Pattern Recognition using Machine Learning

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ABSTRACT

Nowadays, traffic congestion is a serious problem in every city. To relieve this situation, all sorts of traffic control techniques are applied. This project retrains three different versions of you only looks once (YOLO) models (the state-of-the-art object detection model using neural network) and these three models are also applied on the real-time traffic images from Transport Bureau of the Macao S.A.R. website (DSAT) to detect vehicles on the roads. Their performances are compared in detail under the local circumstance with the consideration of the limitations of DSAT surveillance materials [1]. Meanwhile a web application which is especially built for real-time object detection models is also implemented. Real-time traffic images and prediction results of three models will be displayed in the website.

The three different YOLO models are trained to gain better performance on self-made DSAT datasets which consist of 4001 object-labelled traffic images. The tiny YOLOv2 model increases its mean absolute precision (mAP) more than 50% after training compared with mAP before training. As the most accurate model among the three models, YOLOv2 can achieves 61.45% mAP.

This project is especially designed to fit the object detection techniques into the traffic in Macao. The well-retrained models have significant improvement accuracy compared to original object detection models. The YOLO models which have fast processing speed ensure that the prediction can be finished in a very short time. The web application allows commuters to view the real-time traffic images and have a general idea about current traffic congestion level.

INTRODUCTION

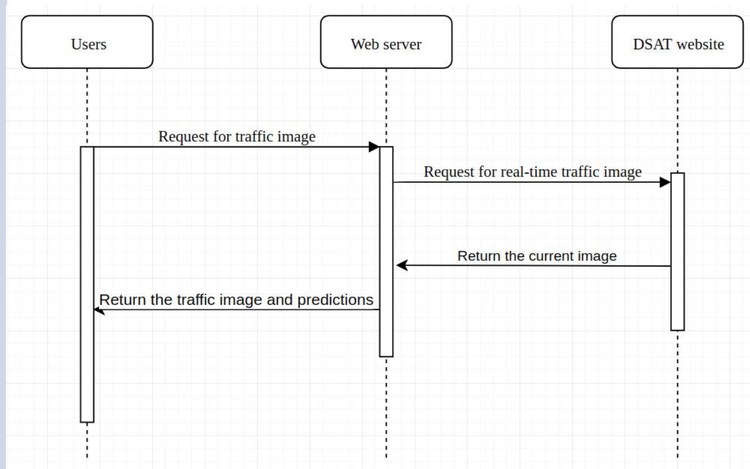
Nowadays, the traffic congestion is one of the major problems in metropolitan cities, such as Macao. The goal of this project is to implement an object detection algorithm for detecting the vehicles in traffic images from the DSAT website.

The main objectives of this project are:

- Do literatures review on object detection algorithms.
- Implement a machine-learning algorithm to recognise the traffic condition.
- Test the algorithm using real-time traffic image crawled from DSAT website and analyse the traffic results.

WEB ARCHITECTURE

The web application involves three entities: user, web server and DSAT website. The server will return prediction results from three YOLO models and real-time traffic images from DSAT website. The image and prediction results will be updated every 5 seconds. The sequence diagram is shown as below.



DATASETS

More than 60,000 images have been downloaded from different locations of traffic cameras. 3901 traffic images from the Tunel do Monte da Guia (the direction of Rodrigo) are labelled (4 classes: car, bus, motorbike and truck) and saved in XML format.

The labelled traffic images will be divided into three datasets.

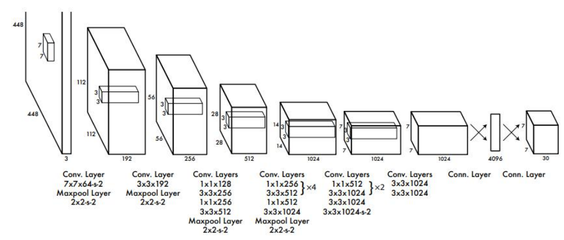
Train dataset	Validation dataset	Test dataset	Total
3511	39	351	3901

YOLO MODELS

Three versions of YOLO models have been explored to fit the case of Macao's traffic. The models are shown in table below.

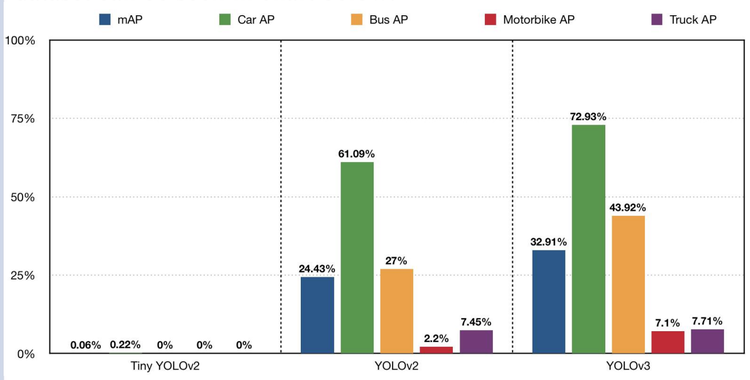
	Tiny YOLOv2	YOLOv2	YOLOv3
No. of detection classes	20	20/80	80
No. of convolutional layers	9	19	53

The architecture of the YOLOv1 model is shown below.

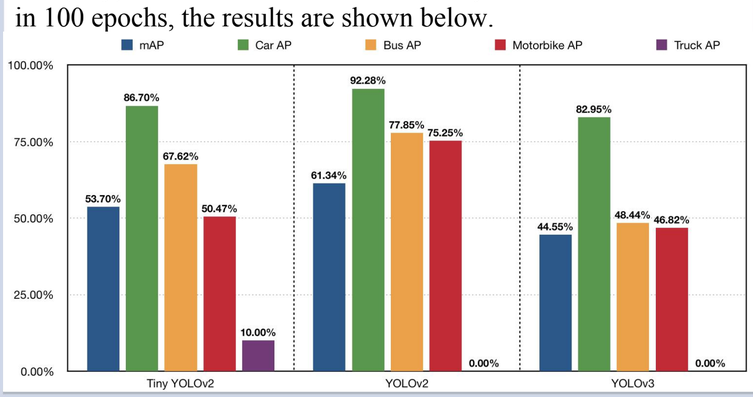


RESULTS

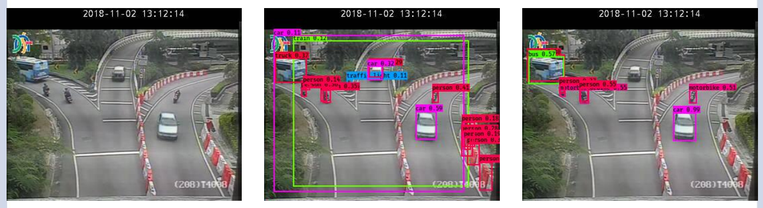
The precision of three original YOLO models in the same test dataset can be seen in chart below.



The classes are restricted to only 4 classes. After retraining the full (tiny) YOLOv2 models and last 3 layers of YOLOv3 model in 100 epochs, the results are shown below.

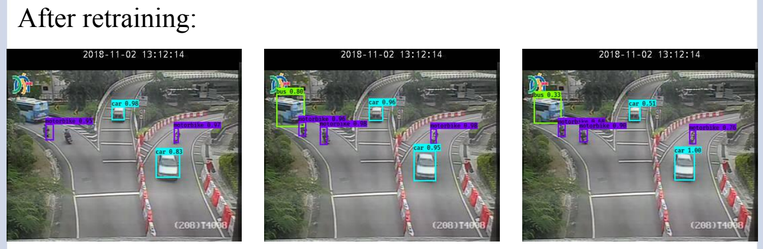


Before retraining, the detection results are shown below:



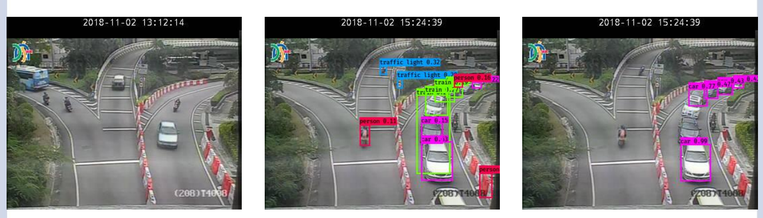
Tiny YOLOv2 YOLOv2 YOLOv3

After retraining:



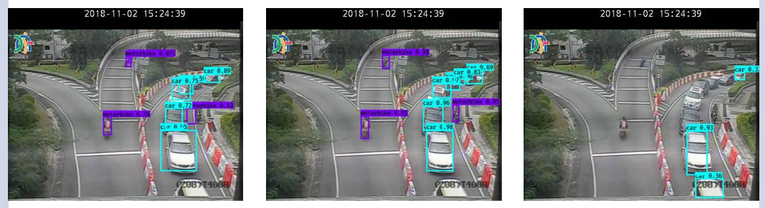
Tiny YOLOv2 YOLOv2 YOLOv3

Before retraining, the detection results on another traffic images are shown below:



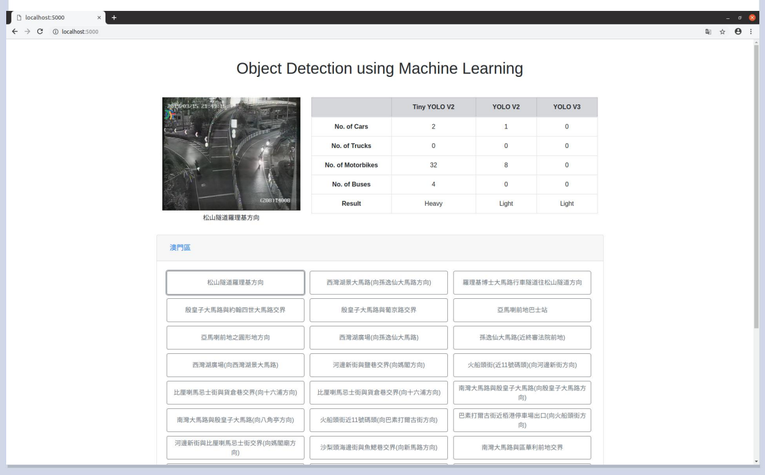
Tiny YOLOv2 YOLOv2 YOLOv3

After retraining:



Tiny YOLOv2 YOLOv2 YOLOv3

The web application provides more than 40 places of the real-time traffic image and the prediciton results of three YOLO models. The congestion level is also given according to Np. of vehicles.



Conclusions

In this project, three versions of YOLO object detection models have been explored to fit in Macao. The datasets consist of 3901 images which contain annotations are also made. In order to improve the prediction accuracy of three original object models, retraining processes have been done. After training, the mAP of tiny YOLOv2 model improves more than 50%. The YOLOv2 model can go up to 61.34% which is the highest among three models. In addition, the web application is built for commuters to have better ideas about the current traffic congestion level.