Improving Vehicle Detection Using YOLOv5 with Hyperparameter Evolution, Data Augmentation and Model Ensemble

Team: Transportist

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Abstract

Deep convolutional neural networks have performed remarkably well on many Computer Vision tasks. However, these networks are heavily reliant on big data for better learning. But when dataset is smaller than necessary for the cause, augmentation, hyperparameter evolution and model ensemble are some of the few steps proven already for proving better result.

Introduction

- We used YOLOv5 [1] for the vehicle detection problem
- We evolved the hyperparameters based on the competition dataset
- Scarcity of image was tackled by image augmentation
- Multiple models based on different optimizers were ensembled for building a stronger model
- Workflow:

Input data processing → Hyperparameter evolution and augmentation → Model training → Model ensembling

Hyperparameter Evolution

- Hyperparameters were evolved using genetic algorithm for 300 generations
- These hyperparameters were evolved:
  Lr (Learning rate) , momentum, weight_decay, warmup_epochs, warmup_momentum, warmup_bias_lr, box, Cls, cls_pw, obj, obj_pw, iou_t, anchor_t, fl_gamma, hsv_h, s v, degrees, translate, Scale, shear, perspective, flip, mosaic. Mixup
- Hyperparameters were separately evolved for different YOLOv5 model configurations (s, m, l and x) and optimizers (ADAM and SGD)

Data Augmentation

- Object detection models need a lot of images as training data for avoid overfitting.
- If not available, then the training images can be increased by image augmentation processes.
- Most common image augmentation techniques are: flipping (horizontal/vertical), rotation, cutout, color shifting, blurring, mix-up, resize, crop, etc.
- We used *gamma, scale, shear, perspective, flip, mosaic and mixup* for augmentation of data, which were set during the hyperparameter evolution

Model Ensemble

- Model ensemble is a concept to combine different weaker models to build a stronger model.
- In the 1st stage we only utilized ensemble of YOLOv5 l and x based on both ADAM and SGD.
- But in the final round, we ensembled 11 different models trained by using corresponding different hyperparameters, including different configurations of YOLOv5 m, l, and x.

Results

Description	1st round	2nd round
Default YOLOv5	0.1567	
Hyp evolved (YOLO v5), Augmentation, Ensemble (4 models)	0.1895	0.2357
Hyp evolved (YOLO v5), Augmentation, Ensemble (11 models)		0.2705

Conclusion

- Hyperparameter evolution and model ensemble are crucial for getting the best performance from YOLOv5
- Training separate models with different optimizers (ADAM and SGD) and ensembling them improves the generalization of the model

Reference

1. Glenn Jocher, Alex Stoken, Jirka Borovec, NanoCode012, ChristopherSTAN, Liu Changyu, … Prashant Rai. (2020, October 29). ultralytics/yolov5: v3.1 - Bug Fixes and Performance Improvements (Version v3.1). Zenodo. http://doi.org/10.5281/zenodo.4154370