

Object Detection using YOLOv2

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Abstract

This is a presentation on the final project. It will contain the description of the problem I am trying to solve, the algorithms I employed to solve the problem, implementation details like program design issues and the results obtained. The results obtained will be analyzed for correctness. The performance of the algorithm will be evaluated and discussed.

1 Problem Statement:

- Write a program in Python using TensorFlow and Keras libraries to perform object detection (i.e. predicting the bounding box and label of each object present in the image).

2 Proposed Solution:

- To perform the task of object detection, I have implemented the network architecture of YOLOv2 or YOLO9000 from scratch using TensorFlow and Keras as deep learning libraries.
- For this task I have used PASCAL VOC 2012 dataset. It consists of 20 unique classes as the class labels/target variable. The names of these classes are: aeroplane, bicycle, bird, boat, bottle, bus, car, cat, chair, cow, diningtable,

dog, horse, motorbike, person, pottedplant, sheep, sofa, train and tvmonitor. The training data provided consists of a set of images; each image has an annotation file giving a bounding box and object class label for each object in one of the twenty classes present in the image.

- YOLO9000 – Better, Faster and Stronger. Better: Batch normalization, high resolution classifier, convolution with anchor boxes, dimension clusters, direct location prediction, fine grained features and multi-scale training. Faster: Darknet-19, training for classification and training for detection. Stronger: Hierarchical classification, dataset combination with Word-tree, joint classification and detection.
- YOLOv2 uses k-means clustering to find the best anchor box sizes for the given dataset. The anchors defined in the project are taken from the following blog:
https://fairyonice.github.io/Part_1_Object_Detection_with_Yolo_for_VOC_2014_data_anchor_box_clustering.html
- We defined a ImageReader class to process an image. It takes in an image and returns the resized image and all the objects in the image.
- Next, we used “BestAnchorBoxFinder” function which finds the best anchor box for a particular object. This is done by finding the anchor box with the highest IOU (Intersection over union) with the bounding box of the object.
- Next, we define a custom Batch generator to get a batch of 16 images and its corresponding bounding boxes.
- Now, I am adding a function to prepare the input and the output. The input is a (448, 448, 3) image and the output is a (7, 7, 30) tensor.
- Next, we defined the model architecture of YOLOv2/YOLO9000 from scratch as described in the original paper. (Note:- I have implemented the architecture from scratch on my own and for the rest of the part I followed the Yumi’s blog as I am beginner to computer vision and took the code from his blog. Link to Yumi’s blog:
https://fairyonice.github.io/Part_1_Object_Detection_with_Yolo_for_VOC_2014_data_anchor_box_clustering.html)

- Darknet-19 architecture given in the research paper is as follows:

Type	Filters	Size/Stride	Output
Convolutional	32	3×3	224×224
Maxpool		$2 \times 2/2$	112×112
Convolutional	64	3×3	112×112
Maxpool		$2 \times 2/2$	56×56
Convolutional	128	3×3	56×56
Convolutional	64	1×1	56×56
Convolutional	128	3×3	56×56
Maxpool		$2 \times 2/2$	28×28
Convolutional	256	3×3	28×28
Convolutional	128	1×1	28×28
Convolutional	256	3×3	28×28
Maxpool		$2 \times 2/2$	14×14
Convolutional	512	3×3	14×14
Convolutional	256	1×1	14×14
Convolutional	512	3×3	14×14
Convolutional	256	1×1	14×14
Convolutional	512	3×3	14×14
Maxpool		$2 \times 2/2$	7×7
Convolutional	1024	3×3	7×7
Convolutional	512	1×1	7×7
Convolutional	1024	3×3	7×7
Convolutional	512	1×1	7×7
Convolutional	1024	3×3	7×7
Convolutional	1000	1×1	7×7
Avgpool		Global	1000
Softmax			

- YOLOv2 model architecture repeatedly stacks Convolution + Batch Normalization + Leaky Relu layers until the image shape reduces to the grid cell size.
- We trained only the last convolution layer and used pre-trained weights for the rest of the layers.
- For calculating the loss I have taken the code from Yumi's blog.

- I have only trained the final 23rd layer and freeze the other weights as it will take a long time to train the full network.
- After the model is trained I saved it so that it can be used for inference part later on.

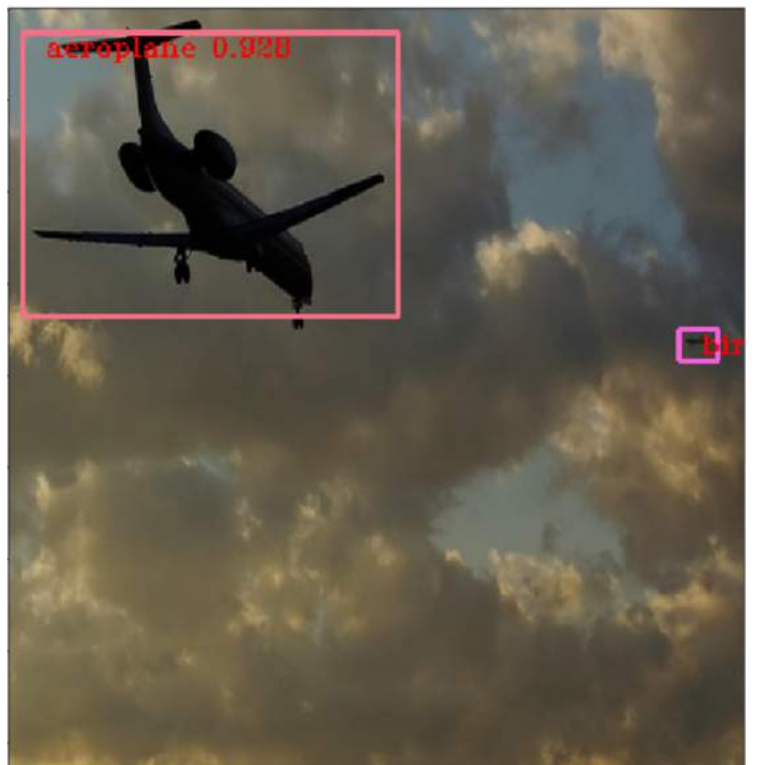
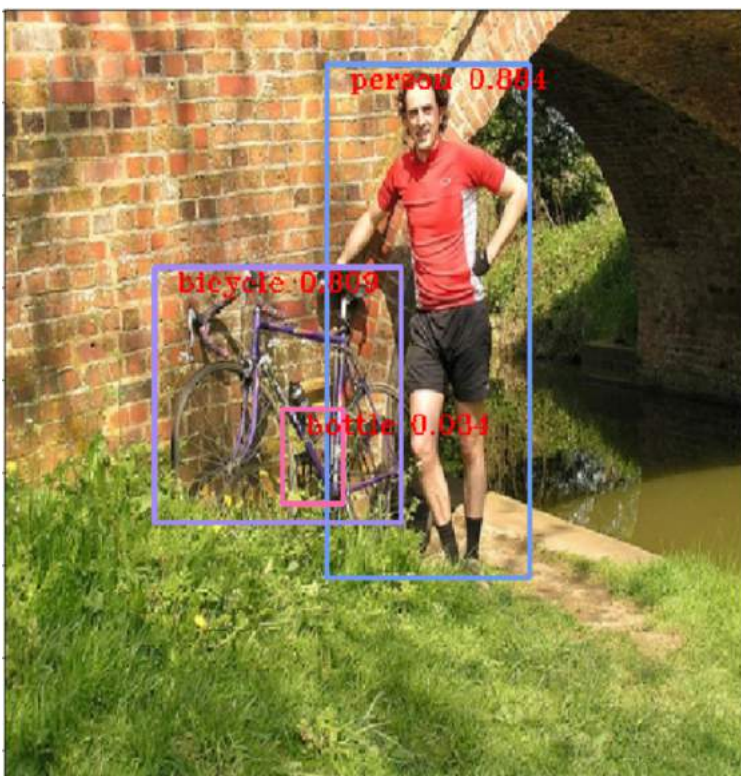
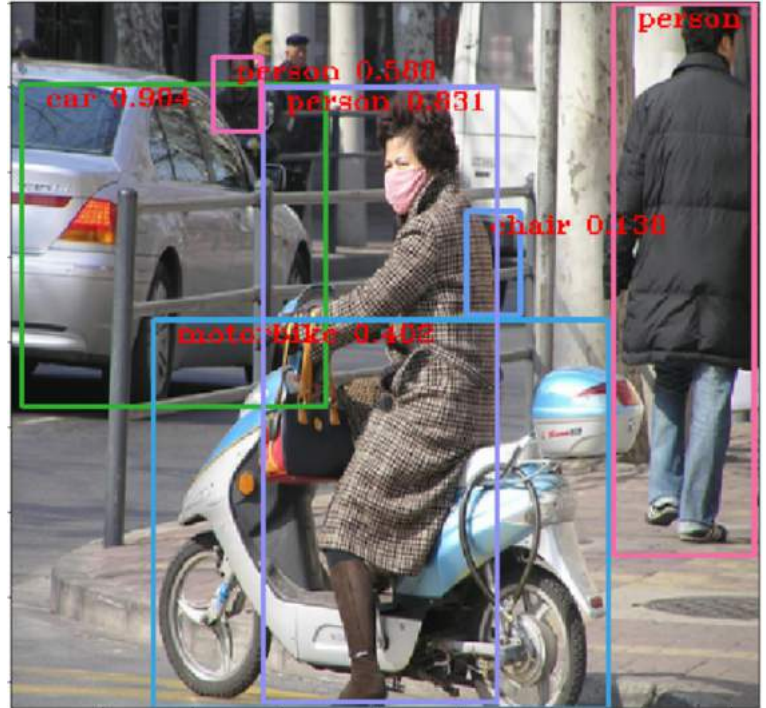
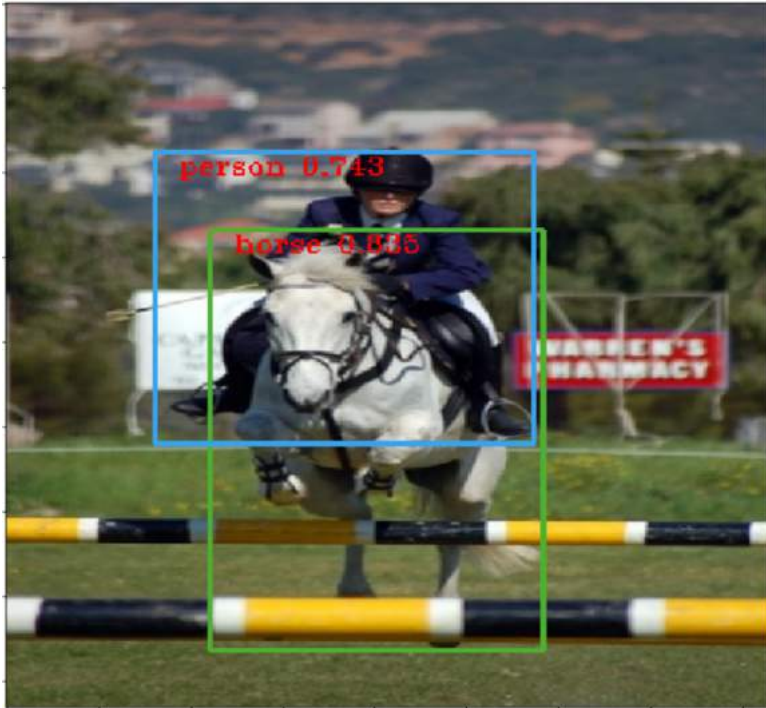
3 Implementation Details:

- I have implemented the model architecture of YOLOv2/YOLO9000 from scratch on my own in the filename “model_architecture.py”.
- I have trained the model on Google colab in the filename “model_training.ipynb”.
- Last part of the project i.e. objects detection in the images using previously trained model is performed in the filename “Inference.ipynb”.
- The name of the trained model file is ‘weights_yolo_on_voc2012.h5’. Since the size of the model is 579 MB approximately. So, I have uploaded it on the Google drive. Please click on this link to download the file of the trained model: https://drive.google.com/file/d/1vdP69qEVdRM3NmB1LvFdus0_Sy-R8eBN/view?usp=sharing .
- After downloading the file of the model, put it in the folder named ‘yolo_v2’ which is inside the ‘src’ folder. After that you can execute ‘Inference.ipynb’ file on various test images given in ‘data’ folder.
- Folder structure: project (main folder) →
 - (1). src (sub-folder) – It contains four source code files and their names are: “backend.py”, “Inference.ipynb”, “model_architecture.py” and “model_training.ipynb”. It also contains one sub-folder named ‘yolo_v2’. “weights_yolo_on_voc2012.h5” file should be put in ‘yolo_v2’ folder.
 - (2). data (sub-folder) – It contains all test files (images).
 - (3). doc (sub-folder) – It contains one pdf file and its name is “project report.pdf”.
 - (4). presentation (sub-folder) – It contains one pdf file and its name is “project presentation.pdf”.

(5). sources (sub-folder) – It contains two files. The names of these files are: “YOLO9000 research paper.pdf” and “backend.py”.

4 Results and discussion:

Following are the few results on the test images:



5 References:

- <https://drive.google.com/file/d/1YIT2R2NcU1T7ezljAxaHp0ESdmfbJqJ8/view?usp=sharing> (Project Video link)
- <http://host.robots.ox.ac.uk/pascal/VOC/voc2012/>
- <https://ieeexplore.ieee.org/document/8100173>
- <https://arxiv.org/pdf/1612.08242.pdf>
- <https://pjreddie.com/darknet/yolo/>
- <https://www.geeksforgeeks.org/yolo-v2-object-detection/>
- <https://arxiv.org/pdf/1506.02640.pdf>
- <https://medium.com/@y1017c121y/how-does-yolov2-work-daaaa967c5f7>
- https://fairyonice.github.io/Part_1_Object_Detection_with_Yolo_for_VOC_2014_data_anchor_box_clustering.html/ .
- <https://www.slideshare.net/JinwonLee9/pr12-yolo9000>