Assessing image data quality for a vehicle damage detection algortihm

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Our Goal

$Vehicle\ Damage\ detection\ model\ M$

$Raw\ Image\ Data\ Ds$

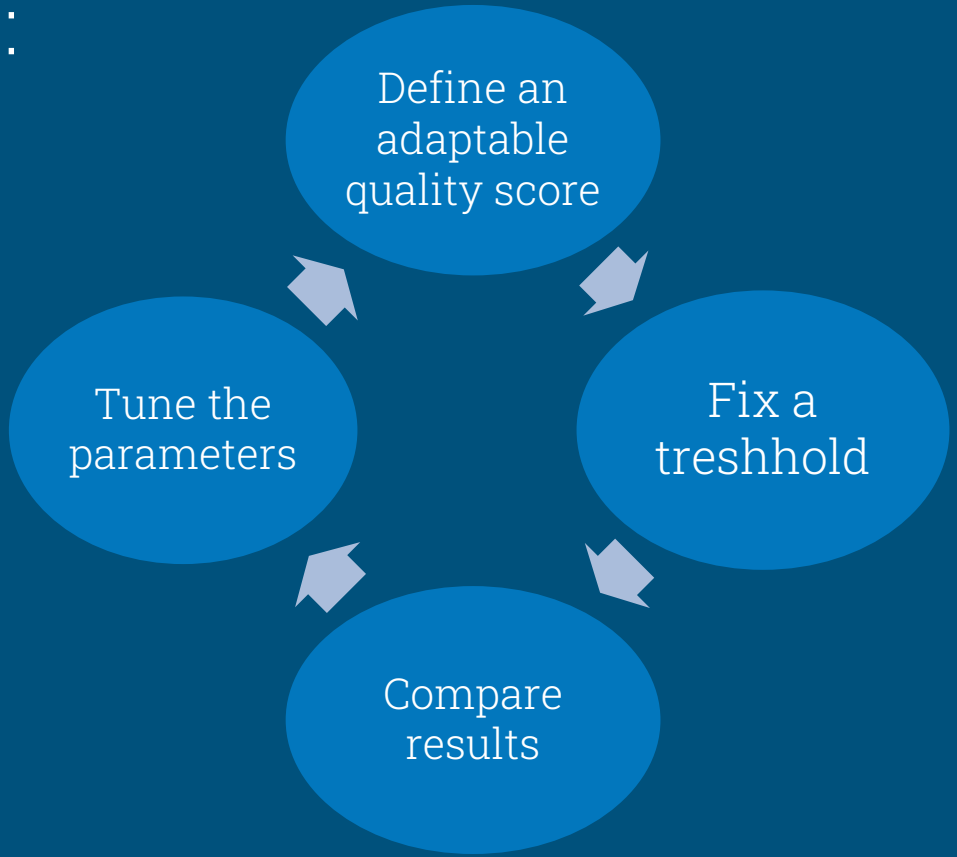
$I_M : \{Image\ |Image \in True\ positives \cup True\ negatives\}$

$Our\ Model\ M'$

$Raw\ Image\ Data\ Ds$

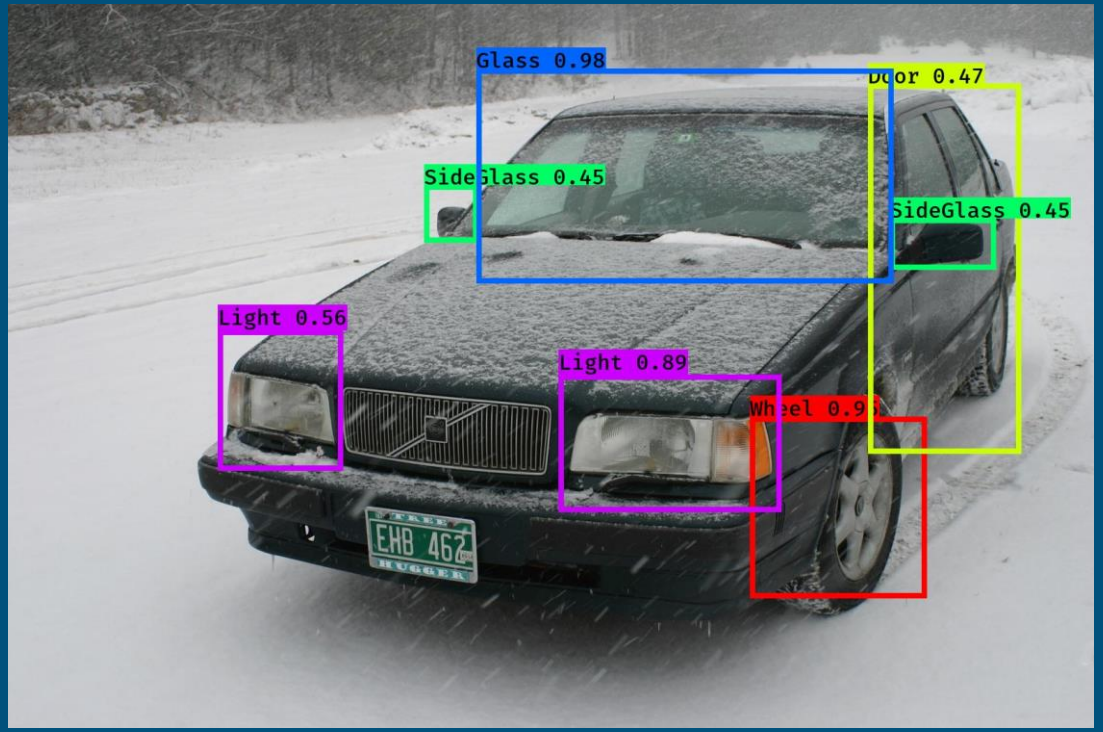
$Predicting\ Ds\ - I_M$

Approach :


Define an adaptable quality score
Fix a treshhold
Compare results
Tune the parameters

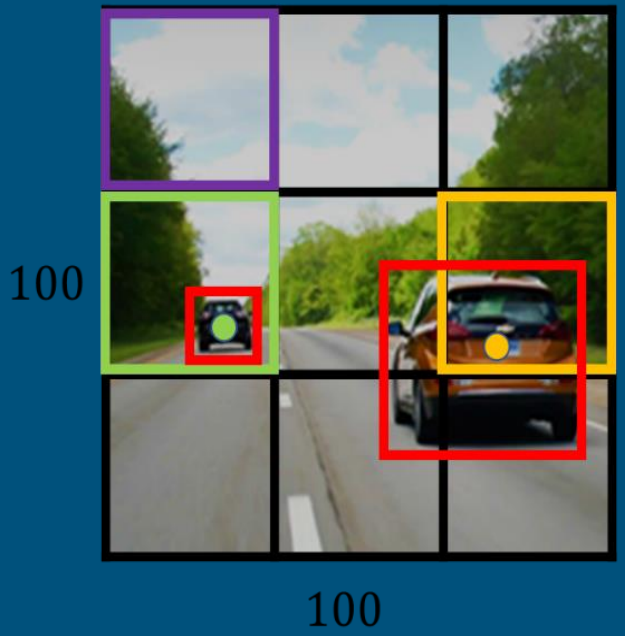
An Object detection solution

- Sliding window object detection
- R CNN
- Fast R CNN
- Faster R CNN
- Yolo



Vehicle parts detection solution using Yolov5

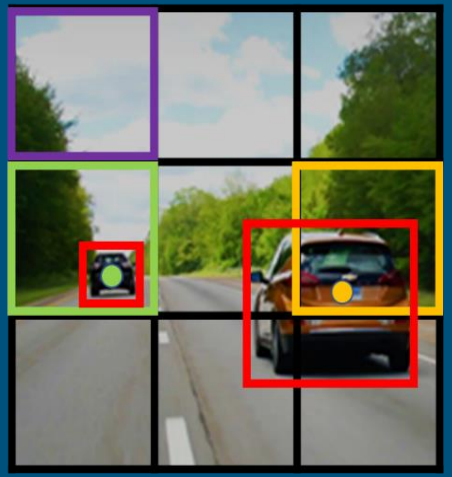
Data : Training a custom yolo model



Labels for training for each grid cell:

$$y = \begin{bmatrix} p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \end{bmatrix} \quad \begin{bmatrix} 0 \\ ? \\ ? \\ ? \\ ? \\ ? \\ ? \\ ? \end{bmatrix} \quad \begin{bmatrix} 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 0 \\ 1 \\ 0 \end{bmatrix} \quad \begin{bmatrix} 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 0 \\ 1 \\ 0 \end{bmatrix} \rightarrow \text{bounding box}$$

A confidence vector



$S\ x\ S\ grid, each\ grid\ cell\ predicts\ B\ bounding\ boxes\ and\ N\ conditional\ class\ probabilities.$

$$Pr(Class\ i|Object)*Pr(Object)*IoU\ =\ Pr(Class\ i)*IoU.$$

$$\boldsymbol{Confidence\ =\ Pr(object)\ *\ IoU}$$

IoU: $Intersection\ over\ Union\ between\ the\ predicted\ box\ and\ the\ ground\ truth.$

$The\ final\ predictions\ are\ encoded\ as\ an\ S\ x\ S\ x\ (B*5\ +\ N)\ tensor$

$If\ no\ object\ exists\ in\ a\ cell, its\ confidence\ score\ should\ be\ zero.$

A first criterion of data quality

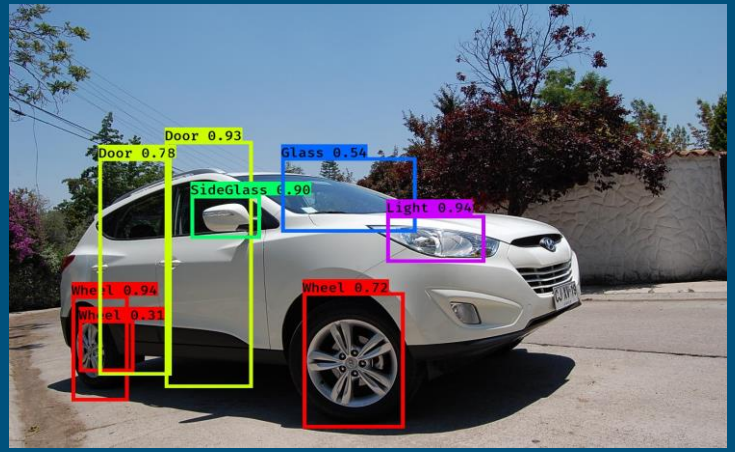
The confidence threshold allowed us to extract two different relevance classes from our dataset

$$\boldsymbol{Relevant\ Data_{cy}} : \{Image\ I \mid min(C_i(I)) > Treshold_1\}$$
$$\boldsymbol{Irrelevant\ Data_{cy}} : \{Image\ I \mid \max\big(C_i(I)\big) < Treshold_1\}$$

$C_i(I)$ *is the confidence score of class* i *for an image* I

- We trained the yolov5 object detection model to recognize 5 classes of vehicle parts. We collected images of vehicles of different types and states using web scraping, then we set a confidence score threshold $Treshold_1 = 0.30$.

Initial image: 1504 x 1000
Horizontal resolution: 300 dpi
Vertical resolution: 300 dpi
Color depth: 24



$min(C_i(I)) > Treshold_1$

Example

- The image on the right belongs to the irrelevant dataset, with $\max(\boldsymbol{C_i}(\boldsymbol{I})) = 0.19 < Treshold_1 = 0.30$
- Based on our Model, this image is irrelevant. We will predict that the image is non usable by the model M.

Example

We were able to test this prediction with the demo available on the company's website.

Initial image: 130 x 111
Horizontal resolution: 96 dpi
Vertical resolution: 96 dpi
Color depth: 24

Monk’s website demo : damage detection results

Points to explore

- Learning more about the vehicle damage detection algorithm
- Using the demo to test image quality scores.
- Effects of inter-class variations: camera position/ sensors, light, internal parameters.
- Image preprocessing pipelines.
- A quality score to predict false predictions ?