	1/(1+0) = 1	1/16 = 0.08
	0.91	FP	1	1	1/(1+1) = 0.5	1/16 = 0.08
	0.88	TP	2	1	2/(2+3) = 0.66	2/16 = 0.16
	0.86	FP	2	2	0.5	0.16
	0.77	TP	3	2	0.6	0.25
	0.63	TP	4	2	0.66	0.33
	0.58	TP	5	2	0.71	0.41

주요 개념

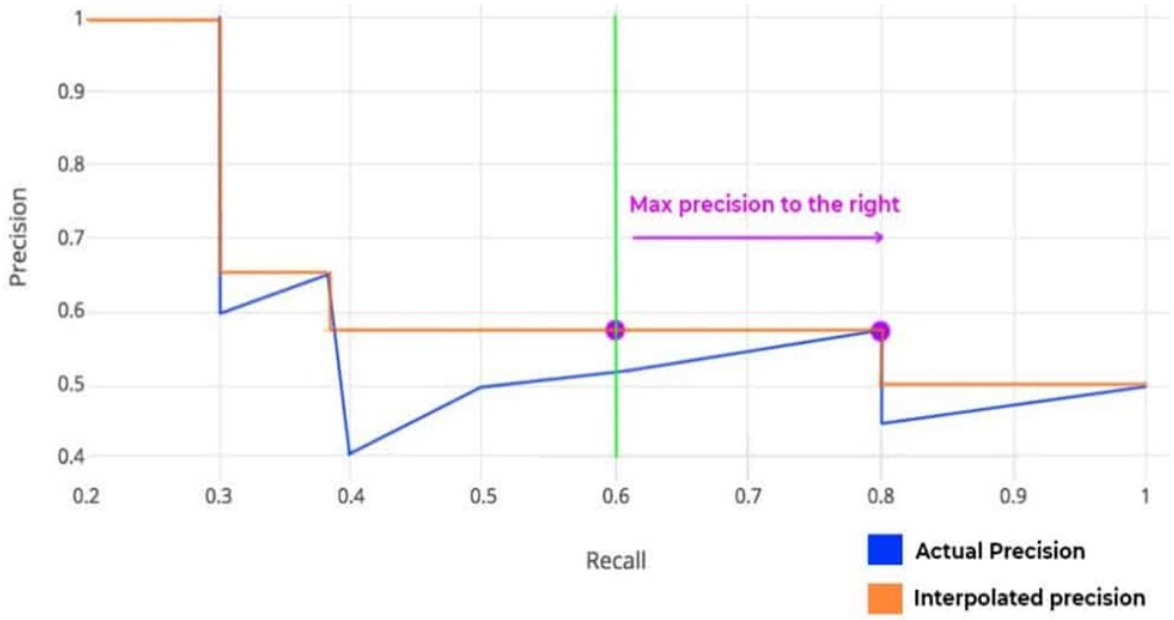
- AP: ‘dog’ class
  - 3) Precision-Recall 그래프 그리기



주요 개념

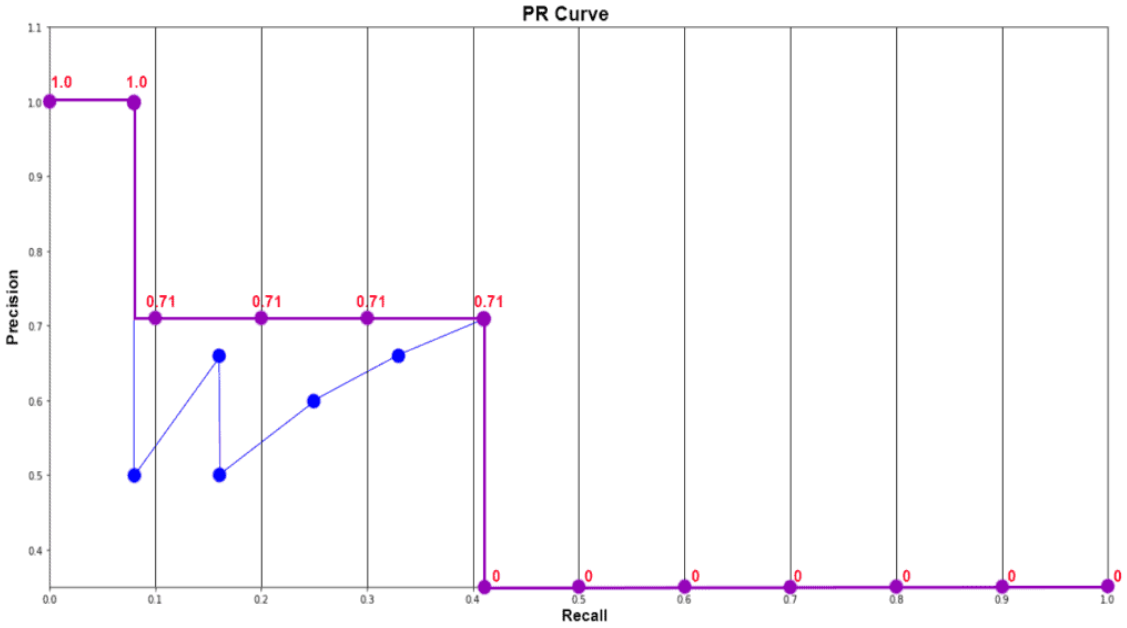
- AP: 'dog' class
  - 4) Calculate AP using PASCAL VOC 11 Point Interpolation Method
    - The 11 point interpolation method: Precision values are interpolated across 11 Recall values, i.e., 0, 0.1, 0.2, 0.3,…,1.0.
    - The interpolated Precision is the maximum precision value to the right.

<An example>



주요 개념

- AP: ‘dog’ class
  - 5) Plot Final Interpolated graph and calculate Average Precision for Dog Class



AP = 1/11 x (Sum of 11 interpolated Precision values)

= 1/11 x (1 + 4 x 0.71 + 6 x 0)

= 0.349 = 34.9%

주요 개념

- AP for the other classes

CLASS	dog	person	sheep	truck	teddy
AP	0.349	0.545	0.00	1.00	0.50

- mAP: the average (mean) of AP over all detected classes
  - mAP = 1/n x sum(AP), where n is the number of classes
  - 위의 예
    - mAP = 1/5 x (0.349 + 0.545 + 0 + 1 + 0.5) = 0.4788

주요 개념

- MS COCO mAP
  - MS COCO introduced 101 Point Interpolation AP in 2014.
  - Moreover, COCO made the challenge tougher by redefining the mAP@0.5 to mAP@[0.5:0.05:0.95]. Earlier, mAP was evaluated at IoU threshold 0.5.
  - COCO mAP is calculated for a set of 10 different IoU thresholds and then averaged. It ranges from 0.5 to 0.95 at a step frequency of 0.05.