hcliang2_mp3_part2_output

April 3, 2024

[1]:
```
# you will be prompted with a window asking to grant permissions
from google.colab import drive
drive.mount("/content/drive/")
```

```
Mounted at /content/drive/
```

[2]:
```
# fill in the path in your Google Drive in the string below. Note: do not␣
 ↪escape slashes or spaces
import os
datadir = "/content/drive/MyDrive/CS444/assignment3_starter_sp24/
 ↪assignment3_part2/"
if not os.path.exists(datadir):
  !ln -s "/content/drive/My Drive/Your/Assignment3/path/" $datadir # TODO: Fill␣
 ↪your Assignment 3 path
os.chdir(datadir)
!pwd
```

```
/content/drive/MyDrive/CS444/assignment3_starter_sp24/assignment3_part2
```

[3]:
```
!sh download_data.sh
```

```
--2024-04-03 18:40:07--
http://host.robots.ox.ac.uk/pascal/VOC/voc2007/VOCtrainval_06-Nov-2007.tar
Resolving host.robots.ox.ac.uk (host.robots.ox.ac.uk)… 129.67.94.152
Connecting to host.robots.ox.ac.uk (host.robots.ox.ac.uk)|129.67.94.152|:80…
connected.
HTTP request sent, awaiting response… 200 OK
Length: 460032000 (439M) [application/x-tar]
Saving to: ‘VOCtrainval_06-Nov-2007.tar.2’

VOCtrainval_06-Nov- 100%[===================>] 438.72M  15.5MB/s    in 27s

2024-04-03 18:40:34 (16.4 MB/s) - ‘VOCtrainval_06-Nov-2007.tar.2’ saved
[460032000/460032000]

--2024-04-03 18:44:07--
http://host.robots.ox.ac.uk/pascal/VOC/voc2007/VOCtest_06-Nov-2007.tar
Resolving host.robots.ox.ac.uk (host.robots.ox.ac.uk)… 129.67.94.152
Connecting to host.robots.ox.ac.uk (host.robots.ox.ac.uk)|129.67.94.152|:80…
```

```
connected.
HTTP request sent, awaiting response… 200 OK
Length: 451020800 (430M) [application/x-tar]
Saving to: 'VOCtest_06-Nov-2007.tar'

VOCtest_06-Nov-2007 100%[===================>] 430.13M  19.5MB/s    in 25s

2024-04-03 18:44:32 (17.1 MB/s) - 'VOCtest_06-Nov-2007.tar' saved
[451020800/451020800]
```

[4]:
```
import os
import random

import cv2
import numpy as np

import torch
from torch.utils.data import DataLoader
from torchvision import models

from src.resnet_yolo import resnet50
from yolo_loss import YoloLoss
from src.dataset import VocDetectorDataset
from src.eval_voc import evaluate
from src.predict import predict_image
from src.config import VOC_CLASSES, COLORS
from kaggle_submission import output_submission_csv

import matplotlib.pyplot as plt
import collections

%matplotlib inline
%load_ext autoreload
%autoreload 2
```

0.1 Initialization

[5]:
```
device = torch.device("cuda:0" if torch.cuda.is_available() else "cpu")
```

[6]:
```
# YOLO network hyperparameters
B = 2  # number of bounding box predictions per cell
S = 14  # width/height of network output grid (larger than 7x7 from paper since␣
 ↪we use a different network)
```

To implement Yolo we will rely on a pretrained classifier as the backbone for our detection network. PyTorch offers a variety of models which are pretrained on ImageNet in the `torchvision.models` package. In particular, we will use the ResNet50 architecture as a base for our detector. This is

different from the base architecture in the Yolo paper and also results in a different output grid size (14x14 instead of 7x7).

Models are typically pretrained on ImageNet since the dataset is very large (> 1 million images) and widely used. The pretrained model provides a very useful weight initialization for our detector, so that the network is able to learn quickly and effectively.

[7]:
```
load_network_path = None #'checkpoints/best_detector.pth'
pretrained = True

# use to load a previously trained network
if load_network_path is not None:
    print('Loading saved network from {}'.format(load_network_path))
    net = resnet50().to(device)
    net.load_state_dict(torch.load(load_network_path))
else:
    print('Load pre-trained model')
    net = resnet50(pretrained=pretrained).to(device)
```

```
Load pre-trained model

/usr/local/lib/python3.10/dist-packages/torchvision/models/_utils.py:208:
UserWarning: The parameter 'pretrained' is deprecated since 0.13 and may be
removed in the future, please use 'weights' instead.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/torchvision/models/_utils.py:223:
UserWarning: Arguments other than a weight enum or `None` for 'weights' are
deprecated since 0.13 and may be removed in the future. The current behavior is
equivalent to passing `weights=ResNet50_Weights.IMAGENET1K_V1`. You can also use
`weights=ResNet50_Weights.DEFAULT` to get the most up-to-date weights.
  warnings.warn(msg)
Downloading: "https://download.pytorch.org/models/resnet50-0676ba61.pth" to
/root/.cache/torch/hub/checkpoints/resnet50-0676ba61.pth
100%|      | 97.8M/97.8M [00:00<00:00, 143MB/s]
```

[8]:
```
learning_rate = 0.001
num_epochs = 50
batch_size = 20

# Yolo loss component coefficients (as given in Yolo v1 paper)
lambda_coord = 5
lambda_noobj = 0.5
```

0.2 Reading Pascal Data

Since Pascal is a small dataset (5000 in train+val) we have combined the train and val splits to train our detector. This is not typically a good practice, but we will make an exception in this case to be able to get reasonable detection results with a comparatively small object detection dataset.

The train dataset loader also using a variety of data augmentation techniques including random

shift, scaling, crop, and flips. Data augmentation is slightly more complicated for detection datasets since the bounding box annotations must be kept consistent throughout the transformations.

Since the output of the detector network we train is an SxSx(B*5+C), we use an encoder to convert the original bounding box coordinates into relative grid bounding box coordinates corresponding to the expected output. We also use a decoder which allows us to convert the opposite direction into image coordinate bounding boxes.

[9]:
```
file_root_train = 'data/VOCdevkit_2007/VOC2007/JPEGImages/'
annotation_file_train = 'data/voc2007.txt'

train_dataset =␣
 ↪VocDetectorDataset(root_img_dir=file_root_train,dataset_file=annotation_file_train,train=Tr
 ↪S=S)
train_loader =␣
 ↪DataLoader(train_dataset,batch_size=batch_size,shuffle=True,num_workers=2)
print('Loaded %d train images' % len(train_dataset))
```

```
Initializing dataset
Loaded 5011 train images
```

[10]:
```
file_root_test = 'data/VOCdevkit_2007/VOC2007test/JPEGImages/'
annotation_file_test = 'data/voc2007test.txt'

test_dataset =␣
 ↪VocDetectorDataset(root_img_dir=file_root_test,dataset_file=annotation_file_test,train=Fals
 ↪S=S)
test_loader =␣
 ↪DataLoader(test_dataset,batch_size=batch_size,shuffle=False,num_workers=2)
print('Loaded %d test images' % len(test_dataset))
```

```
Initializing dataset
Loaded 4950 test images
```

[11]:
```
data = train_dataset[0]
```

0.3 Set up training tools

[12]:
```
criterion = YoloLoss(S, B, lambda_coord, lambda_noobj)
optimizer = torch.optim.SGD(net.parameters(), lr=learning_rate, momentum=0.9,␣
 ↪weight_decay=5e-4)
```

0.4 Train detector

[14]:
```
best_test_loss = np.inf
learning_rate = 1e-3
for epoch in range(num_epochs):
    net.train()
```

```
    # Update learning rate late in training
    if epoch == 30 or epoch == 40:
        learning_rate /= 10.0

    for param_group in optimizer.param_groups:
        param_group['lr'] = learning_rate

    print('\n\nStarting epoch %d / %d' % (epoch + 1, num_epochs))
    print('Learning Rate for this epoch: {}'.format(learning_rate))

    total_loss = collections.defaultdict(int)

    for i, data in enumerate(train_loader):
        data = (item.to(device) for item in data)
        images, target_boxes, target_cls, has_object_map = data
        pred = net(images)
        loss_dict = criterion(pred, target_boxes, target_cls, has_object_map)
        for key in loss_dict:
            total_loss[key] += loss_dict[key].item()

        optimizer.zero_grad()
        loss_dict['total_loss'].backward()
        optimizer.step()

        if (i+1) % 50 == 0:
            outstring = 'Epoch [%d/%d], Iter [%d/%d], Loss: ' % ((epoch+1,␣
↪num_epochs, i+1, len(train_loader)))
            outstring += ', '.join( "%s=%.3f" % (key[:-5], val / (i+1)) for␣
↪key, val in total_loss.items() )
            print(outstring)

    # evaluate the network on the test data
    if (epoch + 1) % 5 == 0:
        test_aps = evaluate(net, test_dataset_file=annotation_file_test,␣
↪img_root=file_root_test)
        print(epoch, test_aps)
    with torch.no_grad():
        test_loss = 0.0
        net.eval()
        for i, data in enumerate(test_loader):
            data = (item.to(device) for item in data)
            images, target_boxes, target_cls, has_object_map = data

            pred = net(images)
            loss_dict = criterion(pred, target_boxes, target_cls,␣
↪has_object_map)
            test_loss += loss_dict['total_loss'].item()
```

```
        test_loss /= len(test_loader)

    if best_test_loss > test_loss:
        best_test_loss = test_loss
        print('Updating best test loss: %.5f' % best_test_loss)
        torch.save(net.state_dict(),'checkpoints/best_detector.pth')

    if (epoch+1) in [5, 10, 20, 30, 40]:
        torch.save(net.state_dict(),'checkpoints/detector_epoch_%d.pth' %␣
↪(epoch+1))

    torch.save(net.state_dict(),'checkpoints/detector.pth')
```

```
Starting epoch 1 / 50
Learning Rate for this epoch: 0.001
Epoch [1/50], Iter [50/251], Loss: total=23.917, reg=0.749,
containing_obj=0.339, no_obj=25.045, cls=7.312
Epoch [1/50], Iter [100/251], Loss: total=15.912, reg=0.657,
containing_obj=0.444, no_obj=12.975, cls=5.693
Epoch [1/50], Iter [150/251], Loss: total=12.764, reg=0.593,
containing_obj=0.507, no_obj=8.860, cls=4.861
Epoch [1/50], Iter [200/251], Loss: total=11.040, reg=0.557,
containing_obj=0.551, no_obj=6.770, cls=4.319
Epoch [1/50], Iter [250/251], Loss: total=9.977, reg=0.536,
containing_obj=0.584, no_obj=5.499, cls=3.964
Updating best test loss: 5.36129


Starting epoch 2 / 50
Learning Rate for this epoch: 0.001
Epoch [2/50], Iter [50/251], Loss: total=5.055, reg=0.415, containing_obj=0.723,
no_obj=0.356, cls=2.081
Epoch [2/50], Iter [100/251], Loss: total=4.932, reg=0.407,
containing_obj=0.731, no_obj=0.335, cls=1.996
Epoch [2/50], Iter [150/251], Loss: total=4.944, reg=0.405,
containing_obj=0.760, no_obj=0.317, cls=2.001
Epoch [2/50], Iter [200/251], Loss: total=4.933, reg=0.405,
containing_obj=0.773, no_obj=0.302, cls=1.984
Epoch [2/50], Iter [250/251], Loss: total=4.865, reg=0.402,
containing_obj=0.778, no_obj=0.289, cls=1.932
Updating best test loss: 4.67364


Starting epoch 3 / 50
Learning Rate for this epoch: 0.001
Epoch [3/50], Iter [50/251], Loss: total=4.617, reg=0.383, containing_obj=0.849,
```

```
no_obj=0.220, cls=1.743
Epoch [3/50], Iter [100/251], Loss: total=4.511, reg=0.381,
containing_obj=0.851, no_obj=0.214, cls=1.649
Epoch [3/50], Iter [150/251], Loss: total=4.422, reg=0.378,
containing_obj=0.846, no_obj=0.208, cls=1.583
Epoch [3/50], Iter [200/251], Loss: total=4.382, reg=0.375,
containing_obj=0.844, no_obj=0.203, cls=1.563
Epoch [3/50], Iter [250/251], Loss: total=4.330, reg=0.371,
containing_obj=0.840, no_obj=0.198, cls=1.535
Updating best test loss: 4.27295


Starting epoch 4 / 50
Learning Rate for this epoch: 0.001
Epoch [4/50], Iter [50/251], Loss: total=4.120, reg=0.368, containing_obj=0.874,
no_obj=0.174, cls=1.317
Epoch [4/50], Iter [100/251], Loss: total=4.012, reg=0.358,
containing_obj=0.848, no_obj=0.173, cls=1.290
Epoch [4/50], Iter [150/251], Loss: total=4.068, reg=0.364,
containing_obj=0.858, no_obj=0.172, cls=1.301
Epoch [4/50], Iter [200/251], Loss: total=4.039, reg=0.360,
containing_obj=0.859, no_obj=0.171, cls=1.294
Epoch [4/50], Iter [250/251], Loss: total=4.004, reg=0.358,
containing_obj=0.855, no_obj=0.173, cls=1.273
Updating best test loss: 3.92597


Starting epoch 5 / 50
Learning Rate for this epoch: 0.001
Epoch [5/50], Iter [50/251], Loss: total=3.705, reg=0.344, containing_obj=0.816,
no_obj=0.187, cls=1.075
Epoch [5/50], Iter [100/251], Loss: total=3.819, reg=0.354,
containing_obj=0.844, no_obj=0.190, cls=1.112
Epoch [5/50], Iter [150/251], Loss: total=3.781, reg=0.353,
containing_obj=0.826, no_obj=0.195, cls=1.093
Epoch [5/50], Iter [200/251], Loss: total=3.744, reg=0.350,
containing_obj=0.818, no_obj=0.201, cls=1.073
Epoch [5/50], Iter [250/251], Loss: total=3.735, reg=0.351,
containing_obj=0.818, no_obj=0.207, cls=1.059
---Evaluate model on test samples---

100%|     | 4950/4950 [03:00<00:00, 27.47it/s]

---class aeroplane ap 0.10687337924320241---
---class bicycle ap 0.09698684022398726---
---class bird ap 0.0795545697260614---
---class boat ap 0.039588906784010475---
---class bottle ap 0.013826939394020183---
---class bus ap 0.0--- (no predictions for this class)
```

```
---class car ap 0.23905448245224026---
---class cat ap 0.05798397065433763---
---class chair ap 0.023963521763087504---
---class cow ap 0.046350007005744716---
---class diningtable ap 0.0--- (no predictions for this class)
---class dog ap 0.06979810279457307---
---class horse ap 0.35253757726006707---
---class motorbike ap 0.02366863905325444---
---class person ap 0.12785224784808702---
---class pottedplant ap 0.011454820016215119---
---class sheep ap 0.03719490816245503---
---class sofa ap 0.0--- (no predictions for this class)
---class train ap 0.010638297872340425---
---class tvmonitor ap 0.20944559535585716---
---map 0.07733864028047707---
4 [0.10687337924320241, 0.09698684022398726, 0.0795545697260614,
0.039588906784010475, 0.013826939394020183, 0.0, 0.23905448245224026,
0.05798397065433763, 0.023963521763087504, 0.046350007005744716, 0.0,
0.06979810279457307, 0.35253757726006707, 0.02366863905325444,
0.12785224784808702, 0.011454820016215119, 0.03719490816245503, 0.0,
0.010638297872340425, 0.20944559535585716]
Updating best test loss: 3.77127


Starting epoch 6 / 50
Learning Rate for this epoch: 0.001
Epoch [6/50], Iter [50/251], Loss: total=3.533, reg=0.339, containing_obj=0.792,
no_obj=0.238, cls=0.929
Epoch [6/50], Iter [100/251], Loss: total=3.538, reg=0.339,
containing_obj=0.792, no_obj=0.243, cls=0.931
Epoch [6/50], Iter [150/251], Loss: total=3.501, reg=0.334,
containing_obj=0.789, no_obj=0.243, cls=0.922
Epoch [6/50], Iter [200/251], Loss: total=3.523, reg=0.336,
containing_obj=0.795, no_obj=0.243, cls=0.925
Epoch [6/50], Iter [250/251], Loss: total=3.500, reg=0.333,
containing_obj=0.794, no_obj=0.243, cls=0.920
Updating best test loss: 3.55536


Starting epoch 7 / 50
Learning Rate for this epoch: 0.001
Epoch [7/50], Iter [50/251], Loss: total=3.309, reg=0.321, containing_obj=0.776,
no_obj=0.249, cls=0.804
Epoch [7/50], Iter [100/251], Loss: total=3.364, reg=0.327,
containing_obj=0.796, no_obj=0.249, cls=0.809
Epoch [7/50], Iter [150/251], Loss: total=3.334, reg=0.323,
containing_obj=0.791, no_obj=0.249, cls=0.804
Epoch [7/50], Iter [200/251], Loss: total=3.329, reg=0.323,
```

```
containing_obj=0.789, no_obj=0.250, cls=0.801
Epoch [7/50], Iter [250/251], Loss: total=3.310, reg=0.320,
containing_obj=0.785, no_obj=0.250, cls=0.800
Updating best test loss: 3.43935


Starting epoch 8 / 50
Learning Rate for this epoch: 0.001
Epoch [8/50], Iter [50/251], Loss: total=3.259, reg=0.323, containing_obj=0.776,
no_obj=0.262, cls=0.737
Epoch [8/50], Iter [100/251], Loss: total=3.168, reg=0.312,
containing_obj=0.772, no_obj=0.259, cls=0.706
Epoch [8/50], Iter [150/251], Loss: total=3.190, reg=0.312,
containing_obj=0.767, no_obj=0.260, cls=0.732
Epoch [8/50], Iter [200/251], Loss: total=3.194, reg=0.313,
containing_obj=0.769, no_obj=0.262, cls=0.729
Epoch [8/50], Iter [250/251], Loss: total=3.219, reg=0.317,
containing_obj=0.777, no_obj=0.260, cls=0.728
Updating best test loss: 3.34235


Starting epoch 9 / 50
Learning Rate for this epoch: 0.001
Epoch [9/50], Iter [50/251], Loss: total=3.046, reg=0.304, containing_obj=0.777,
no_obj=0.254, cls=0.621
Epoch [9/50], Iter [100/251], Loss: total=3.076, reg=0.303,
containing_obj=0.786, no_obj=0.257, cls=0.648
Epoch [9/50], Iter [150/251], Loss: total=3.096, reg=0.304,
containing_obj=0.783, no_obj=0.258, cls=0.661
Epoch [9/50], Iter [200/251], Loss: total=3.098, reg=0.303,
containing_obj=0.784, no_obj=0.260, cls=0.671
Epoch [9/50], Iter [250/251], Loss: total=3.077, reg=0.302,
containing_obj=0.776, no_obj=0.261, cls=0.658
Updating best test loss: 3.23435


Starting epoch 10 / 50
Learning Rate for this epoch: 0.001
Epoch [10/50], Iter [50/251], Loss: total=2.960, reg=0.291,
containing_obj=0.764, no_obj=0.263, cls=0.611
Epoch [10/50], Iter [100/251], Loss: total=2.953, reg=0.292,
containing_obj=0.768, no_obj=0.260, cls=0.595
Epoch [10/50], Iter [150/251], Loss: total=2.991, reg=0.297,
containing_obj=0.774, no_obj=0.261, cls=0.599
Epoch [10/50], Iter [200/251], Loss: total=2.946, reg=0.291,
containing_obj=0.766, no_obj=0.266, cls=0.590
Epoch [10/50], Iter [250/251], Loss: total=2.944, reg=0.291,
containing_obj=0.770, no_obj=0.264, cls=0.586
```

```
---Evaluate model on test samples---
100%|     | 4950/4950 [03:09<00:00, 26.15it/s]
---class aeroplane ap 0.32730411055874054---
---class bicycle ap 0.4362020907123775---
---class bird ap 0.3143910209991354---
---class boat ap 0.15689923235228517---
---class bottle ap 0.06639401215358469---
---class bus ap 0.28975689906312097---
---class car ap 0.48129725917847826---
---class cat ap 0.3196203134827377---
---class chair ap 0.17867913894109794---
---class cow ap 0.22121229806597756---
---class diningtable ap 0.0048543689320388345---
---class dog ap 0.2617735769951993---
---class horse ap 0.5250894944212665---
---class motorbike ap 0.32169853037671364---
---class person ap 0.3317907654899359---
---class pottedplant ap 0.05007605677899179---
---class sheep ap 0.2626657779777885---
---class sofa ap 0.19737443102441277---
---class train ap 0.37534565838616507---
---class tvmonitor ap 0.3375480470920823---
---map 0.2729986541491065---
9 [0.32730411055874054, 0.4362020907123775, 0.3143910209991354,
0.15689923235228517, 0.06639401215358469, 0.28975689906312097,
0.48129725917847826, 0.3196203134827377, 0.17867913894109794,
0.22121229806597756, 0.0048543689320388345, 0.2617735769951993,
0.5250894944212665, 0.32169853037671364, 0.3317907654899359,
0.05007605677899179, 0.2626657779777885, 0.19737443102441277,
0.37534565838616507, 0.3375480470920823]
Updating best test loss: 3.19895


Starting epoch 11 / 50
Learning Rate for this epoch: 0.001
Epoch [11/50], Iter [50/251], Loss: total=2.935, reg=0.288,
containing_obj=0.776, no_obj=0.272, cls=0.585
Epoch [11/50], Iter [100/251], Loss: total=2.877, reg=0.285,
containing_obj=0.765, no_obj=0.271, cls=0.554
Epoch [11/50], Iter [150/251], Loss: total=2.871, reg=0.285,
containing_obj=0.762, no_obj=0.270, cls=0.549
Epoch [11/50], Iter [200/251], Loss: total=2.882, reg=0.285,
containing_obj=0.765, no_obj=0.270, cls=0.559
Epoch [11/50], Iter [250/251], Loss: total=2.877, reg=0.285,
containing_obj=0.765, no_obj=0.271, cls=0.549
Updating best test loss: 3.11616
```

```
Starting epoch 12 / 50
Learning Rate for this epoch: 0.001
Epoch [12/50], Iter [50/251], Loss: total=2.941, reg=0.295,
containing_obj=0.764, no_obj=0.285, cls=0.561
Epoch [12/50], Iter [100/251], Loss: total=2.858, reg=0.285,
containing_obj=0.755, no_obj=0.280, cls=0.536
Epoch [12/50], Iter [150/251], Loss: total=2.837, reg=0.282,
containing_obj=0.767, no_obj=0.278, cls=0.521
Epoch [12/50], Iter [200/251], Loss: total=2.812, reg=0.279,
containing_obj=0.768, no_obj=0.279, cls=0.511
Epoch [12/50], Iter [250/251], Loss: total=2.807, reg=0.280,
containing_obj=0.765, no_obj=0.279, cls=0.505


Starting epoch 13 / 50
Learning Rate for this epoch: 0.001
Epoch [13/50], Iter [50/251], Loss: total=2.768, reg=0.275,
containing_obj=0.768, no_obj=0.273, cls=0.489
Epoch [13/50], Iter [100/251], Loss: total=2.725, reg=0.269,
containing_obj=0.751, no_obj=0.280, cls=0.489
Epoch [13/50], Iter [150/251], Loss: total=2.697, reg=0.266,
containing_obj=0.755, no_obj=0.286, cls=0.471
Epoch [13/50], Iter [200/251], Loss: total=2.730, reg=0.270,
containing_obj=0.755, no_obj=0.286, cls=0.481
Epoch [13/50], Iter [250/251], Loss: total=2.740, reg=0.271,
containing_obj=0.755, no_obj=0.286, cls=0.488
Updating best test loss: 3.05215


Starting epoch 14 / 50
Learning Rate for this epoch: 0.001
Epoch [14/50], Iter [50/251], Loss: total=2.685, reg=0.270,
containing_obj=0.758, no_obj=0.284, cls=0.436
Epoch [14/50], Iter [100/251], Loss: total=2.631, reg=0.261,
containing_obj=0.747, no_obj=0.293, cls=0.433
Epoch [14/50], Iter [150/251], Loss: total=2.689, reg=0.267,
containing_obj=0.757, no_obj=0.296, cls=0.448
Epoch [14/50], Iter [200/251], Loss: total=2.677, reg=0.266,
containing_obj=0.744, no_obj=0.302, cls=0.451
Epoch [14/50], Iter [250/251], Loss: total=2.668, reg=0.266,
containing_obj=0.739, no_obj=0.307, cls=0.447
Updating best test loss: 3.03400


Starting epoch 15 / 50
Learning Rate for this epoch: 0.001
Epoch [15/50], Iter [50/251], Loss: total=2.663, reg=0.272,
```

```
containing_obj=0.743, no_obj=0.324, cls=0.401
Epoch [15/50], Iter [100/251], Loss: total=2.687, reg=0.273,
containing_obj=0.738, no_obj=0.332, cls=0.420
Epoch [15/50], Iter [150/251], Loss: total=2.631, reg=0.265,
containing_obj=0.721, no_obj=0.333, cls=0.416
Epoch [15/50], Iter [200/251], Loss: total=2.608, reg=0.260,
containing_obj=0.719, no_obj=0.333, cls=0.422
Epoch [15/50], Iter [250/251], Loss: total=2.593, reg=0.257,
containing_obj=0.723, no_obj=0.332, cls=0.421
---Evaluate model on test samples---

100%|     | 4950/4950 [03:11<00:00, 25.84it/s]

---class aeroplane ap 0.43264722149318685---
---class bicycle ap 0.4435634521170906---
---class bird ap 0.31736171663924984---
---class boat ap 0.17489445911937257---
---class bottle ap 0.0872472231475937---
---class bus ap 0.4738151833661055---
---class car ap 0.5102269956204414---
---class cat ap 0.42516553015155584---
---class chair ap 0.21829152233492863---
---class cow ap 0.30140926681120994---
---class diningtable ap 0.16973950328126647---
---class dog ap 0.3893103635579627---
---class horse ap 0.6016545402940562---
---class motorbike ap 0.3788156160300673---
---class person ap 0.4381958519453164---
---class pottedplant ap 0.12952314500399784---
---class sheep ap 0.19013857601446038---
---class sofa ap 0.2907566222272043---
---class train ap 0.609437851543539---
---class tvmonitor ap 0.31944026722654695---
---map 0.3450817453962576---
14 [0.43264722149318685, 0.4435634521170906, 0.31736171663924984,
0.17489445911937257, 0.0872472231475937, 0.4738151833661055, 0.5102269956204414,
0.42516553015155584, 0.21829152233492863, 0.30140926681120994,
0.16973950328126647, 0.3893103635579627, 0.6016545402940562, 0.3788156160300673,
0.4381958519453164, 0.12952314500399784, 0.19013857601446038,
0.2907566222272043, 0.609437851543539, 0.31944026722654695]
Updating best test loss: 2.97778


Starting epoch 16 / 50
Learning Rate for this epoch: 0.001
Epoch [16/50], Iter [50/251], Loss: total=2.625, reg=0.261,
containing_obj=0.725, no_obj=0.346, cls=0.423
Epoch [16/50], Iter [100/251], Loss: total=2.662, reg=0.266,
containing_obj=0.723, no_obj=0.349, cls=0.433
```

```
Epoch [16/50], Iter [150/251], Loss: total=2.608, reg=0.260,
containing_obj=0.712, no_obj=0.354, cls=0.416
Epoch [16/50], Iter [200/251], Loss: total=2.559, reg=0.255,
containing_obj=0.703, no_obj=0.354, cls=0.406
Epoch [16/50], Iter [250/251], Loss: total=2.552, reg=0.254,
containing_obj=0.699, no_obj=0.351, cls=0.406
Updating best test loss: 2.94916


Starting epoch 17 / 50
Learning Rate for this epoch: 0.001
Epoch [17/50], Iter [50/251], Loss: total=2.476, reg=0.249,
containing_obj=0.697, no_obj=0.343, cls=0.362
Epoch [17/50], Iter [100/251], Loss: total=2.445, reg=0.242,
containing_obj=0.689, no_obj=0.351, cls=0.371
Epoch [17/50], Iter [150/251], Loss: total=2.478, reg=0.243,
containing_obj=0.698, no_obj=0.352, cls=0.387
Epoch [17/50], Iter [200/251], Loss: total=2.471, reg=0.244,
containing_obj=0.693, no_obj=0.353, cls=0.379
Epoch [17/50], Iter [250/251], Loss: total=2.483, reg=0.246,
containing_obj=0.696, no_obj=0.352, cls=0.380
Updating best test loss: 2.90950


Starting epoch 18 / 50
Learning Rate for this epoch: 0.001
Epoch [18/50], Iter [50/251], Loss: total=2.506, reg=0.246,
containing_obj=0.720, no_obj=0.343, cls=0.383
Epoch [18/50], Iter [100/251], Loss: total=2.508, reg=0.248,
containing_obj=0.708, no_obj=0.355, cls=0.383
Epoch [18/50], Iter [150/251], Loss: total=2.470, reg=0.245,
containing_obj=0.699, no_obj=0.359, cls=0.366
Epoch [18/50], Iter [200/251], Loss: total=2.467, reg=0.246,
containing_obj=0.691, no_obj=0.360, cls=0.367
Epoch [18/50], Iter [250/251], Loss: total=2.448, reg=0.245,
containing_obj=0.685, no_obj=0.359, cls=0.359
Updating best test loss: 2.88094


Starting epoch 19 / 50
Learning Rate for this epoch: 0.001
Epoch [19/50], Iter [50/251], Loss: total=2.359, reg=0.237,
containing_obj=0.652, no_obj=0.360, cls=0.342
Epoch [19/50], Iter [100/251], Loss: total=2.379, reg=0.238,
containing_obj=0.668, no_obj=0.360, cls=0.342
Epoch [19/50], Iter [150/251], Loss: total=2.389, reg=0.236,
containing_obj=0.671, no_obj=0.362, cls=0.356
Epoch [19/50], Iter [200/251], Loss: total=2.372, reg=0.234,
```

```
containing_obj=0.670, no_obj=0.361, cls=0.351
Epoch [19/50], Iter [250/251], Loss: total=2.385, reg=0.235,
containing_obj=0.676, no_obj=0.362, cls=0.351


Starting epoch 20 / 50
Learning Rate for this epoch: 0.001
Epoch [20/50], Iter [50/251], Loss: total=2.261, reg=0.221,
containing_obj=0.664, no_obj=0.362, cls=0.311
Epoch [20/50], Iter [100/251], Loss: total=2.346, reg=0.235,
containing_obj=0.665, no_obj=0.361, cls=0.325
Epoch [20/50], Iter [150/251], Loss: total=2.322, reg=0.233,
containing_obj=0.653, no_obj=0.366, cls=0.322
Epoch [20/50], Iter [200/251], Loss: total=2.342, reg=0.233,
containing_obj=0.667, no_obj=0.364, cls=0.328
Epoch [20/50], Iter [250/251], Loss: total=2.343, reg=0.233,
containing_obj=0.669, no_obj=0.363, cls=0.330
---Evaluate model on test samples---

100%|     | 4950/4950 [03:11<00:00, 25.84it/s]

---class aeroplane ap 0.4874801993817604---
---class bicycle ap 0.47125081234235766---
---class bird ap 0.40285118377947066---
---class boat ap 0.24063619149365362---
---class bottle ap 0.0876267944669314---
---class bus ap 0.5663564211191601---
---class car ap 0.5698571379623056---
---class cat ap 0.5329558142126392---
---class chair ap 0.23516430904425192---
---class cow ap 0.3573435470568559---
---class diningtable ap 0.24137306866139727---
---class dog ap 0.4829713724261533---
---class horse ap 0.5076751351384173---
---class motorbike ap 0.35536851632229205---
---class person ap 0.4170429687033427---
---class pottedplant ap 0.15479881463628462---
---class sheep ap 0.3268036188644365---
---class sofa ap 0.41284042969903156---
---class train ap 0.6520130316367881---
---class tvmonitor ap 0.32722082080167547---
---map 0.3914815093874603---
19 [0.4874801993817604, 0.47125081234235766, 0.40285118377947066,
0.24063619149365362, 0.0876267944669314, 0.5663564211191601, 0.5698571379623056,
0.5329558142126392, 0.23516430904425192, 0.3573435470568559,
0.24137306866139727, 0.4829713724261533, 0.5076751351384173,
0.35536851632229205, 0.4170429687033427, 0.15479881463628462,
0.3268036188644365, 0.41284042969903156, 0.6520130316367881,
0.32722082080167547]
```

```
Updating best test loss: 2.88070


Starting epoch 21 / 50
Learning Rate for this epoch: 0.001
Epoch [21/50], Iter [50/251], Loss: total=2.235, reg=0.219,
containing_obj=0.670, no_obj=0.365, cls=0.288
Epoch [21/50], Iter [100/251], Loss: total=2.298, reg=0.230,
containing_obj=0.668, no_obj=0.371, cls=0.294
Epoch [21/50], Iter [150/251], Loss: total=2.300, reg=0.231,
containing_obj=0.668, no_obj=0.371, cls=0.291
Epoch [21/50], Iter [200/251], Loss: total=2.308, reg=0.230,
containing_obj=0.668, no_obj=0.372, cls=0.302
Epoch [21/50], Iter [250/251], Loss: total=2.297, reg=0.230,
containing_obj=0.662, no_obj=0.371, cls=0.301
Updating best test loss: 2.82489


Starting epoch 22 / 50
Learning Rate for this epoch: 0.001
Epoch [22/50], Iter [50/251], Loss: total=2.183, reg=0.211,
containing_obj=0.648, no_obj=0.370, cls=0.296
Epoch [22/50], Iter [100/251], Loss: total=2.217, reg=0.217,
containing_obj=0.650, no_obj=0.366, cls=0.297
Epoch [22/50], Iter [150/251], Loss: total=2.222, reg=0.217,
containing_obj=0.648, no_obj=0.366, cls=0.306
Epoch [22/50], Iter [200/251], Loss: total=2.224, reg=0.218,
containing_obj=0.649, no_obj=0.367, cls=0.303
Epoch [22/50], Iter [250/251], Loss: total=2.258, reg=0.222,
containing_obj=0.657, no_obj=0.372, cls=0.304


Starting epoch 23 / 50
Learning Rate for this epoch: 0.001
Epoch [23/50], Iter [50/251], Loss: total=2.203, reg=0.215,
containing_obj=0.667, no_obj=0.389, cls=0.267
Epoch [23/50], Iter [100/251], Loss: total=2.158, reg=0.211,
containing_obj=0.643, no_obj=0.378, cls=0.273
Epoch [23/50], Iter [150/251], Loss: total=2.188, reg=0.214,
containing_obj=0.646, no_obj=0.374, cls=0.285
Epoch [23/50], Iter [200/251], Loss: total=2.219, reg=0.220,
containing_obj=0.653, no_obj=0.371, cls=0.282
Epoch [23/50], Iter [250/251], Loss: total=2.218, reg=0.219,
containing_obj=0.654, no_obj=0.373, cls=0.284
Updating best test loss: 2.79835


Starting epoch 24 / 50
```

```
Learning Rate for this epoch: 0.001
Epoch [24/50], Iter [50/251], Loss: total=2.163, reg=0.216,
containing_obj=0.634, no_obj=0.388, cls=0.257
Epoch [24/50], Iter [100/251], Loss: total=2.180, reg=0.217,
containing_obj=0.637, no_obj=0.385, cls=0.263
Epoch [24/50], Iter [150/251], Loss: total=2.168, reg=0.216,
containing_obj=0.637, no_obj=0.376, cls=0.265
Epoch [24/50], Iter [200/251], Loss: total=2.191, reg=0.218,
containing_obj=0.642, no_obj=0.380, cls=0.268
Epoch [24/50], Iter [250/251], Loss: total=2.203, reg=0.220,
containing_obj=0.642, no_obj=0.382, cls=0.271
Updating best test loss: 2.78650


Starting epoch 25 / 50
Learning Rate for this epoch: 0.001
Epoch [25/50], Iter [50/251], Loss: total=2.057, reg=0.206,
containing_obj=0.608, no_obj=0.356, cls=0.243
Epoch [25/50], Iter [100/251], Loss: total=2.115, reg=0.210,
containing_obj=0.630, no_obj=0.370, cls=0.251
Epoch [25/50], Iter [150/251], Loss: total=2.115, reg=0.209,
containing_obj=0.627, no_obj=0.375, cls=0.253
Epoch [25/50], Iter [200/251], Loss: total=2.128, reg=0.210,
containing_obj=0.633, no_obj=0.376, cls=0.256
Epoch [25/50], Iter [250/251], Loss: total=2.142, reg=0.212,
containing_obj=0.637, no_obj=0.379, cls=0.257
---Evaluate model on test samples---

100%|     | 4950/4950 [03:13<00:00, 25.62it/s]

---class aeroplane ap 0.4778005668749642---
---class bicycle ap 0.5462121591221515---
---class bird ap 0.3796650973941227---
---class boat ap 0.1828716521871214---
---class bottle ap 0.16111545256548254---
---class bus ap 0.5815020581802111---
---class car ap 0.6443377915289145---
---class cat ap 0.7302904601287944---
---class chair ap 0.26782572924290515---
---class cow ap 0.41666400469055953---
---class diningtable ap 0.33670076392630843---
---class dog ap 0.5313763690956357---
---class horse ap 0.5539087094437158---
---class motorbike ap 0.5027568664730542---
---class person ap 0.5073396471321974---
---class pottedplant ap 0.1739769992332411---
---class sheep ap 0.3866453519926413---
---class sofa ap 0.3953538125756791---
---class train ap 0.6394709020677616---
```

```
---class tvmonitor ap 0.4404654211396404---
---map 0.4428139907497551---
24 [0.4778005668749642, 0.5462121591221515, 0.3796650973941227,
0.1828716521871214, 0.16111545256548254, 0.5815020581802111, 0.6443377915289145,
0.7302904601287944, 0.26782572924290515, 0.41666400469055953,
0.33670076392630843, 0.5313763690956357, 0.5539087094437158, 0.5027568664730542,
0.5073396471321974, 0.1739769992332411, 0.3866453519926413, 0.3953538125756791,
0.6394709020677616, 0.4404654211396404]
Updating best test loss: 2.77970


Starting epoch 26 / 50
Learning Rate for this epoch: 0.001
Epoch [26/50], Iter [50/251], Loss: total=2.080, reg=0.208,
containing_obj=0.608, no_obj=0.386, cls=0.237
Epoch [26/50], Iter [100/251], Loss: total=2.106, reg=0.210,
containing_obj=0.619, no_obj=0.379, cls=0.245
Epoch [26/50], Iter [150/251], Loss: total=2.131, reg=0.211,
containing_obj=0.634, no_obj=0.381, cls=0.253
Epoch [26/50], Iter [200/251], Loss: total=2.125, reg=0.210,
containing_obj=0.633, no_obj=0.384, cls=0.251
Epoch [26/50], Iter [250/251], Loss: total=2.136, reg=0.212,
containing_obj=0.634, no_obj=0.383, cls=0.253
Updating best test loss: 2.74088


Starting epoch 27 / 50
Learning Rate for this epoch: 0.001
Epoch [27/50], Iter [50/251], Loss: total=2.031, reg=0.198,
containing_obj=0.610, no_obj=0.374, cls=0.243
Epoch [27/50], Iter [100/251], Loss: total=2.060, reg=0.202,
containing_obj=0.620, no_obj=0.384, cls=0.240
Epoch [27/50], Iter [150/251], Loss: total=2.090, reg=0.204,
containing_obj=0.626, no_obj=0.387, cls=0.251
Epoch [27/50], Iter [200/251], Loss: total=2.073, reg=0.202,
containing_obj=0.624, no_obj=0.385, cls=0.247
Epoch [27/50], Iter [250/251], Loss: total=2.078, reg=0.203,
containing_obj=0.623, no_obj=0.387, cls=0.244


Starting epoch 28 / 50
Learning Rate for this epoch: 0.001
Epoch [28/50], Iter [50/251], Loss: total=2.069, reg=0.202,
containing_obj=0.624, no_obj=0.382, cls=0.246
Epoch [28/50], Iter [100/251], Loss: total=2.053, reg=0.201,
containing_obj=0.609, no_obj=0.386, cls=0.247
Epoch [28/50], Iter [150/251], Loss: total=2.064, reg=0.204,
containing_obj=0.613, no_obj=0.379, cls=0.239
```

```
Epoch [28/50], Iter [200/251], Loss: total=2.063, reg=0.205,
containing_obj=0.615, no_obj=0.381, cls=0.234
Epoch [28/50], Iter [250/251], Loss: total=2.082, reg=0.207,
containing_obj=0.619, no_obj=0.385, cls=0.237


Starting epoch 29 / 50
Learning Rate for this epoch: 0.001
Epoch [29/50], Iter [50/251], Loss: total=2.047, reg=0.201,
containing_obj=0.608, no_obj=0.389, cls=0.240
Epoch [29/50], Iter [100/251], Loss: total=2.039, reg=0.198,
containing_obj=0.629, no_obj=0.381, cls=0.230
Epoch [29/50], Iter [150/251], Loss: total=2.040, reg=0.199,
containing_obj=0.620, no_obj=0.389, cls=0.232
Epoch [29/50], Iter [200/251], Loss: total=2.056, reg=0.202,
containing_obj=0.618, no_obj=0.390, cls=0.233
Epoch [29/50], Iter [250/251], Loss: total=2.046, reg=0.201,
containing_obj=0.615, no_obj=0.392, cls=0.230
Updating best test loss: 2.73290


Starting epoch 30 / 50
Learning Rate for this epoch: 0.001
Epoch [30/50], Iter [50/251], Loss: total=1.921, reg=0.189,
containing_obj=0.585, no_obj=0.392, cls=0.194
Epoch [30/50], Iter [100/251], Loss: total=1.970, reg=0.193,
containing_obj=0.599, no_obj=0.381, cls=0.216
Epoch [30/50], Iter [150/251], Loss: total=1.984, reg=0.195,
containing_obj=0.605, no_obj=0.381, cls=0.214
Epoch [30/50], Iter [200/251], Loss: total=1.993, reg=0.195,
containing_obj=0.605, no_obj=0.387, cls=0.218
Epoch [30/50], Iter [250/251], Loss: total=2.008, reg=0.196,
containing_obj=0.615, no_obj=0.384, cls=0.219
---Evaluate model on test samples---

100%|      | 4950/4950 [03:16<00:00, 25.20it/s]

---class aeroplane ap 0.4531619805526001---
---class bicycle ap 0.4847311946799633---
---class bird ap 0.40909963485496614---
---class boat ap 0.278149987488552---
---class bottle ap 0.18927931740116916---
---class bus ap 0.5676682092846236---
---class car ap 0.626929212924448---
---class cat ap 0.6272487560618513---
---class chair ap 0.29005415372398824---
---class cow ap 0.48116467140958297---
---class diningtable ap 0.2748728337690833---
---class dog ap 0.5604941528060935---
```

```
---class horse ap 0.6388844213668845---
---class motorbike ap 0.4896229364819871---
---class person ap 0.4984612540226282---
---class pottedplant ap 0.1910112860248377---
---class sheep ap 0.4361899542411045---
---class sofa ap 0.4294890426280597---
---class train ap 0.6217055081544979---
---class tvmonitor ap 0.4298052761638571---
---map 0.448901189202039---
29 [0.4531619805526001, 0.4847311946799633, 0.40909963485496614,
0.278149987488552, 0.18927931740116916, 0.5676682092846236, 0.626929212924448,
0.6272487560618513, 0.29005415372398824, 0.48116467140958297,
0.2748728337690833, 0.5604941528060935, 0.6388844213668845, 0.4896229364819871,
0.4984612540226282, 0.1910112860248377, 0.4361899542411045, 0.4294890426280597,
0.6217055081544979, 0.4298052761638571]


Starting epoch 31 / 50
Learning Rate for this epoch: 0.0001
Epoch [31/50], Iter [50/251], Loss: total=1.967, reg=0.187,
containing_obj=0.611, no_obj=0.393, cls=0.227
Epoch [31/50], Iter [100/251], Loss: total=1.948, reg=0.188,
containing_obj=0.596, no_obj=0.398, cls=0.212
Epoch [31/50], Iter [150/251], Loss: total=1.933, reg=0.188,
containing_obj=0.592, no_obj=0.397, cls=0.203
Epoch [31/50], Iter [200/251], Loss: total=1.935, reg=0.187,
containing_obj=0.592, no_obj=0.396, cls=0.207
Epoch [31/50], Iter [250/251], Loss: total=1.923, reg=0.187,
containing_obj=0.589, no_obj=0.394, cls=0.203
Updating best test loss: 2.66836


Starting epoch 32 / 50
Learning Rate for this epoch: 0.0001
Epoch [32/50], Iter [50/251], Loss: total=1.781, reg=0.169,
containing_obj=0.561, no_obj=0.397, cls=0.177
Epoch [32/50], Iter [100/251], Loss: total=1.834, reg=0.176,
containing_obj=0.576, no_obj=0.396, cls=0.181
Epoch [32/50], Iter [150/251], Loss: total=1.851, reg=0.178,
containing_obj=0.579, no_obj=0.396, cls=0.182
Epoch [32/50], Iter [200/251], Loss: total=1.866, reg=0.180,
containing_obj=0.583, no_obj=0.397, cls=0.186
Epoch [32/50], Iter [250/251], Loss: total=1.863, reg=0.180,
containing_obj=0.582, no_obj=0.396, cls=0.184
Updating best test loss: 2.66583


Starting epoch 33 / 50
```

```
Learning Rate for this epoch: 0.0001
Epoch [33/50], Iter [50/251], Loss: total=1.922, reg=0.187,
containing_obj=0.599, no_obj=0.390, cls=0.191
Epoch [33/50], Iter [100/251], Loss: total=1.877, reg=0.182,
containing_obj=0.576, no_obj=0.405, cls=0.186
Epoch [33/50], Iter [150/251], Loss: total=1.863, reg=0.182,
containing_obj=0.573, no_obj=0.405, cls=0.179
Epoch [33/50], Iter [200/251], Loss: total=1.859, reg=0.180,
containing_obj=0.579, no_obj=0.404, cls=0.178
Epoch [33/50], Iter [250/251], Loss: total=1.853, reg=0.179,
containing_obj=0.578, no_obj=0.405, cls=0.180
Updating best test loss: 2.64256


Starting epoch 34 / 50
Learning Rate for this epoch: 0.0001
Epoch [34/50], Iter [50/251], Loss: total=1.833, reg=0.177,
containing_obj=0.566, no_obj=0.405, cls=0.179
Epoch [34/50], Iter [100/251], Loss: total=1.805, reg=0.173,
containing_obj=0.568, no_obj=0.408, cls=0.168
Epoch [34/50], Iter [150/251], Loss: total=1.789, reg=0.171,
containing_obj=0.564, no_obj=0.409, cls=0.163
Epoch [34/50], Iter [200/251], Loss: total=1.823, reg=0.176,
containing_obj=0.574, no_obj=0.405, cls=0.166
Epoch [34/50], Iter [250/251], Loss: total=1.823, reg=0.175,
containing_obj=0.574, no_obj=0.406, cls=0.172
Updating best test loss: 2.64046


Starting epoch 35 / 50
Learning Rate for this epoch: 0.0001
Epoch [35/50], Iter [50/251], Loss: total=1.774, reg=0.175,
containing_obj=0.534, no_obj=0.402, cls=0.163
Epoch [35/50], Iter [100/251], Loss: total=1.796, reg=0.175,
containing_obj=0.551, no_obj=0.403, cls=0.169
Epoch [35/50], Iter [150/251], Loss: total=1.792, reg=0.173,
containing_obj=0.561, no_obj=0.401, cls=0.165
Epoch [35/50], Iter [200/251], Loss: total=1.776, reg=0.170,
containing_obj=0.561, no_obj=0.400, cls=0.165
Epoch [35/50], Iter [250/251], Loss: total=1.802, reg=0.173,
containing_obj=0.571, no_obj=0.398, cls=0.166
---Evaluate model on test samples---

100%|     | 4950/4950 [03:08<00:00, 26.29it/s]

---class aeroplane ap 0.506002129399317---
---class bicycle ap 0.5626662908549454---
---class bird ap 0.4588744026635095---
---class boat ap 0.2680074084971519---
```

```
---class bottle ap 0.22066353432389726---
---class bus ap 0.5881893228575584---
---class car ap 0.6757970834855598---
---class cat ap 0.7089012802353085---
---class chair ap 0.2865357905630802---
---class cow ap 0.5252036919654284---
---class diningtable ap 0.34549176631023537---
---class dog ap 0.6096881124883082---
---class horse ap 0.6046068767737851---
---class motorbike ap 0.49604358815347493---
---class person ap 0.5143865126348388---
---class pottedplant ap 0.18366487822256028---
---class sheep ap 0.4649390969249105---
---class sofa ap 0.4847176661931966---
---class train ap 0.6876783632091288---
---class tvmonitor ap 0.45704004656788344---
---map 0.48245489211620385---
34 [0.506002129399317, 0.5626662908549454, 0.4588744026635095,
0.2680074084971519, 0.22066353432389726, 0.5881893228575584, 0.6757970834855598,
0.7089012802353085, 0.2865357905630802, 0.5252036919654284, 0.34549176631023537,
0.6096881124883082, 0.6046068767737851, 0.49604358815347493, 0.5143865126348388,
0.18366487822256028, 0.4649390969249105, 0.4847176661931966, 0.6876783632091288,
0.45704004656788344]


Starting epoch 36 / 50
Learning Rate for this epoch: 0.0001
Epoch [36/50], Iter [50/251], Loss: total=1.818, reg=0.176,
containing_obj=0.572, no_obj=0.405, cls=0.164
Epoch [36/50], Iter [100/251], Loss: total=1.820, reg=0.174,
containing_obj=0.571, no_obj=0.405, cls=0.176
Epoch [36/50], Iter [150/251], Loss: total=1.821, reg=0.174,
containing_obj=0.575, no_obj=0.408, cls=0.172
Epoch [36/50], Iter [200/251], Loss: total=1.820, reg=0.175,
containing_obj=0.572, no_obj=0.409, cls=0.170
Epoch [36/50], Iter [250/251], Loss: total=1.803, reg=0.173,
containing_obj=0.565, no_obj=0.407, cls=0.168


Starting epoch 37 / 50
Learning Rate for this epoch: 0.0001
Epoch [37/50], Iter [50/251], Loss: total=1.902, reg=0.185,
containing_obj=0.598, no_obj=0.393, cls=0.182
Epoch [37/50], Iter [100/251], Loss: total=1.800, reg=0.172,
containing_obj=0.570, no_obj=0.402, cls=0.168
Epoch [37/50], Iter [150/251], Loss: total=1.822, reg=0.175,
containing_obj=0.573, no_obj=0.403, cls=0.172
Epoch [37/50], Iter [200/251], Loss: total=1.791, reg=0.171,
```

```
containing_obj=0.569, no_obj=0.402, cls=0.165
Epoch [37/50], Iter [250/251], Loss: total=1.789, reg=0.172,
containing_obj=0.566, no_obj=0.404, cls=0.164


Starting epoch 38 / 50
Learning Rate for this epoch: 0.0001
Epoch [38/50], Iter [50/251], Loss: total=1.739, reg=0.165,
containing_obj=0.555, no_obj=0.397, cls=0.161
Epoch [38/50], Iter [100/251], Loss: total=1.733, reg=0.164,
containing_obj=0.559, no_obj=0.398, cls=0.157
Epoch [38/50], Iter [150/251], Loss: total=1.771, reg=0.169,
containing_obj=0.562, no_obj=0.400, cls=0.161
Epoch [38/50], Iter [200/251], Loss: total=1.776, reg=0.170,
containing_obj=0.566, no_obj=0.400, cls=0.160
Epoch [38/50], Iter [250/251], Loss: total=1.778, reg=0.170,
containing_obj=0.567, no_obj=0.402, cls=0.162


Starting epoch 39 / 50
Learning Rate for this epoch: 0.0001
Epoch [39/50], Iter [50/251], Loss: total=1.834, reg=0.175,
containing_obj=0.592, no_obj=0.390, cls=0.171
Epoch [39/50], Iter [100/251], Loss: total=1.799, reg=0.172,
containing_obj=0.574, no_obj=0.399, cls=0.165
Epoch [39/50], Iter [150/251], Loss: total=1.798, reg=0.171,
containing_obj=0.575, no_obj=0.398, cls=0.170
Epoch [39/50], Iter [200/251], Loss: total=1.788, reg=0.171,
containing_obj=0.566, no_obj=0.405, cls=0.165
Epoch [39/50], Iter [250/251], Loss: total=1.785, reg=0.172,
containing_obj=0.561, no_obj=0.406, cls=0.161


Starting epoch 40 / 50
Learning Rate for this epoch: 0.0001
Epoch [40/50], Iter [50/251], Loss: total=1.692, reg=0.163,
containing_obj=0.531, no_obj=0.399, cls=0.145
Epoch [40/50], Iter [100/251], Loss: total=1.761, reg=0.171,
containing_obj=0.549, no_obj=0.398, cls=0.157
Epoch [40/50], Iter [150/251], Loss: total=1.756, reg=0.170,
containing_obj=0.552, no_obj=0.400, cls=0.153
Epoch [40/50], Iter [200/251], Loss: total=1.748, reg=0.168,
containing_obj=0.552, no_obj=0.402, cls=0.155
Epoch [40/50], Iter [250/251], Loss: total=1.772, reg=0.170,
containing_obj=0.560, no_obj=0.403, cls=0.158
---Evaluate model on test samples---

100%|      | 4950/4950 [03:10<00:00, 25.97it/s]
```

```
---class aeroplane ap 0.5169484844718384---
---class bicycle ap 0.5971759821929579---
---class bird ap 0.44474716287936067---
---class boat ap 0.28288642399243913---
---class bottle ap 0.22452500001484976---
---class bus ap 0.6085078899496961---
---class car ap 0.6688138764189255---
---class cat ap 0.7234888592877085---
---class chair ap 0.31300657686861777---
---class cow ap 0.5235046732959835---
---class diningtable ap 0.34056058008486817---
---class dog ap 0.5964844317598974---
---class horse ap 0.6359358709042106---
---class motorbike ap 0.5349380249703167---
---class person ap 0.521839104756294---
---class pottedplant ap 0.18633840907670257---
---class sheep ap 0.4857360875803583---
---class sofa ap 0.4575993820461658---
---class train ap 0.7021096461417418---
---class tvmonitor ap 0.46858683490798947---
---map 0.4916866650800461---
39 [0.5169484844718384, 0.5971759821929579, 0.44474716287936067,
0.28288642399243913, 0.22452500001484976, 0.6085078899496961,
0.6688138764189255, 0.7234888592877085, 0.31300657686861777, 0.5235046732959835,
0.34056058008486817, 0.5964844317598974, 0.6359358709042106, 0.5349380249703167,
0.521839104756294, 0.18633840907670257, 0.4857360875803583, 0.4575993820461658,
0.7021096461417418, 0.46858683490798947]


Starting epoch 41 / 50
Learning Rate for this epoch: 1e-05
Epoch [41/50], Iter [50/251], Loss: total=1.776, reg=0.168,
containing_obj=0.568, no_obj=0.403, cls=0.164
Epoch [41/50], Iter [100/251], Loss: total=1.734, reg=0.165,
containing_obj=0.555, no_obj=0.410, cls=0.152
Epoch [41/50], Iter [150/251], Loss: total=1.730, reg=0.164,
containing_obj=0.553, no_obj=0.411, cls=0.151
Epoch [41/50], Iter [200/251], Loss: total=1.736, reg=0.164,
containing_obj=0.557, no_obj=0.408, cls=0.154
Epoch [41/50], Iter [250/251], Loss: total=1.738, reg=0.164,
containing_obj=0.558, no_obj=0.409, cls=0.155


Starting epoch 42 / 50
Learning Rate for this epoch: 1e-05
Epoch [42/50], Iter [50/251], Loss: total=1.856, reg=0.175,
containing_obj=0.586, no_obj=0.423, cls=0.184
Epoch [42/50], Iter [100/251], Loss: total=1.781, reg=0.168,
```

```
containing_obj=0.563, no_obj=0.419, cls=0.166
Epoch [42/50], Iter [150/251], Loss: total=1.782, reg=0.170,
containing_obj=0.560, no_obj=0.414, cls=0.164
Epoch [42/50], Iter [200/251], Loss: total=1.783, reg=0.170,
containing_obj=0.565, no_obj=0.409, cls=0.165
Epoch [42/50], Iter [250/251], Loss: total=1.753, reg=0.167,
containing_obj=0.555, no_obj=0.412, cls=0.159
Updating best test loss: 2.63404


Starting epoch 43 / 50
Learning Rate for this epoch: 1e-05
Epoch [43/50], Iter [50/251], Loss: total=1.717, reg=0.161,
containing_obj=0.554, no_obj=0.411, cls=0.154
Epoch [43/50], Iter [100/251], Loss: total=1.746, reg=0.166,
containing_obj=0.562, no_obj=0.408, cls=0.151
Epoch [43/50], Iter [150/251], Loss: total=1.722, reg=0.164,
containing_obj=0.550, no_obj=0.409, cls=0.148
Epoch [43/50], Iter [200/251], Loss: total=1.728, reg=0.164,
containing_obj=0.550, no_obj=0.405, cls=0.153
Epoch [43/50], Iter [250/251], Loss: total=1.742, reg=0.165,
containing_obj=0.558, no_obj=0.405, cls=0.155


Starting epoch 44 / 50
Learning Rate for this epoch: 1e-05
Epoch [44/50], Iter [50/251], Loss: total=1.696, reg=0.161,
containing_obj=0.550, no_obj=0.391, cls=0.144
Epoch [44/50], Iter [100/251], Loss: total=1.765, reg=0.168,
containing_obj=0.564, no_obj=0.392, cls=0.162
Epoch [44/50], Iter [150/251], Loss: total=1.752, reg=0.168,
containing_obj=0.556, no_obj=0.397, cls=0.157
Epoch [44/50], Iter [200/251], Loss: total=1.753, reg=0.168,
containing_obj=0.558, no_obj=0.398, cls=0.155
Epoch [44/50], Iter [250/251], Loss: total=1.736, reg=0.166,
containing_obj=0.558, no_obj=0.399, cls=0.150
Updating best test loss: 2.63142


Starting epoch 45 / 50
Learning Rate for this epoch: 1e-05
Epoch [45/50], Iter [50/251], Loss: total=1.684, reg=0.160,
containing_obj=0.520, no_obj=0.414, cls=0.157
Epoch [45/50], Iter [100/251], Loss: total=1.701, reg=0.162,
containing_obj=0.536, no_obj=0.408, cls=0.149
Epoch [45/50], Iter [150/251], Loss: total=1.742, reg=0.167,
containing_obj=0.548, no_obj=0.403, cls=0.157
Epoch [45/50], Iter [200/251], Loss: total=1.758, reg=0.169,
```

```
containing_obj=0.553, no_obj=0.403, cls=0.158
Epoch [45/50], Iter [250/251], Loss: total=1.782, reg=0.172,
containing_obj=0.562, no_obj=0.406, cls=0.159
---Evaluate model on test samples---
100%|     | 4950/4950 [03:10<00:00, 25.93it/s]
---class aeroplane ap 0.5246300171375355---
---class bicycle ap 0.5962571212365649---
---class bird ap 0.4482264311220192---
---class boat ap 0.28470637591102316---
---class bottle ap 0.2253797449796421---
---class bus ap 0.6254640811640256---
---class car ap 0.6776975844792325---
---class cat ap 0.7223880717789374---
---class chair ap 0.30943719859338165---
---class cow ap 0.546913076483837---
---class diningtable ap 0.36325766841758494---
---class dog ap 0.6060656960262162---
---class horse ap 0.6269535734371602---
---class motorbike ap 0.5445490231721051---
---class person ap 0.5206086308457696---
---class pottedplant ap 0.19152633182361567---
---class sheep ap 0.49458522115950626---
---class sofa ap 0.47720727325254153---
---class train ap 0.7013269967158363---
---class tvmonitor ap 0.46072718233714705---
---map 0.4973953650036841---
44 [0.5246300171375355, 0.5962571212365649, 0.4482264311220192,
0.28470637591102316, 0.2253797449796421, 0.6254640811640256, 0.6776975844792325,
0.7223880717789374, 0.30943719859338165, 0.546913076483837, 0.36325766841758494,
0.6060656960262162, 0.6269535734371602, 0.5445490231721051, 0.5206086308457696,
0.19152633182361567, 0.49458522115950626, 0.47720727325254153,
0.7013269967158363, 0.46072718233714705]


Starting epoch 46 / 50
Learning Rate for this epoch: 1e-05
Epoch [46/50], Iter [50/251], Loss: total=1.790, reg=0.172,
containing_obj=0.570, no_obj=0.410, cls=0.155
Epoch [46/50], Iter [100/251], Loss: total=1.762, reg=0.171,
containing_obj=0.552, no_obj=0.408, cls=0.151
Epoch [46/50], Iter [150/251], Loss: total=1.791, reg=0.176,
containing_obj=0.552, no_obj=0.407, cls=0.155
Epoch [46/50], Iter [200/251], Loss: total=1.770, reg=0.173,
containing_obj=0.549, no_obj=0.408, cls=0.152
Epoch [46/50], Iter [250/251], Loss: total=1.769, reg=0.172,
containing_obj=0.553, no_obj=0.407, cls=0.154
```

```
Starting epoch 47 / 50
Learning Rate for this epoch: 1e-05
Epoch [47/50], Iter [50/251], Loss: total=1.691, reg=0.156,
containing_obj=0.541, no_obj=0.419, cls=0.161
Epoch [47/50], Iter [100/251], Loss: total=1.659, reg=0.155,
containing_obj=0.532, no_obj=0.410, cls=0.146
Epoch [47/50], Iter [150/251], Loss: total=1.698, reg=0.159,
containing_obj=0.546, no_obj=0.410, cls=0.153
Epoch [47/50], Iter [200/251], Loss: total=1.703, reg=0.160,
containing_obj=0.548, no_obj=0.411, cls=0.151
Epoch [47/50], Iter [250/251], Loss: total=1.709, reg=0.160,
containing_obj=0.554, no_obj=0.410, cls=0.147


Starting epoch 48 / 50
Learning Rate for this epoch: 1e-05
Epoch [48/50], Iter [50/251], Loss: total=1.657, reg=0.156,
containing_obj=0.535, no_obj=0.409, cls=0.140
Epoch [48/50], Iter [100/251], Loss: total=1.736, reg=0.164,
containing_obj=0.556, no_obj=0.407, cls=0.155
Epoch [48/50], Iter [150/251], Loss: total=1.726, reg=0.164,
containing_obj=0.547, no_obj=0.408, cls=0.154
Epoch [48/50], Iter [200/251], Loss: total=1.755, reg=0.167,
containing_obj=0.561, no_obj=0.403, cls=0.159
Epoch [48/50], Iter [250/251], Loss: total=1.745, reg=0.166,
containing_obj=0.559, no_obj=0.405, cls=0.154


Starting epoch 49 / 50
Learning Rate for this epoch: 1e-05
Epoch [49/50], Iter [50/251], Loss: total=1.651, reg=0.156,
containing_obj=0.529, no_obj=0.405, cls=0.140
Epoch [49/50], Iter [100/251], Loss: total=1.707, reg=0.162,
containing_obj=0.553, no_obj=0.399, cls=0.142
Epoch [49/50], Iter [150/251], Loss: total=1.712, reg=0.162,
containing_obj=0.554, no_obj=0.405, cls=0.143
Epoch [49/50], Iter [200/251], Loss: total=1.737, reg=0.166,
containing_obj=0.562, no_obj=0.401, cls=0.144
Epoch [49/50], Iter [250/251], Loss: total=1.729, reg=0.165,
containing_obj=0.554, no_obj=0.403, cls=0.148


Starting epoch 50 / 50
Learning Rate for this epoch: 1e-05
Epoch [50/50], Iter [50/251], Loss: total=1.711, reg=0.163,
containing_obj=0.544, no_obj=0.406, cls=0.150
Epoch [50/50], Iter [100/251], Loss: total=1.743, reg=0.166,
```

```
containing_obj=0.568, no_obj=0.404, cls=0.144
Epoch [50/50], Iter [150/251], Loss: total=1.736, reg=0.165,
containing_obj=0.566, no_obj=0.408, cls=0.142
Epoch [50/50], Iter [200/251], Loss: total=1.716, reg=0.163,
containing_obj=0.554, no_obj=0.409, cls=0.145
Epoch [50/50], Iter [250/251], Loss: total=1.733, reg=0.164,
containing_obj=0.559, no_obj=0.407, cls=0.149
---Evaluate model on test samples---

100%|     | 4950/4950 [03:16<00:00, 25.17it/s]

---class aeroplane ap 0.5015392841500723---
---class bicycle ap 0.605322624869322---
---class bird ap 0.45157953504514897---
---class boat ap 0.27310073904090737---
---class bottle ap 0.23949186115617327---
---class bus ap 0.6159703991559411---
---class car ap 0.6784234376797692---
---class cat ap 0.717467415358505---
---class chair ap 0.3133533278575145---
---class cow ap 0.5354136398545819---
---class diningtable ap 0.3450547552783455---
---class dog ap 0.5952104103026192---
---class horse ap 0.6278936062434319---
---class motorbike ap 0.5389371757561761---
---class person ap 0.5234838506333201---
---class pottedplant ap 0.19866485928619398---
---class sheep ap 0.4923334105593275---
---class sofa ap 0.47863110294241695---
---class train ap 0.6727740500199872---
---class tvmonitor ap 0.46654524990170654---
---map 0.493559536754573---
49 [0.5015392841500723, 0.605322624869322, 0.45157953504514897,
0.27310073904090737, 0.23949186115617327, 0.6159703991559411,
0.6784234376797692, 0.717467415358505, 0.3133533278575145, 0.5354136398545819,
0.3450547552783455, 0.5952104103026192, 0.6278936062434319, 0.5389371757561761,
0.5234838506333201, 0.19866485928619398, 0.4923334105593275,
0.47863110294241695, 0.6727740500199872, 0.46654524990170654]
```

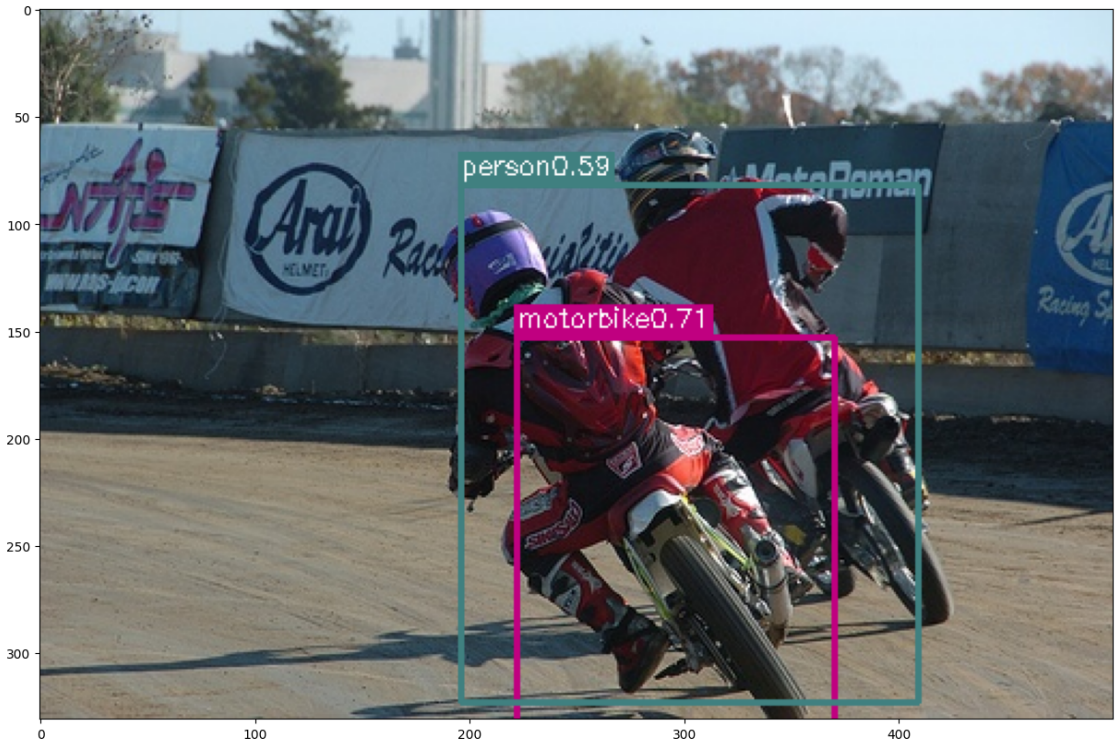
1 View example predictions

[15]:
```python
net.eval()

# select random image from test set
image_name = random.choice(test_dataset.fnames)
image = cv2.imread(os.path.join(file_root_test, image_name))
image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
```

```
print('predicting...')
result = predict_image(net, image_name, root_img_directory=file_root_test)
for left_up, right_bottom, class_name, _, prob in result:
    color = COLORS[VOC_CLASSES.index(class_name)]
    cv2.rectangle(image, left_up, right_bottom, color, 2)
    label = class_name + str(round(prob, 2))
    text_size, baseline = cv2.getTextSize(label, cv2.FONT_HERSHEY_SIMPLEX, 0.4,␣
 ↪1)
    p1 = (left_up[0], left_up[1] - text_size[1])
    cv2.rectangle(image, (p1[0] - 2 // 2, p1[1] - 2 - baseline), (p1[0] +␣
 ↪text_size[0], p1[1] + text_size[1]),
                  color, -1)
    cv2.putText(image, label, (p1[0], p1[1] + baseline), cv2.
 ↪FONT_HERSHEY_SIMPLEX, 0.4, (255, 255, 255), 1, 8)

plt.figure(figsize = (15,15))
plt.imshow(image)
```

```
predicting...
```

[15]: <matplotlib.image.AxesImage at 0x7bf230cafdf0>



1.1 Evaluate on Test

To evaluate detection results we use mAP (mean of average precision over each class)

[16]:
```
test_aps = evaluate(net, test_dataset_file=annotation_file_test,␣
↪img_root=file_root_test)
```

```
---Evaluate model on test samples---

100%|      | 4950/4950 [03:21<00:00, 24.54it/s]

---class aeroplane ap 0.5015392841500723---
---class bicycle ap 0.605322624869322---
---class bird ap 0.45157953504514897---
---class boat ap 0.27310073904090737---
---class bottle ap 0.23949186115617327---
---class bus ap 0.6159703991559411---
---class car ap 0.6784234376797692---
---class cat ap 0.717467415358505---
---class chair ap 0.3133533278575145---
---class cow ap 0.5354136398545819---
---class diningtable ap 0.3450547552783455---
---class dog ap 0.5952104103026192---
---class horse ap 0.6278936062434319---
---class motorbike ap 0.5389371757561761---
---class person ap 0.5234838506333201---
---class pottedplant ap 0.19866485928619398---
---class sheep ap 0.4923334105593275---
---class sofa ap 0.47863110294241695---
---class train ap 0.6727740500199872---
---class tvmonitor ap 0.46654524990170654---
---map 0.493559536754573---
```

1.1.1 Cell added to get intermediate mAP values for students

[17]:
```
network_paths = ['./checkpoints/detector_epoch_%d.pth' % epoch for epoch in [5,␣
↪10, 20, 30, 40]]+['./checkpoints/detector.pth']
for load_network_path in network_paths:
    print('Loading saved network from {}'.format(load_network_path))
    net_loaded =  resnet50().to(device)
    net_loaded.load_state_dict(torch.load(load_network_path))
    evaluate(net_loaded, test_dataset_file=annotation_file_test,␣
↪img_root=file_root_test)
```

```
Loading saved network from ./checkpoints/detector_epoch_5.pth
---Evaluate model on test samples---

100%|      | 4950/4950 [03:01<00:00, 27.24it/s]

---class aeroplane ap 0.10687337924320241---
---class bicycle ap 0.09698684022398726---
```

```
---class bird ap 0.0795545697260614---
---class boat ap 0.039588906784010475---
---class bottle ap 0.013826939394020183---
---class bus ap 0.0--- (no predictions for this class)
---class car ap 0.23905448245224026---
---class cat ap 0.05798397065433763---
---class chair ap 0.023963521763087504---
---class cow ap 0.046350007005744716---
---class diningtable ap 0.0--- (no predictions for this class)
---class dog ap 0.06979810279457307---
---class horse ap 0.35253757726006707---
---class motorbike ap 0.02366863905325444---
---class person ap 0.12785224784808702---
---class pottedplant ap 0.011454820016215119---
---class sheep ap 0.03719490816245503---
---class sofa ap 0.0--- (no predictions for this class)
---class train ap 0.010638297872340425---
---class tvmonitor ap 0.20944559535585716---
---map 0.07733864028047707---
Loading saved network from ./checkpoints/detector_epoch_10.pth
---Evaluate model on test samples---

100%|     | 4950/4950 [03:05<00:00, 26.63it/s]

---class aeroplane ap 0.32730411055874054---
---class bicycle ap 0.4362020907123775---
---class bird ap 0.3143910209991354---
---class boat ap 0.15689923235228517---
---class bottle ap 0.06639401215358469---
---class bus ap 0.28975689906312097---
---class car ap 0.48129725917847826---
---class cat ap 0.3196203134827377---
---class chair ap 0.17867913894109794---
---class cow ap 0.22121229806597756---
---class diningtable ap 0.0048543689320388345---
---class dog ap 0.2617735769951993---
---class horse ap 0.5250894944212665---
---class motorbike ap 0.32169853037671364---
---class person ap 0.3317907654899359---
---class pottedplant ap 0.05007605677899179---
---class sheep ap 0.2626657779777885---
---class sofa ap 0.19737443102441277---
---class train ap 0.37534565838616507---
---class tvmonitor ap 0.3375480470920823---
---map 0.2729986541491065---
Loading saved network from ./checkpoints/detector_epoch_20.pth
---Evaluate model on test samples---

100%|     | 4950/4950 [03:09<00:00, 26.13it/s]
```

```
---class aeroplane ap 0.4874801993817604---
---class bicycle ap 0.4712508123423576 6---
---class bird ap 0.40285118377947066---
---class boat ap 0.24063619149365362---
---class bottle ap 0.0876267944669314---
---class bus ap 0.5663564211191601---
---class car ap 0.5698571379623056---
---class cat ap 0.5329558142126392---
---class chair ap 0.23516430904425192---
---class cow ap 0.3573435470568559---
---class diningtable ap 0.24137306866139727---
---class dog ap 0.4829713724261533---
---class horse ap 0.5076751351384173---
---class motorbike ap 0.35536851632229205---
---class person ap 0.4170429687033427---
---class pottedplant ap 0.15479881463628462---
---class sheep ap 0.3268036188644365---
---class sofa ap 0.41284042969903156---
---class train ap 0.6520130316367881---
---class tvmonitor ap 0.32722082080167547---
---map 0.3914815093874603---
Loading saved network from ./checkpoints/detector_epoch_30.pth
---Evaluate model on test samples---

100%|     | 4950/4950 [03:12<00:00, 25.71it/s]

---class aeroplane ap 0.4531619805526001---
---class bicycle ap 0.4847311946799633---
---class bird ap 0.40909963485496614---
---class boat ap 0.278149987488552---
---class bottle ap 0.18927931740116916---
---class bus ap 0.5676682092846236---
---class car ap 0.626929212924448---
---class cat ap 0.6272487560618513---
---class chair ap 0.29005415372398824---
---class cow ap 0.48116467140958297---
---class diningtable ap 0.2748728337690833---
---class dog ap 0.5604941528060935---
---class horse ap 0.6388844213668845---
---class motorbike ap 0.4896229364819871---
---class person ap 0.4984612540226282---
---class pottedplant ap 0.1910112860248377---
---class sheep ap 0.4361899542411045---
---class sofa ap 0.4294890426280597---
---class train ap 0.6217055081544979---
---class tvmonitor ap 0.4298052761638571---
---map 0.448901189202039---
Loading saved network from ./checkpoints/detector_epoch_40.pth
---Evaluate model on test samples---
```

```
100%|     | 4950/4950 [03:10<00:00, 26.04it/s]
---class aeroplane ap 0.5169484844718384---
---class bicycle ap 0.5971759821929579---
---class bird ap 0.44474716287936067---
---class boat ap 0.28288642399243913---
---class bottle ap 0.22452500001484976---
---class bus ap 0.6085078899496961---
---class car ap 0.6688138764189255---
---class cat ap 0.7234888592877085---
---class chair ap 0.31300657686861777---
---class cow ap 0.5235046732959835---
---class diningtable ap 0.34056058008486817---
---class dog ap 0.5964844317598974---
---class horse ap 0.6359358709042106---
---class motorbike ap 0.5349380249703167---
---class person ap 0.521839104756294---
---class pottedplant ap 0.18633840907670257---
---class sheep ap 0.4857360875803583---
---class sofa ap 0.4575993820461658---
---class train ap 0.7021096461417418---
---class tvmonitor ap 0.46858683490798947---
---map 0.4916866650800461---
Loading saved network from ./checkpoints/detector.pth
---Evaluate model on test samples---
100%|     | 4950/4950 [03:11<00:00, 25.80it/s]
---class aeroplane ap 0.5015392841500723---
---class bicycle ap 0.605322624869322---
---class bird ap 0.45157953504514897---
---class boat ap 0.27310073904090737---
---class bottle ap 0.23949186115617327---
---class bus ap 0.6159703991559411---
---class car ap 0.6784234376797692---
---class cat ap 0.717467415358505---
---class chair ap 0.3133533278575145---
---class cow ap 0.5354136398545819---
---class diningtable ap 0.3450547552783455---
---class dog ap 0.5952104103026192---
---class horse ap 0.6278936062434319---
---class motorbike ap 0.5389371757561761---
---class person ap 0.5234838506333201---
---class pottedplant ap 0.19866485928619398---
---class sheep ap 0.4923334105593275---
---class sofa ap 0.47863110294241695---
---class train ap 0.6727740500199872---
---class tvmonitor ap 0.46654524990170654---
---map 0.493559536754573---
```

[18]:
```
output_submission_csv('my_new_solution.csv', test_aps)
```