

FasterR-CNN

March 9, 2020

```
[2]: import torchvision
from PIL import Image
from torchvision import transforms as T
import cv2
import matplotlib
from matplotlib import pyplot as plt

[3]: model = torchvision.models.detection.fasterrcnn_resnet50_fpn(pretrained=True)
model.eval()

[3]: FasterRCNN(
    (transform): GeneralizedRCNNTransform()
    (backbone): BackboneWithFPN(
        (body): IntermediateLayerGetter(
            (conv1): Conv2d(3, 64, kernel_size=(7, 7), stride=(2, 2), padding=(3, 3),
bias=False)
            (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
            (relu): ReLU(inplace=True)
            (maxpool): MaxPool2d(kernel_size=3, stride=2, padding=1, dilation=1,
ceil_mode=False)
            (layer1): Sequential(
                (0): Bottleneck(
                    (conv1): Conv2d(64, 64, kernel_size=(1, 1), stride=(1, 1), bias=False)
                    (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
                    (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False)
                    (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
                    (conv3): Conv2d(64, 256, kernel_size=(1, 1), stride=(1, 1),
bias=False)
                    (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
                    (relu): ReLU(inplace=True)
                    (downsample): Sequential(
                        (0): Conv2d(64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False)
                        (1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
                    )
                )
            )
        (1): Bottleneck(
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(conv1): Conv2d(256, 64, kernel_size=(1, 1), stride=(1, 1),
bias=False)
    (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
    (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False)
        (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv3): Conv2d(64, 256, kernel_size=(1, 1), stride=(1, 1),
bias=False)
            (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
            (relu): ReLU(inplace=True)
        )
    (2): Bottleneck(
        (conv1): Conv2d(256, 64, kernel_size=(1, 1), stride=(1, 1),
bias=False)
            (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
            (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False)
                (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
                (conv3): Conv2d(64, 256, kernel_size=(1, 1), stride=(1, 1),
bias=False)
                    (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
                    (relu): ReLU(inplace=True)
                )
            )
        (layer2): Sequential(
            (0): Bottleneck(
                (conv1): Conv2d(256, 128, kernel_size=(1, 1), stride=(1, 1),
bias=False)
                    (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
                    (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(2, 2),
padding=(1, 1), bias=False)
                        (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
                        (conv3): Conv2d(128, 512, kernel_size=(1, 1), stride=(1, 1),
bias=False)
                            (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
                            (relu): ReLU(inplace=True)
                            (downsample): Sequential(
                                (0): Conv2d(256, 512, kernel_size=(1, 1), stride=(2, 2),
bias=False)
                                (1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
                            )
                        )
                    )
                (1): Bottleneck(
                    (conv1): Conv2d(512, 128, kernel_size=(1, 1), stride=(1, 1),
bias=False)
                        (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
                        (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), bias=False)

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        (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv3): Conv2d(128, 512, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (relu): ReLU(inplace=True)
    )
    (2): Bottleneck(
        (conv1): Conv2d(512, 128, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), bias=False)
        (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv3): Conv2d(128, 512, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (relu): ReLU(inplace=True)
    )
    (3): Bottleneck(
        (conv1): Conv2d(512, 128, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), bias=False)
        (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv3): Conv2d(128, 512, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (relu): ReLU(inplace=True)
    )
)
(layer3): Sequential(
    (0): Bottleneck(
        (conv1): Conv2d(512, 256, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(2, 2),
padding=(1, 1), bias=False)
        (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv3): Conv2d(256, 1024, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (relu): ReLU(inplace=True)
        (downsample): Sequential(
            (0): Conv2d(512, 1024, kernel_size=(1, 1), stride=(2, 2),
bias=False)
            (1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)

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        )
    )
(1): Bottleneck(
    (conv1): Conv2d(1024, 256, kernel_size=(1, 1), stride=(1, 1),
bias=False)
    (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
    (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), bias=False)
    (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
    (conv3): Conv2d(256, 1024, kernel_size=(1, 1), stride=(1, 1),
bias=False)
    (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
    (relu): ReLU(inplace=True)
)
(2): Bottleneck(
    (conv1): Conv2d(1024, 256, kernel_size=(1, 1), stride=(1, 1),
bias=False)
    (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
    (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), bias=False)
    (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
    (conv3): Conv2d(256, 1024, kernel_size=(1, 1), stride=(1, 1),
bias=False)
    (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
    (relu): ReLU(inplace=True)
)
(3): Bottleneck(
    (conv1): Conv2d(1024, 256, kernel_size=(1, 1), stride=(1, 1),
bias=False)
    (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
    (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), bias=False)
    (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
    (conv3): Conv2d(256, 1024, kernel_size=(1, 1), stride=(1, 1),
bias=False)
    (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
    (relu): ReLU(inplace=True)
)
(4): Bottleneck(
    (conv1): Conv2d(1024, 256, kernel_size=(1, 1), stride=(1, 1),
bias=False)
    (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
    (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), bias=False)
    (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
    (conv3): Conv2d(256, 1024, kernel_size=(1, 1), stride=(1, 1),
bias=False)
)

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        (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (relu): ReLU(inplace=True)
    )
    (5): Bottleneck(
        (conv1): Conv2d(1024, 256, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), bias=False)
        (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv3): Conv2d(256, 1024, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (relu): ReLU(inplace=True)
    )
)
(layer4): Sequential(
    (0): Bottleneck(
        (conv1): Conv2d(1024, 512, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(2, 2),
padding=(1, 1), bias=False)
        (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv3): Conv2d(512, 2048, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (relu): ReLU(inplace=True)
        (downsample): Sequential(
            (0): Conv2d(1024, 2048, kernel_size=(1, 1), stride=(2, 2),
bias=False)
            (1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        )
    )
    (1): Bottleneck(
        (conv1): Conv2d(2048, 512, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), bias=False)
        (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv3): Conv2d(512, 2048, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (relu): ReLU(inplace=True)
    )
    (2): Bottleneck(

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        (conv1): Conv2d(2048, 512, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn1): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), bias=False)
        (bn2): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (conv3): Conv2d(512, 2048, kernel_size=(1, 1), stride=(1, 1),
bias=False)
        (bn3): FrozenBatchNorm2d(original_name=FrozenBatchNorm2d)
        (relu): ReLU(inplace=True)
    )
)
)
)
(fpn): FeaturePyramidNetwork(
    (inner_blocks): ModuleList(
        (0): Conv2d(256, 256, kernel_size=(1, 1), stride=(1, 1))
        (1): Conv2d(512, 256, kernel_size=(1, 1), stride=(1, 1))
        (2): Conv2d(1024, 256, kernel_size=(1, 1), stride=(1, 1))
        (3): Conv2d(2048, 256, kernel_size=(1, 1), stride=(1, 1))
    )
    (layer_blocks): ModuleList(
        (0): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
        (1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
        (2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
        (3): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    )
    (extra_blocks): LastLevelMaxPool()
)
)
(rpn): RegionProposalNetwork(
    (anchor_generator): AnchorGenerator()
    (head): RPNHead(
        (conv): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1))
        (cls_logits): Conv2d(256, 3, kernel_size=(1, 1), stride=(1, 1))
        (bbox_pred): Conv2d(256, 12, kernel_size=(1, 1), stride=(1, 1))
    )
)
(roi_heads): RoIHeads(
    (box_roi_pool): MultiScaleRoIAlign()
    (box_head): TwoMLPHead(
        (fc6): Linear(in_features=12544, out_features=1024, bias=True)
        (fc7): Linear(in_features=1024, out_features=1024, bias=True)
    )
    (box_predictor): FastRCNNPredictor(
        (cls_score): Linear(in_features=1024, out_features=91, bias=True)
        (bbox_pred): Linear(in_features=1024, out_features=364, bias=True)
    )
)

```

```

        )
    )
)

[4]: COCO_INSTANCE_CATEGORY_NAMES = [
    '__background__', 'person', 'bicycle', 'car', 'motorcycle', 'airplane',
    'bus',
    'train', 'truck', 'boat', 'traffic light', 'fire hydrant', 'N/A', 'stop sign',
    'parking meter', 'bench', 'bird', 'cat', 'dog', 'horse', 'sheep', 'cow',
    'elephant', 'bear', 'zebra', 'giraffe', 'N/A', 'backpack', 'umbrella', 'N/A',
    'N/A', 'N/A',
    'handbag', 'tie', 'suitcase', 'frisbee', 'skis', 'snowboard', 'sports ball',
    'kite', 'baseball bat', 'baseball glove', 'skateboard', 'surfboard',
    'tennis racket',
    'bottle', 'N/A', 'wine glass', 'cup', 'fork', 'knife', 'spoon', 'bowl',
    'banana', 'apple', 'sandwich', 'orange', 'broccoli', 'carrot', 'hot dog',
    'pizza',
    'donut', 'cake', 'chair', 'couch', 'potted plant', 'bed', 'N/A', 'dining table',
    'N/A', 'N/A', 'toilet', 'N/A', 'tv', 'laptop', 'mouse', 'remote',
    'keyboard', 'cell phone',
    'microwave', 'oven', 'toaster', 'sink', 'refrigerator', 'N/A', 'book',
    'clock', 'vase', 'scissors', 'teddy bear', 'hair drier', 'toothbrush'
]

```

```

[5]: def get_prediction(img_path, threshold):
    img = Image.open(img_path) # Load the image
    transform = T.Compose([T.ToTensor()]) # Defing PyTorch Transform
    img = transform(img) # Apply the transform to the image
    pred = model([img]) # Pass the image to the model
    pred_class = [COCO_INSTANCE_CATEGORY_NAMES[i] for i in list(pred[0]['labels']).numpy()] # Get the Prediction Score
    pred_boxes = [[(i[0], i[1]), (i[2], i[3])] for i in list(pred[0]['boxes']).detach().numpy()] # Bounding boxes
    pred_score = list(pred[0]['scores'].detach().numpy())
    pred_t = [pred_score.index(x) for x in pred_score if x > threshold][-1] # Get list of index with score greater than threshold.
    pred_boxes = pred_boxes[:pred_t+1]
    pred_class = pred_class[:pred_t+1]
    return pred_boxes, pred_class

```

```

[11]: def object_detection_api(img_path, threshold=0.5, rect_th=3, text_size=3,
                           text_th=3):

    boxes, pred_cls = get_prediction(img_path, threshold) # Get predictions

```

```



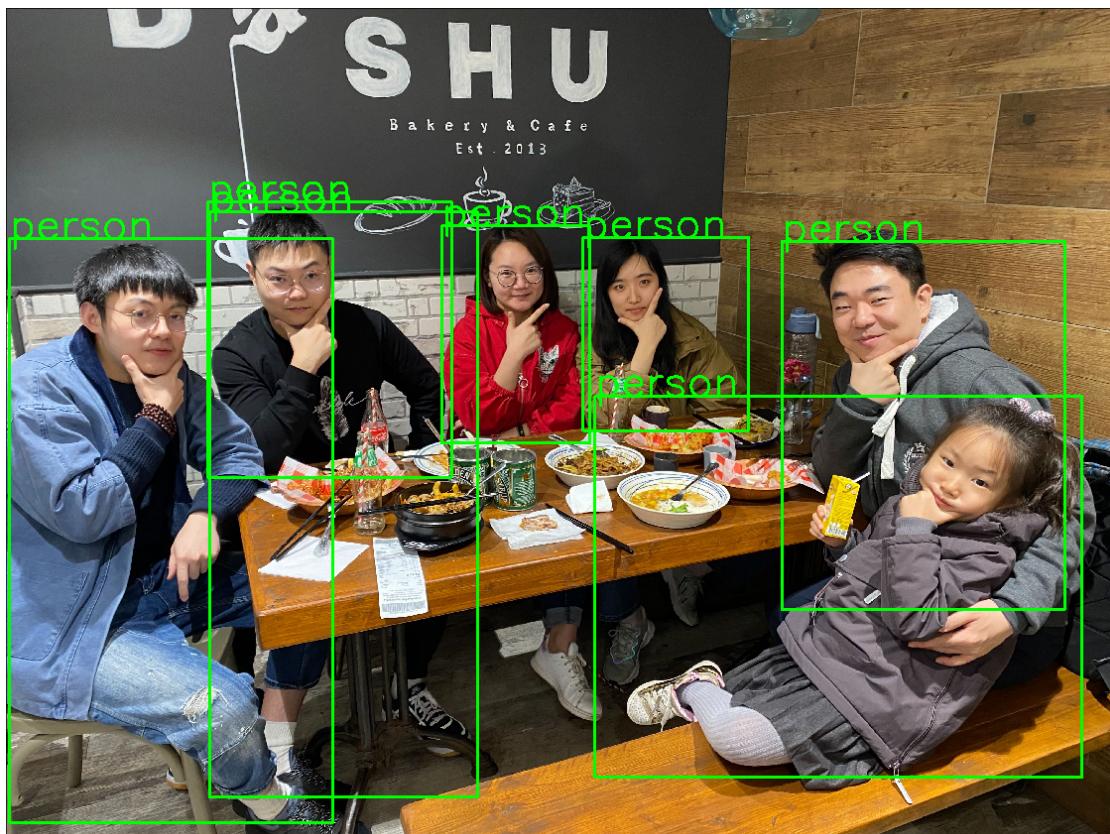
```

[13]:

```

%%time
object_detection_api('./Image from iOS.jpg', threshold=0.8, rect_th=10, text_size=5, text_th=10)

```

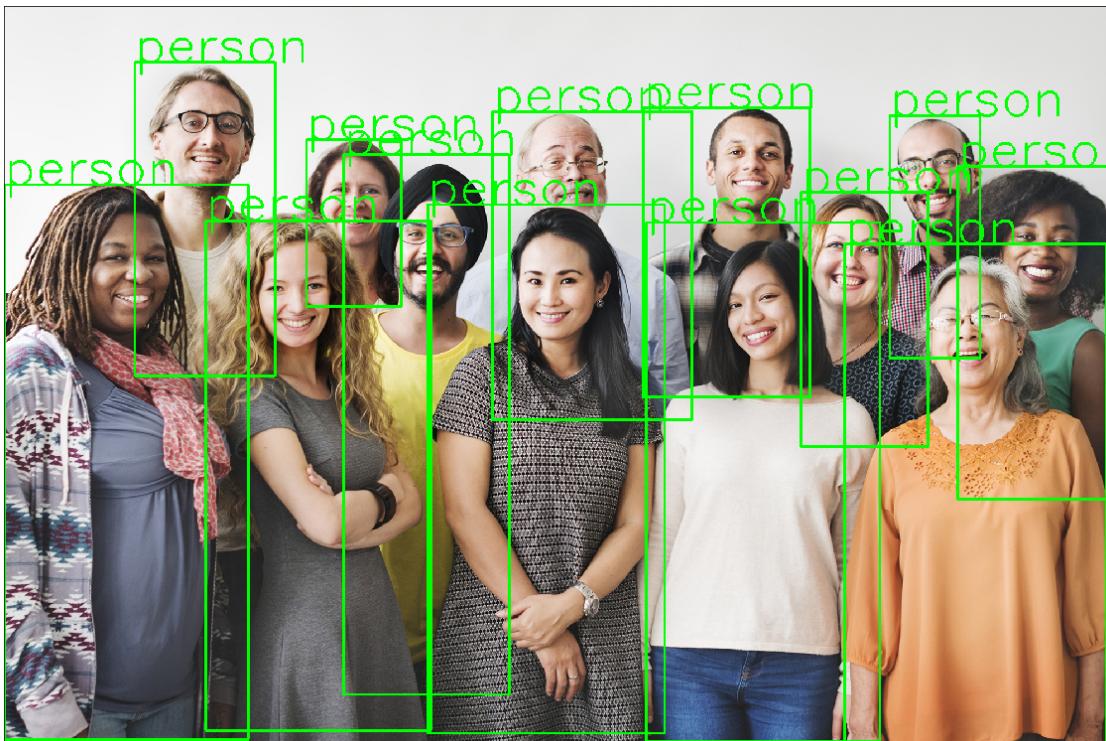


CPU times: user 9 s, sys: 927 ms, total: 9.92 s
Wall time: 4.38 s

```
[6]: !wget https://www.wsha.org/wp-content/uploads/banner-diverse-group-of-people-2.  
→jpg -O people.jpg
```

```
--2020-03-03 13:21:15-- https://www.wsha.org/wp-content/uploads/banner-diverse-  
group-of-people-2.jpg  
Resolving www.wsha.org (www.wsha.org)... 104.198.7.33  
Connecting to www.wsha.org (www.wsha.org)|104.198.7.33|:443... connected.  
HTTP request sent, awaiting response... 200 OK  
Length: 1923610 (1.8M) [image/jpeg]  
Saving to: 'people.jpg'  
  
people.jpg 100%[=====] 1.83M 1.88MB/s in 1.0s  
  
2020-03-03 13:21:17 (1.88 MB/s) - 'people.jpg' saved [1923610/1923610]
```

```
[7]: %%time  
object_detection_api('./people.jpg', threshold=0.8)
```



```
CPU times: user 9.66 s, sys: 1.24 s, total: 10.9 s  
Wall time: 5.34 s
```

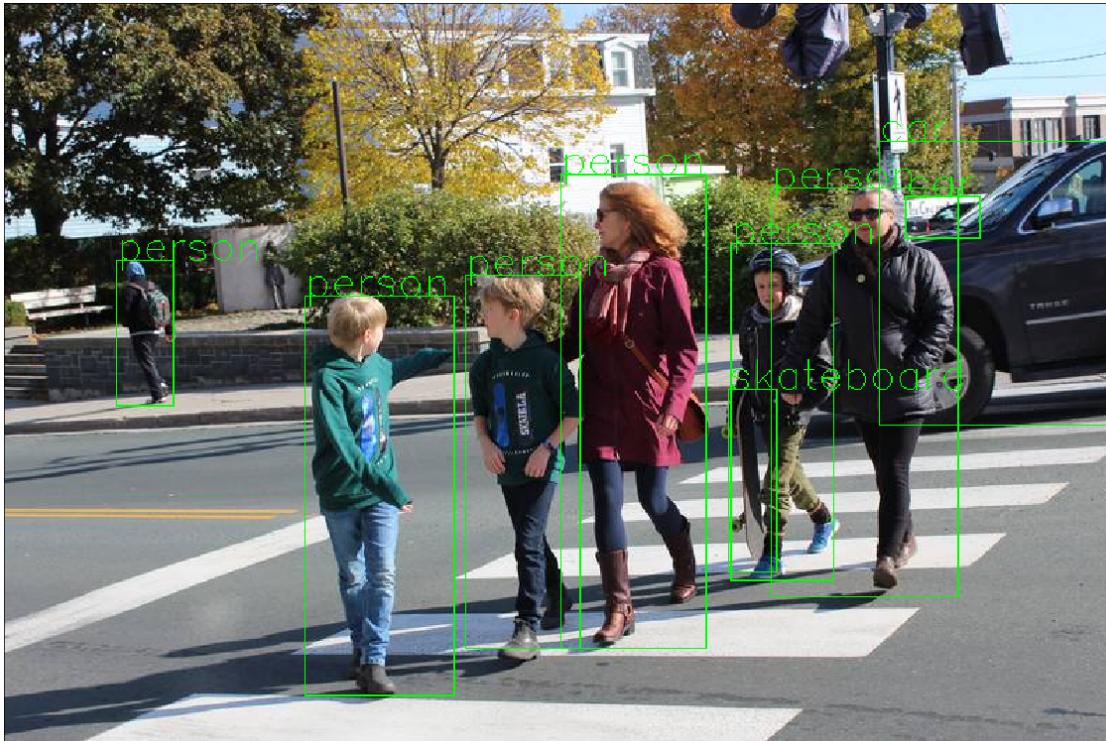
```
[8]: !wget https://www.thetelegram.com/media/photologue/photos/cache/
      ↵STJ-A01-28102019-RawlinsCrossPedestrians3_large.jpg

--2020-03-03 13:21:22-- https://www.thetelegram.com/media/photologue/photos/cache/STJ-A01-28102019-RawlinsCrossPedestrians3_large.jpg
Resolving www.thetelegram.com (www.thetelegram.com)... 209.172.61.44
Connecting to www.thetelegram.com (www.thetelegram.com)|209.172.61.44|:443...
connected.
HTTP request sent, awaiting response... 200 OK
Length: 91842 (90K) [image/jpeg]
Saving to: 'STJ-A01-28102019-RawlinsCrossPedestrians3_large.jpg.1'

STJ-A01-28102019-Ra 100%[=====] 89.69K 539KB/s in 0.2s

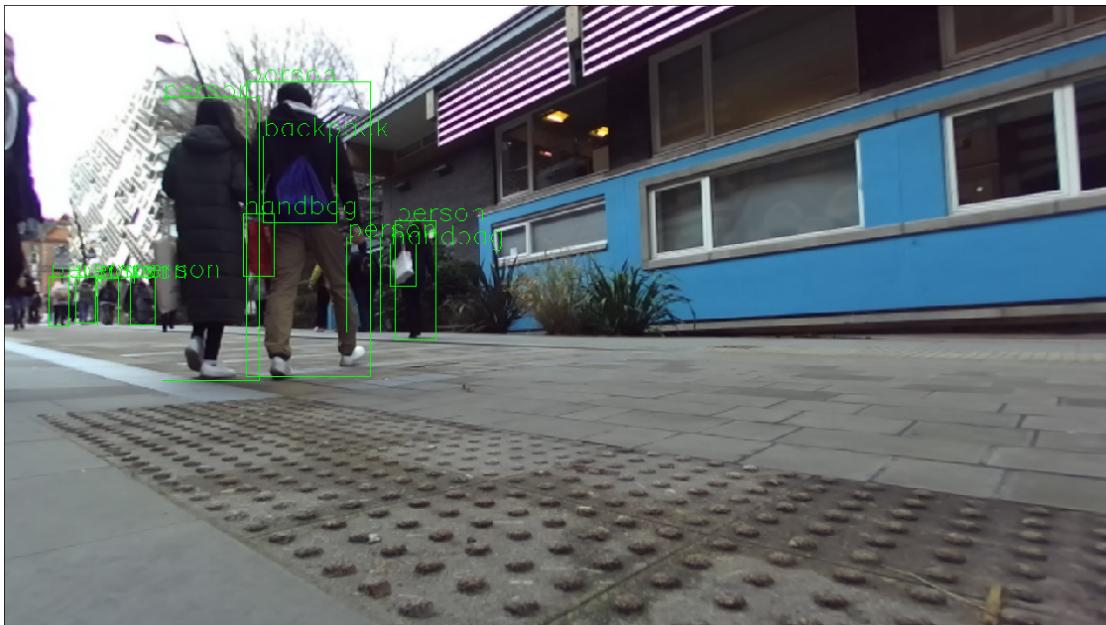
2020-03-03 13:21:23 (539 KB/s) -
'STJ-A01-28102019-RawlinsCrossPedestrians3_large.jpg.1' saved [91842/91842]
```

```
[9]: %%time
# source: https://www.thetelegram.com/opinion/local-perspectives/
      ↵editorial-put-pedestrians-first-381333/
object_detection_api('./STJ-A01-28102019-RawlinsCrossPedestrians3_large.jpg', u
      ↵threshold=0.8, rect_th=1, text_size=1, text_th=1)
```



```
CPU times: user 9.32 s, sys: 753 ms, total: 10.1 s
Wall time: 3.87 s
```

```
[10]: %%time
# source: https://www.thetelegram.com/opinion/local-perspectives/
    ↵editorial-put-pedestrians-first-381333/
object_detection_api('./frame0600.jpg', threshold=0.8, rect_th=1, text_size=1, text_th=1)
```



```
CPU times: user 9.71 s, sys: 990 ms, total: 10.7 s
Wall time: 4.01 s
```

```
[13]: %%time
# source: https://www.thetelegram.com/opinion/local-perspectives/
    ↵editorial-put-pedestrians-first-381333/
object_detection_api('./frame0700.jpg', threshold=0.8, rect_th=1, text_size=1, text_th=1)
```



CPU times: user 10 s, sys: 407 ms, total: 10.4 s

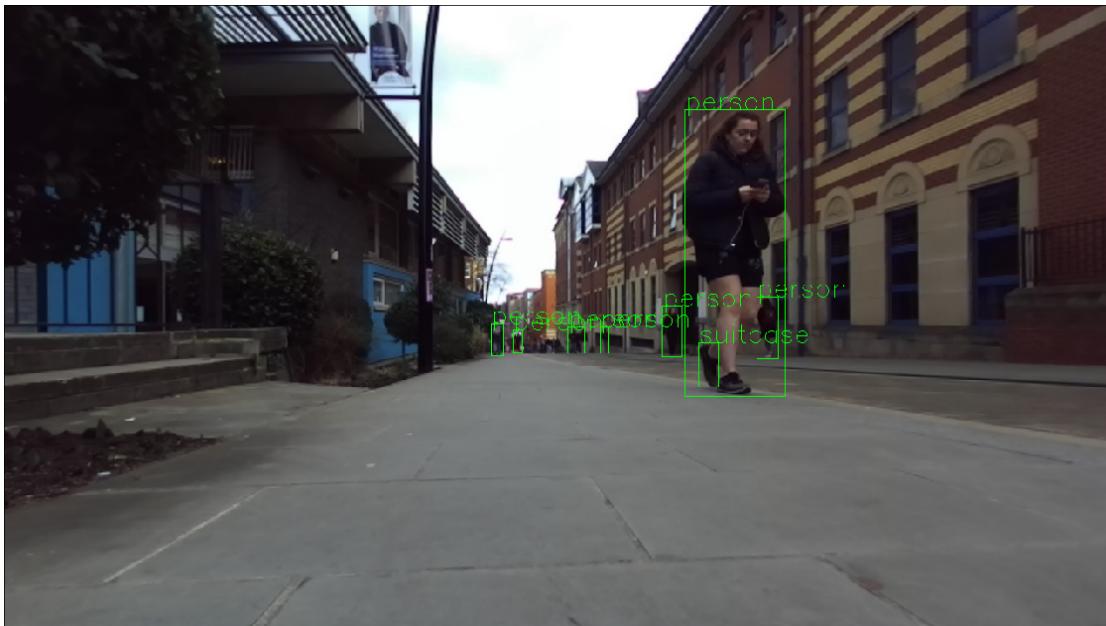
Wall time: 3.97 s

```
[14]: %time
# source: https://www.thetelegram.com/opinion/local-perspectives/
    ↳editorial-put-pedestrians-first-381333/
object_detection_api('./frame0900.jpg', threshold=0.8, rect_th=1, text_size=1, text_th=1)
```



```
CPU times: user 9.89 s, sys: 439 ms, total: 10.3 s
Wall time: 3.85 s
```

```
[15]: ## %%time
# source: https://www.thetelegram.com/opinion/local-perspectives/
#       ↳editorial-put-pedestrians-first-381333/
object_detection_api('./frame1291.jpg', threshold=0.8, rect_th=1, text_size=1, text_th=1)
```

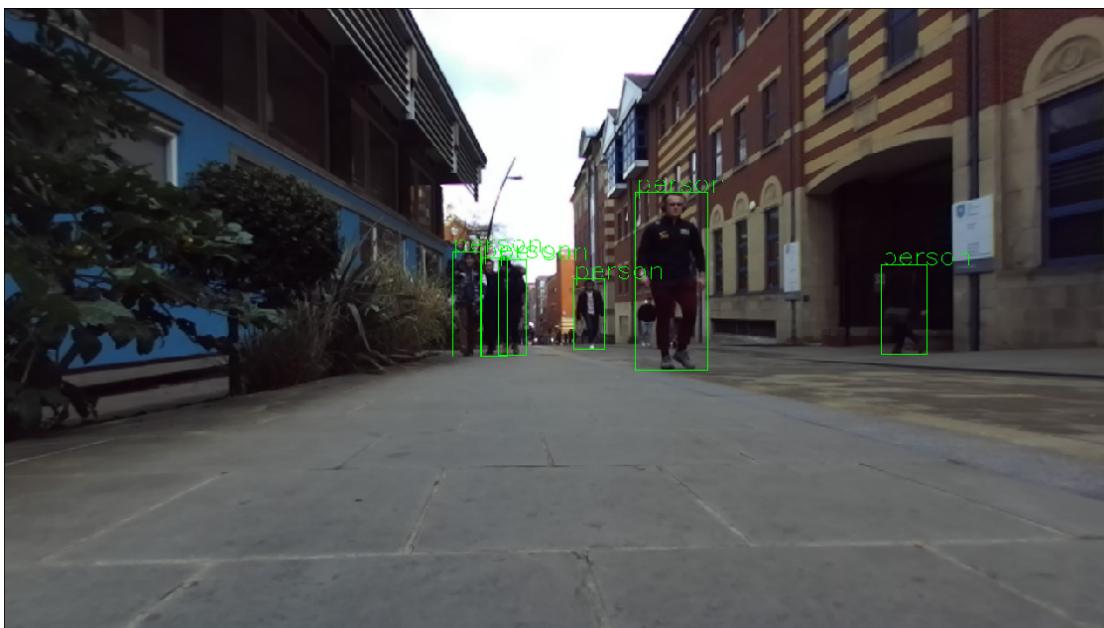


```
[16]: %%time
# source: https://www.thetelegram.com/opinion/local-perspectives/
#       ↳editorial-put-pedestrians-first-381333/
object_detection_api('./frame1309.jpg', threshold=0.8, rect_th=1, text_size=1, text_th=1)
```



```
CPU times: user 9.79 s, sys: 457 ms, total: 10.3 s
Wall time: 3.86 s
```

```
[17]: %%time
# source: https://www.thetelegram.com/opinion/local-perspectives/
    ↳editorial-put-pedestrians-first-381333/
object_detection_api('./frame1441.jpg', threshold=0.8, rect_th=1, text_size=1, text_th=1)
```



```
CPU times: user 9.84 s, sys: 411 ms, total: 10.3 s
Wall time: 3.85 s
```

```
[18]: %%time
# source: https://www.thetelegram.com/opinion/local-perspectives/  
editorial-put-pedestrians-first-381333/
object_detection_api('./frame1700.jpg', threshold=0.8, rect_th=1, text_size=1,  
text_th=1)
```



```
CPU times: user 9.82 s, sys: 427 ms, total: 10.2 s
Wall time: 3.84 s
```

```
[19]: %%time
# source: https://www.thetelegram.com/opinion/local-perspectives/  
editorial-put-pedestrians-first-381333/
object_detection_api('./frame1900.jpg', threshold=0.8, rect_th=1, text_size=1,  
text_th=1)
```



CPU times: user 10.1 s, sys: 426 ms, total: 10.6 s
Wall time: 3.97 s