```python
In [9]: from google.colab import drive
        drive.mount('/content/gdrive', force_remount=True)
        import os
        os.chdir("/content/gdrive/My Drive/Colab Notebooks/Startpkg_A3_P1")
```

```
Mounted at /content/gdrive
```

```python
In [10]: !pip3 install torch torchvision
         import torch
         a = torch.Tensor([1]).cuda()
         print(a)
```

```
Requirement already satisfied: torch in /usr/local/lib/python3.6/dist-packages (1.6.0+c
u101)
Requirement already satisfied: torchvision in /usr/local/lib/python3.6/dist-packages
(0.7.0+cu101)
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from to
rch) (1.18.5)
Requirement already satisfied: future in /usr/local/lib/python3.6/dist-packages (from t
orch) (0.16.0)
Requirement already satisfied: pillow>=4.1.1 in /usr/local/lib/python3.6/dist-packages
(from torchvision) (7.0.0)
tensor([1.], device='cuda:0')
```

# Assignment 3 : Multi-label Image Classification

```python
In [11]: import os
         import numpy as np
         import torch
         import torch.nn as nn
         from torchvision import transforms
         from sklearn.metrics import average_precision_score
         from PIL import Image, ImageDraw
         import matplotlib.pyplot as plt
         from kaggle_submission import output_submission_csv
         from classifier import *
         from voc_dataloader import VocDataset, VOC_CLASSES

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

```
The autoreload extension is already loaded. To reload it, use:
  %reload_ext autoreload
```

In this assignment, you train a classifier to do multi-label classificaton on the PASCAL VOC 2007 dataset. The dataset has 20 different classes which can appear in any given image. Your classifier will predict whether each class appears in an image. This task is slightly different from exclusive multiclass classification like the ImageNet competition where only a single most appropriate class is predicted for an image.

# Reading Pascal Data

## Loading Training Data

In the following cell we will load the training data and also apply some transforms to the data. Feel free to apply more transforms (https://pytorch.org/docs/stable/torchvision/transforms.html) for data augmentation which can lead to better performance.

```python
In [12]:   # Transforms applied to the training data
           normalize = transforms.Normalize(mean=[0.485, 0.456, 0.406],
                                            std= [0.229, 0.224, 0.225])


           #train_transform = transforms.Compose([
           #            transforms.Resize(227),
           #            transforms.CenterCrop(227),
           #            transforms.ToTensor(),
           #            normalize
           #        ])

           train_transform = transforms.Compose([
                   transforms.RandomResizedCrop(227),
                   transforms.RandomHorizontalFlip(),
                   transforms.ToTensor(),
                   normalize
               ])
```

```python
In [13]:   ds_train = VocDataset('VOCdevkit_2007/VOC2007/','train',train_transform)
```

## Loading Validation Data

We will load the test data for the PASCAL VOC 2007 dataset. Do **NOT** add data augmentation transforms to validation data.

```python
In [14]:   # Transforms applied to the testing data
           test_transform = transforms.Compose([
                   transforms.Resize(227),
                   transforms.CenterCrop(227),
                   transforms.ToTensor(),
                   normalize,
               ])
```

```python
In [15]:   ds_val = VocDataset('VOCdevkit_2007/VOC2007/','val',test_transform)
```

## Visualizing the Data

PASCAL VOC has bounding box annotations in addition to class labels. Use the following code to visualize some random examples and corresponding annotations from the train set.

```
In [16]:  for i in range(5):
              idx = np.random.randint(0, len(ds_train.names)-1)
              _imgpath = os.path.join('VOCdevkit_2007/VOC2007/', 'JPEGImages', ds_train.names[idx
          ]+'.jpg')
              img = Image.open(_imgpath).convert('RGB')
              draw = ImageDraw.Draw(img)
              for j in range(len(ds_train.box_indices[idx])):
                  obj = ds_train.box_indices[idx][j]
                  draw.rectangle(list(obj), outline=(255,0,0))
                  draw.text(list(obj[0:2]), ds_train.classes[ds_train.label_order[idx][j]], fill=
          (0,255,0))
              plt.figure(figsize = (10,10))
              plt.imshow(np.array(img))
```

Output hidden; open in https://colab.research.google.com to view.

# Classification

```
In [17]:  device = torch.device("cuda:0" if torch.cuda.is_available() else "cpu")
```

```
In [18]:  train_loader = torch.utils.data.DataLoader(dataset=ds_train,
                                                     batch_size=50,
                                                     shuffle=True,
                                                     num_workers=1)
```

```
In [19]:  val_loader = torch.utils.data.DataLoader(dataset=ds_val,
                                                   batch_size=50,
                                                   shuffle=True,
                                                   num_workers=1)
```

```
In [20]:  def train_classifier(train_loader, classifier, criterion, optimizer):
              classifier.train()
              loss_ = 0.0
              losses = []
              for i, (images, labels, _) in enumerate(train_loader.dataset):
                  images, labels = images.to(device), labels.to(device)
                  optimizer.zero_grad()
                  logits = classifier(torch.unsqueeze(images, 0))
                  loss = criterion(logits, labels)
                  loss.backward()
                  optimizer.step()
                  losses.append(loss)
              return torch.stack(losses).mean().item()
```

```
In [21]:  def test_classifier(test_loader, classifier, criterion, print_ind_classes=True):
              classifier.eval()
              losses = []
              with torch.no_grad():
                  y_true = np.zeros((0,21))
                  y_score = np.zeros((0,21))
                  for i, (images, labels, _) in enumerate(test_loader.dataset):
                      images, labels = images.to(device), labels.to(device)
                      logits = classifier(torch.unsqueeze(images, 0))
                      y_true = np.concatenate((y_true, labels.cpu().numpy()[np.newaxis,:]), axis=
          0)
                      y_score = np.concatenate((y_score, logits.cpu().numpy()), axis=0)
                      loss = criterion(logits, labels)
                      losses.append(loss.cpu().numpy())
              aps = []
              # ignore first class which is background
              for i in range(1, y_true.shape[1]):
                  ap = average_precision_score(y_true[:, i], y_score[:, i])
                  if print_ind_classes:
                      print('-------  Class: {:<12}    AP: {:>8.4f}  -------'.format(VOC_CLA
          SSES[i], ap))
                  aps.append(ap)

              mAP = np.mean(aps)
              test_loss = np.mean(losses)
              print('mAP: {0:.4f}'.format(mAP))
              print('Avg loss: {}'.format(test_loss))

          return mAP, test_loss, aps
```

# Improve the network

The network you are given as is will allow you to reach around 0.3 mAP. You need to build two new networks and compare them to the baseline. There are a variety of different approaches you may try:

- Network architecture changes
  - Number of layers: try adding layers to make your network deeper
  - Layer size: try changing the filter size (channel size, kernel size, etc)
  - FC layers: Change the number of FC layers
  - Batch normalization: adding batch norm between layers will likely give you a significant performance increase
  - Residual connections: as you increase the depth of your network, you will find that having residual connections like those in ResNet architectures will be helpful
- Optimizer: Instead of plain SGD, you may want to add a learning rate schedule, add momentum, or use one of the other optimizers you have learned about like Adam. Check the `torch.optim` package for other optimizers
- Data augmentation: You may use the `torchvision.transforms` module to try adding random resized crops and horizontal flips of the input data. Check `transforms.RandomResizedCrop` and `transforms.RandomHorizontalFlip` for this
- Epochs: Once you have found a generally good hyperparameter setting try training for more epochs
- Loss function: You might want to add weighting to the `MultiLabelSoftMarginLoss` for classes that are less well represented or experiment with a different loss function

```
In [22]:  classifier = ClassifierB().to(device)
          # You can can use this function to reload a network you have already saved previously
          #classifier.load_state_dict(torch.load('voc_classifier.pth'))
```

In [23]:
```python
criterion = nn.MultiLabelSoftMarginLoss()
#optimizer = torch.optim.SGD(classifier.parameters(), lr=0.01, momentum=0.9)
optimizer = torch.optim.SGD(classifier.parameters(), lr=0.001, momentum=0.9, weight_dec
ay = 0.001)
#optimizer = torch.optim.Adam(classifier.parameters(), lr=0.001)
```

In [24]:

```python
# Training the Classifier
NUM_EPOCHS = 150   # Change later for more epochs up to 150
TEST_FREQUENCY = 5

for epoch in range(1, NUM_EPOCHS+1):
    print("Starting epoch number " + str(epoch))
    train_loss = train_classifier(train_loader, classifier, criterion, optimizer)
    print("Loss for Training on Epoch " +str(epoch) + " is "+ str(train_loss))
    if(epoch%TEST_FREQUENCY==0):
        mAP_val, val_loss, _ = test_classifier(val_loader, classifier, criterion)
        print('Evaluating classifier')
        print("Mean Precision Score for Testing on Epoch " +str(epoch) + " is "+ str(mAP_val))
```

```
Starting epoch number 1
Loss for Training on Epoch 1 is 0.2603260576725006
Starting epoch number 2
Loss for Training on Epoch 2 is 0.23643413186073303
Starting epoch number 3
Loss for Training on Epoch 3 is 0.23078635334968567
Starting epoch number 4
Loss for Training on Epoch 4 is 0.22862251102924347
Starting epoch number 5
Loss for Training on Epoch 5 is 0.2257380187511444
        -------  Class: aeroplane      AP:    0.3795  -------
        -------  Class: bicycle        AP:    0.1307  -------
        -------  Class: bird           AP:    0.1215  -------
        -------  Class: boat           AP:    0.2300  -------
        -------  Class: bottle         AP:    0.0839  -------
        -------  Class: bus            AP:    0.1126  -------
        -------  Class: car            AP:    0.2866  -------
        -------  Class: cat            AP:    0.1761  -------
        -------  Class: chair          AP:    0.2360  -------
        -------  Class: cow            AP:    0.0424  -------
        -------  Class: diningtable     AP:    0.1745  -------
        -------  Class: dog            AP:    0.1524  -------
        -------  Class: horse          AP:    0.0998  -------
        -------  Class: motorbike      AP:    0.1556  -------
        -------  Class: person         AP:    0.5352  -------
        -------  Class: pottedplant    AP:    0.0821  -------
        -------  Class: sheep          AP:    0.0337  -------
        -------  Class: sofa           AP:    0.1827  -------
        -------  Class: train          AP:    0.2735  -------
        -------  Class: tvmonitor      AP:    0.1166  -------
mAP: 0.1803
Avg loss: 0.22054727375507355
Evaluating classifier
Mean Precision Score for Testing on Epoch 5 is 0.1802820776919273
Starting epoch number 6
Loss for Training on Epoch 6 is 0.22373142838478088
Starting epoch number 7
Loss for Training on Epoch 7 is 0.2221491038799286
Starting epoch number 8
Loss for Training on Epoch 8 is 0.2207503765821457
Starting epoch number 9
Loss for Training on Epoch 9 is 0.21927766501903534
Starting epoch number 10
Loss for Training on Epoch 10 is 0.2178039699792862
        -------  Class: aeroplane      AP:    0.4456  -------
        -------  Class: bicycle        AP:    0.1489  -------
        -------  Class: bird           AP:    0.1466  -------
        -------  Class: boat           AP:    0.2492  -------
        -------  Class: bottle         AP:    0.1127  -------
        -------  Class: bus            AP:    0.1210  -------
        -------  Class: car            AP:    0.3538  -------
        -------  Class: cat            AP:    0.2319  -------
        -------  Class: chair          AP:    0.2429  -------
        -------  Class: cow            AP:    0.0768  -------
        -------  Class: diningtable     AP:    0.2226  -------
        -------  Class: dog            AP:    0.1780  -------
        -------  Class: horse          AP:    0.1897  -------
        -------  Class: motorbike      AP:    0.1894  -------
        -------  Class: person         AP:    0.5606  -------
        -------  Class: pottedplant    AP:    0.1110  -------
        -------  Class: sheep          AP:    0.0679  -------
        -------  Class: sofa           AP:    0.2026  -------
```

```
-------  Class: train       AP:   0.3260  -------
-------  Class: tvmonitor   AP:   0.1288  -------
mAP: 0.2153
Avg loss: 0.2135046422481537
Evaluating classifier
Mean Precision Score for Testing on Epoch 10 is 0.2152960446352159
Starting epoch number 11
Loss for Training on Epoch 11 is 0.21600216627120972
Starting epoch number 12
Loss for Training on Epoch 12 is 0.2154344767332077
Starting epoch number 13
Loss for Training on Epoch 13 is 0.2145090401172638
Starting epoch number 14
Loss for Training on Epoch 14 is 0.2134944349527359
Starting epoch number 15
Loss for Training on Epoch 15 is 0.21255658566951752
-------  Class: aeroplane   AP:   0.4902  -------
-------  Class: bicycle     AP:   0.1610  -------
-------  Class: bird        AP:   0.1801  -------
-------  Class: boat        AP:   0.2768  -------
-------  Class: bottle      AP:   0.1248  -------
-------  Class: bus         AP:   0.1380  -------
-------  Class: car         AP:   0.4109  -------
-------  Class: cat         AP:   0.2636  -------
-------  Class: chair       AP:   0.2693  -------
-------  Class: cow         AP:   0.0875  -------
-------  Class: diningtable AP:   0.2314  -------
-------  Class: dog         AP:   0.1845  -------
-------  Class: horse       AP:   0.2250  -------
-------  Class: motorbike   AP:   0.1789  -------
-------  Class: person      AP:   0.5750  -------
-------  Class: pottedplant AP:   0.1251  -------
-------  Class: sheep       AP:   0.1070  -------
-------  Class: sofa        AP:   0.2268  -------
-------  Class: train       AP:   0.3149  -------
-------  Class: tvmonitor   AP:   0.1533  -------
mAP: 0.2362
Avg loss: 0.20874415338039398
Evaluating classifier
Mean Precision Score for Testing on Epoch 15 is 0.2362137798890236
Starting epoch number 16
Loss for Training on Epoch 16 is 0.2113424837589264
Starting epoch number 17
Loss for Training on Epoch 17 is 0.20953534543514252
Starting epoch number 18
Loss for Training on Epoch 18 is 0.2096448540687561
Starting epoch number 19
Loss for Training on Epoch 19 is 0.21003474295139313
Starting epoch number 20
Loss for Training on Epoch 20 is 0.20864002406597137
-------  Class: aeroplane   AP:   0.5052  -------
-------  Class: bicycle     AP:   0.1667  -------
-------  Class: bird        AP:   0.1820  -------
-------  Class: boat        AP:   0.3389  -------
-------  Class: bottle      AP:   0.1157  -------
-------  Class: bus         AP:   0.1436  -------
-------  Class: car         AP:   0.4545  -------
-------  Class: cat         AP:   0.2809  -------
-------  Class: chair       AP:   0.2774  -------
-------  Class: cow         AP:   0.0863  -------
-------  Class: diningtable AP:   0.2447  -------
-------  Class: dog         AP:   0.1786  -------
-------  Class: horse       AP:   0.2147  -------
```

```
-------   Class: motorbike      AP:    0.2131   -------
-------   Class: person         AP:    0.5959   -------
-------   Class: pottedplant    AP:    0.1265   -------
-------   Class: sheep          AP:    0.1277   -------
-------   Class: sofa           AP:    0.2576   -------
-------   Class: train          AP:    0.3223   -------
-------   Class: tvmonitor      AP:    0.1338   -------
mAP: 0.2483
Avg loss: 0.2058325707912445
Evaluating classifier
Mean Precision Score for Testing on Epoch 20 is 0.2482908761766458
Starting epoch number 21
Loss for Training on Epoch 21 is 0.20797806978225708
Starting epoch number 22
Loss for Training on Epoch 22 is 0.20726269483566284
Starting epoch number 23
Loss for Training on Epoch 23 is 0.2064197063446045
Starting epoch number 24
Loss for Training on Epoch 24 is 0.20679907500743866
Starting epoch number 25
Loss for Training on Epoch 25 is 0.2061462551355362
-------   Class: aeroplane      AP:    0.5238   -------
-------   Class: bicycle        AP:    0.1948   -------
-------   Class: bird           AP:    0.1858   -------
-------   Class: boat           AP:    0.3142   -------
-------   Class: bottle         AP:    0.1308   -------
-------   Class: bus            AP:    0.1464   -------
-------   Class: car            AP:    0.4736   -------
-------   Class: cat            AP:    0.2800   -------
-------   Class: chair          AP:    0.3058   -------
-------   Class: cow            AP:    0.0936   -------
-------   Class: diningtable    AP:    0.2464   -------
-------   Class: dog            AP:    0.1900   -------
-------   Class: horse          AP:    0.2668   -------
-------   Class: motorbike      AP:    0.2401   -------
-------   Class: person         AP:    0.5982   -------
-------   Class: pottedplant    AP:    0.1550   -------
-------   Class: sheep          AP:    0.1351   -------
-------   Class: sofa           AP:    0.2542   -------
-------   Class: train          AP:    0.3257   -------
-------   Class: tvmonitor      AP:    0.1709   -------
mAP: 0.2616
Avg loss: 0.2027827352285385
Evaluating classifier
Mean Precision Score for Testing on Epoch 25 is 0.2615615373707085
Starting epoch number 26
Loss for Training on Epoch 26 is 0.2061261683702469
Starting epoch number 27
Loss for Training on Epoch 27 is 0.20516686141490936
Starting epoch number 28
Loss for Training on Epoch 28 is 0.20445244014263153
Starting epoch number 29
Loss for Training on Epoch 29 is 0.20414471626281738
Starting epoch number 30
Loss for Training on Epoch 30 is 0.20288197696208954
-------   Class: aeroplane      AP:    0.5165   -------
-------   Class: bicycle        AP:    0.1842   -------
-------   Class: bird           AP:    0.1605   -------
-------   Class: boat           AP:    0.2892   -------
-------   Class: bottle         AP:    0.1146   -------
-------   Class: bus            AP:    0.1468   -------
-------   Class: car            AP:    0.4829   -------
-------   Class: cat            AP:    0.2729   -------
```

```
-------   Class: chair         AP:   0.3147  -------
-------   Class: cow           AP:   0.1016  -------
-------   Class: diningtable   AP:   0.2258  -------
-------   Class: dog           AP:   0.2046  -------
-------   Class: horse         AP:   0.3040  -------
-------   Class: motorbike     AP:   0.2334  -------
-------   Class: person        AP:   0.6237  -------
-------   Class: pottedplant   AP:   0.1363  -------
-------   Class: sheep         AP:   0.1148  -------
-------   Class: sofa          AP:   0.2533  -------
-------   Class: train         AP:   0.3676  -------
-------   Class: tvmonitor     AP:   0.1768  -------
mAP: 0.2612
Avg loss: 0.2018354833126068
Evaluating classifier
Mean Precision Score for Testing on Epoch 30 is 0.2612105209118273
Starting epoch number 31
Loss for Training on Epoch 31 is 0.20293034613132477
Starting epoch number 32
Loss for Training on Epoch 32 is 0.20284776389598846
Starting epoch number 33
Loss for Training on Epoch 33 is 0.20159392058849335
Starting epoch number 34
Loss for Training on Epoch 34 is 0.2022576928138733
Starting epoch number 35
Loss for Training on Epoch 35 is 0.20130427181720734
-------   Class: aeroplane     AP:   0.5156  -------
-------   Class: bicycle       AP:   0.2126  -------
-------   Class: bird          AP:   0.1614  -------
-------   Class: boat          AP:   0.3057  -------
-------   Class: bottle        AP:   0.1154  -------
-------   Class: bus           AP:   0.1421  -------
-------   Class: car           AP:   0.5035  -------
-------   Class: cat           AP:   0.3007  -------
-------   Class: chair         AP:   0.3338  -------
-------   Class: cow           AP:   0.1019  -------
-------   Class: diningtable   AP:   0.2597  -------
-------   Class: dog           AP:   0.2142  -------
-------   Class: horse         AP:   0.3354  -------
-------   Class: motorbike     AP:   0.2600  -------
-------   Class: person        AP:   0.6418  -------
-------   Class: pottedplant   AP:   0.1471  -------
-------   Class: sheep         AP:   0.1227  -------
-------   Class: sofa          AP:   0.2866  -------
-------   Class: train         AP:   0.3778  -------
-------   Class: tvmonitor     AP:   0.2013  -------
mAP: 0.2770
Avg loss: 0.19815786182880402
Evaluating classifier
Mean Precision Score for Testing on Epoch 35 is 0.27696667619171295
Starting epoch number 36
Loss for Training on Epoch 36 is 0.2013459950685501
Starting epoch number 37
Loss for Training on Epoch 37 is 0.19983460009098053
Starting epoch number 38
Loss for Training on Epoch 38 is 0.20001019537448883
Starting epoch number 39
Loss for Training on Epoch 39 is 0.20040342211723328
Starting epoch number 40
Loss for Training on Epoch 40 is 0.1983151137828827
-------   Class: aeroplane     AP:   0.5267  -------
-------   Class: bicycle       AP:   0.2200  -------
-------   Class: bird          AP:   0.1638  -------
```

```
-------   Class: boat          AP:   0.3392  -------
-------   Class: bottle        AP:   0.1254  -------
-------   Class: bus           AP:   0.1681  -------
-------   Class: car           AP:   0.4912  -------
-------   Class: cat           AP:   0.3012  -------
-------   Class: chair         AP:   0.3405  -------
-------   Class: cow           AP:   0.1100  -------
-------   Class: diningtable   AP:   0.2604  -------
-------   Class: dog           AP:   0.2131  -------
-------   Class: horse         AP:   0.3311  -------
-------   Class: motorbike     AP:   0.2582  -------
-------   Class: person        AP:   0.6375  -------
-------   Class: pottedplant   AP:   0.1511  -------
-------   Class: sheep         AP:   0.1255  -------
-------   Class: sofa          AP:   0.2943  -------
-------   Class: train         AP:   0.3556  -------
-------   Class: tvmonitor     AP:   0.2349  -------
mAP: 0.2824
Avg loss: 0.1990842968225479
Evaluating classifier
Mean Precision Score for Testing on Epoch 40 is 0.2823953686763356
Starting epoch number 41
Loss for Training on Epoch 41 is 0.1984701305627823
Starting epoch number 42
Loss for Training on Epoch 42 is 0.19869975745677948
Starting epoch number 43
Loss for Training on Epoch 43 is 0.19951876997947693
Starting epoch number 44
Loss for Training on Epoch 44 is 0.19729527831077576
Starting epoch number 45
Loss for Training on Epoch 45 is 0.19710351526737213
-------   Class: aeroplane     AP:   0.5361  -------
-------   Class: bicycle       AP:   0.2127  -------
-------   Class: bird          AP:   0.1579  -------
-------   Class: boat          AP:   0.3638  -------
-------   Class: bottle        AP:   0.1285  -------
-------   Class: bus           AP:   0.1810  -------
-------   Class: car           AP:   0.5119  -------
-------   Class: cat           AP:   0.2884  -------
-------   Class: chair         AP:   0.3648  -------
-------   Class: cow           AP:   0.1165  -------
-------   Class: diningtable   AP:   0.3081  -------
-------   Class: dog           AP:   0.2214  -------
-------   Class: horse         AP:   0.3664  -------
-------   Class: motorbike     AP:   0.2720  -------
-------   Class: person        AP:   0.6239  -------
-------   Class: pottedplant   AP:   0.1458  -------
-------   Class: sheep         AP:   0.1317  -------
-------   Class: sofa          AP:   0.2980  -------
-------   Class: train         AP:   0.3944  -------
-------   Class: tvmonitor     AP:   0.2414  -------
mAP: 0.2932
Avg loss: 0.19723206758499146
Evaluating classifier
Mean Precision Score for Testing on Epoch 45 is 0.2932349313282333
Starting epoch number 46
Loss for Training on Epoch 46 is 0.199070006608963
Starting epoch number 47
Loss for Training on Epoch 47 is 0.19632954895496368
Starting epoch number 48
Loss for Training on Epoch 48 is 0.1972953975200653
Starting epoch number 49
Loss for Training on Epoch 49 is 0.1953592300415039
```

```
Starting epoch number 50
Loss for Training on Epoch 50 is 0.1955459713935852
-------  Class: aeroplane      AP:    0.5255   -------
-------  Class: bicycle        AP:    0.2075   -------
-------  Class: bird           AP:    0.1703   -------
-------  Class: boat           AP:    0.3583   -------
-------  Class: bottle         AP:    0.1423   -------
-------  Class: bus            AP:    0.2123   -------
-------  Class: car            AP:    0.4902   -------
-------  Class: cat            AP:    0.3101   -------
-------  Class: chair          AP:    0.3609   -------
-------  Class: cow            AP:    0.1108   -------
-------  Class: diningtable     AP:   0.2902   -------
-------  Class: dog            AP:    0.2331   -------
-------  Class: horse          AP:    0.3739   -------
-------  Class: motorbike      AP:    0.2632   -------
-------  Class: person         AP:    0.6272   -------
-------  Class: pottedplant    AP:    0.1487   -------
-------  Class: sheep          AP:    0.1134   -------
-------  Class: sofa           AP:    0.2974   -------
-------  Class: train          AP:    0.4076   -------
-------  Class: tvmonitor      AP:    0.2854   -------
mAP: 0.2964
Avg loss: 0.1958998292684555
Evaluating classifier
Mean Precision Score for Testing on Epoch 50 is 0.2964248459755476
Starting epoch number 51
Loss for Training on Epoch 51 is 0.19597475230693817
Starting epoch number 52
Loss for Training on Epoch 52 is 0.19454555213451385
Starting epoch number 53
Loss for Training on Epoch 53 is 0.19410833716392517
Starting epoch number 54
Loss for Training on Epoch 54 is 0.19431060552597046
Starting epoch number 55
Loss for Training on Epoch 55 is 0.19341658055782318
-------  Class: aeroplane      AP:    0.5232   -------
-------  Class: bicycle        AP:    0.2416   -------
-------  Class: bird           AP:    0.1889   -------
-------  Class: boat           AP:    0.3708   -------
-------  Class: bottle         AP:    0.1282   -------
-------  Class: bus            AP:    0.2110   -------
-------  Class: car            AP:    0.5105   -------
-------  Class: cat            AP:    0.2901   -------
-------  Class: chair          AP:    0.3881   -------
-------  Class: cow            AP:    0.1158   -------
-------  Class: diningtable     AP:   0.3155   -------
-------  Class: dog            AP:    0.2405   -------
-------  Class: horse          AP:    0.3738   -------
-------  Class: motorbike      AP:    0.3184   -------
-------  Class: person         AP:    0.6497   -------
-------  Class: pottedplant    AP:    0.1713   -------
-------  Class: sheep          AP:    0.1109   -------
-------  Class: sofa           AP:    0.2869   -------
-------  Class: train          AP:    0.4280   -------
-------  Class: tvmonitor      AP:    0.2795   -------
mAP: 0.3071
Avg loss: 0.1944078654050827
Evaluating classifier
Mean Precision Score for Testing on Epoch 55 is 0.3071359617101448
Starting epoch number 56
Loss for Training on Epoch 56 is 0.19426976144313812
Starting epoch number 57
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Loss for Training on Epoch 57 is 0.1928134709596634
Starting epoch number 58
Loss for Training on Epoch 58 is 0.19360046088695526
Starting epoch number 59
Loss for Training on Epoch 59 is 0.19292326271533966
Starting epoch number 60
Loss for Training on Epoch 60 is 0.1925959587097168
-------   Class: aeroplane       AP:    0.5166   -------
-------   Class: bicycle         AP:    0.2789   -------
-------   Class: bird            AP:    0.1970   -------
-------   Class: boat            AP:    0.3605   -------
-------   Class: bottle          AP:    0.1378   -------
-------   Class: bus             AP:    0.2123   -------
-------   Class: car             AP:    0.4918   -------
-------   Class: cat             AP:    0.3250   -------
-------   Class: chair           AP:    0.3870   -------
-------   Class: cow             AP:    0.1004   -------
-------   Class: diningtable      AP:    0.3144   -------
-------   Class: dog             AP:    0.2449   -------
-------   Class: horse           AP:    0.3591   -------
-------   Class: motorbike        AP:    0.3090   -------
-------   Class: person          AP:    0.6512   -------
-------   Class: pottedplant      AP:    0.1792   -------
-------   Class: sheep           AP:    0.1284   -------
-------   Class: sofa            AP:    0.2646   -------
-------   Class: train           AP:    0.4141   -------
-------   Class: tvmonitor        AP:    0.2444   -------
mAP: 0.3058
Avg loss: 0.19359451532363892
Evaluating classifier
Mean Precision Score for Testing on Epoch 60 is 0.30583000474229094
Starting epoch number 61
Loss for Training on Epoch 61 is 0.19128845632076263
Starting epoch number 62
Loss for Training on Epoch 62 is 0.19043447077274323
Starting epoch number 63
Loss for Training on Epoch 63 is 0.1915195882320404
Starting epoch number 64
Loss for Training on Epoch 64 is 0.1912088841199875
Starting epoch number 65
Loss for Training on Epoch 65 is 0.19007498025894165
-------   Class: aeroplane       AP:    0.5382   -------
-------   Class: bicycle         AP:    0.2022   -------
-------   Class: bird            AP:    0.1847   -------
-------   Class: boat            AP:    0.3730   -------
-------   Class: bottle          AP:    0.1674   -------
-------   Class: bus             AP:    0.1967   -------
-------   Class: car             AP:    0.5156   -------
-------   Class: cat             AP:    0.3198   -------
-------   Class: chair           AP:    0.3764   -------
-------   Class: cow             AP:    0.1186   -------
-------   Class: diningtable      AP:    0.3106   -------
-------   Class: dog             AP:    0.2466   -------
-------   Class: horse           AP:    0.3884   -------
-------   Class: motorbike        AP:    0.3575   -------
-------   Class: person          AP:    0.6634   -------
-------   Class: pottedplant      AP:    0.1526   -------
-------   Class: sheep           AP:    0.1357   -------
-------   Class: sofa            AP:    0.2987   -------
-------   Class: train           AP:    0.4374   -------
-------   Class: tvmonitor        AP:    0.3154   -------
mAP: 0.3149
Avg loss: 0.19098682701587677
```

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Evaluating classifier
Mean Precision Score for Testing on Epoch 65 is 0.314946324380514
Starting epoch number 66
Loss for Training on Epoch 66 is 0.1930859237909317
Starting epoch number 67
Loss for Training on Epoch 67 is 0.19004426896572113
Starting epoch number 68
Loss for Training on Epoch 68 is 0.19016529619693756
Starting epoch number 69
Loss for Training on Epoch 69 is 0.18987707793712616
Starting epoch number 70
Loss for Training on Epoch 70 is 0.19102634489536285
-------  Class: aeroplane      AP:    0.5572   -------
-------  Class: bicycle        AP:    0.2607   -------
-------  Class: bird           AP:    0.1929   -------
-------  Class: boat           AP:    0.3844   -------
-------  Class: bottle         AP:    0.1297   -------
-------  Class: bus            AP:    0.2110   -------
-------  Class: car            AP:    0.5191   -------
-------  Class: cat            AP:    0.2927   -------
-------  Class: chair          AP:    0.4194   -------
-------  Class: cow            AP:    0.1185   -------
-------  Class: diningtable    AP:    0.3073   -------
-------  Class: dog            AP:    0.2471   -------
-------  Class: horse          AP:    0.4246   -------
-------  Class: motorbike      AP:    0.3552   -------
-------  Class: person         AP:    0.6479   -------
-------  Class: pottedplant    AP:    0.1715   -------
-------  Class: sheep          AP:    0.1410   -------
-------  Class: sofa           AP:    0.3121   -------
-------  Class: train          AP:    0.4561   -------
-------  Class: tvmonitor      AP:    0.3059   -------
mAP: 0.3227
Avg loss: 0.19173596799373627
Evaluating classifier
Mean Precision Score for Testing on Epoch 70 is 0.32271388363133585
Starting epoch number 71
Loss for Training on Epoch 71 is 0.19140583276748657
Starting epoch number 72
Loss for Training on Epoch 72 is 0.18935193121433258
Starting epoch number 73
Loss for Training on Epoch 73 is 0.19014188647270203
Starting epoch number 74
Loss for Training on Epoch 74 is 0.1901332139968872
Starting epoch number 75
Loss for Training on Epoch 75 is 0.18992029130458832
-------  Class: aeroplane      AP:    0.5401   -------
-------  Class: bicycle        AP:    0.2602   -------
-------  Class: bird           AP:    0.2005   -------
-------  Class: boat           AP:    0.3785   -------
-------  Class: bottle         AP:    0.1256   -------
-------  Class: bus            AP:    0.2212   -------
-------  Class: car            AP:    0.5125   -------
-------  Class: cat            AP:    0.2802   -------
-------  Class: chair          AP:    0.4168   -------
-------  Class: cow            AP:    0.1267   -------
-------  Class: diningtable    AP:    0.3224   -------
-------  Class: dog            AP:    0.2574   -------
-------  Class: horse          AP:    0.4200   -------
-------  Class: motorbike      AP:    0.3443   -------
-------  Class: person         AP:    0.6588   -------
-------  Class: pottedplant    AP:    0.1760   -------
-------  Class: sheep          AP:    0.1310   -------
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------- Class: sofa          AP:  0.2988  -------
------- Class: train         AP:  0.4126  -------
------- Class: tvmonitor     AP:  0.2878  -------
mAP: 0.3186
Avg loss: 0.19132843613624573
Evaluating classifier
Mean Precision Score for Testing on Epoch 75 is 0.3185750398921496
Starting epoch number 76
Loss for Training on Epoch 76 is 0.18741394579410553
Starting epoch number 77
Loss for Training on Epoch 77 is 0.18856124579906464
Starting epoch number 78
Loss for Training on Epoch 78 is 0.18867062032222748
Starting epoch number 79
Loss for Training on Epoch 79 is 0.18884769082069397
Starting epoch number 80
Loss for Training on Epoch 80 is 0.18772324919700623
------- Class: aeroplane     AP:  0.5418  -------
------- Class: bicycle       AP:  0.2451  -------
------- Class: bird          AP:  0.2113  -------
------- Class: boat          AP:  0.3752  -------
------- Class: bottle        AP:  0.1530  -------
------- Class: bus           AP:  0.2162  -------
------- Class: car           AP:  0.5209  -------
------- Class: cat           AP:  0.3069  -------
------- Class: chair         AP:  0.4040  -------
------- Class: cow           AP:  0.1282  -------
------- Class: diningtable   AP:  0.3260  -------
------- Class: dog           AP:  0.2520  -------
------- Class: horse         AP:  0.4410  -------
------- Class: motorbike     AP:  0.3038  -------
------- Class: person        AP:  0.6556  -------
------- Class: pottedplant   AP:  0.1475  -------
------- Class: sheep         AP:  0.1517  -------
------- Class: sofa          AP:  0.2866  -------
------- Class: train         AP:  0.4476  -------
------- Class: tvmonitor     AP:  0.3214  -------
mAP: 0.3218
Avg loss: 0.19144083559513092
Evaluating classifier
Mean Precision Score for Testing on Epoch 80 is 0.3217737925796894
Starting epoch number 81
Loss for Training on Epoch 81 is 0.188606560023025513
Starting epoch number 82
Loss for Training on Epoch 82 is 0.18682776391506195
Starting epoch number 83
Loss for Training on Epoch 83 is 0.18762636184692383
Starting epoch number 84
Loss for Training on Epoch 84 is 0.18665635585784912
Starting epoch number 85
Loss for Training on Epoch 85 is 0.18727657198905945
------- Class: aeroplane     AP:  0.5798  -------
------- Class: bicycle       AP:  0.2366  -------
------- Class: bird          AP:  0.2011  -------
------- Class: boat          AP:  0.3745  -------
------- Class: bottle        AP:  0.1516  -------
------- Class: bus           AP:  0.2378  -------
------- Class: car           AP:  0.5167  -------
------- Class: cat           AP:  0.3349  -------
------- Class: chair         AP:  0.3975  -------
------- Class: cow           AP:  0.1262  -------
------- Class: diningtable   AP:  0.3350  -------
------- Class: dog           AP:  0.2530  -------
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-------   Class: horse        AP:   0.4405   -------
-------   Class: motorbike    AP:   0.3144   -------
-------   Class: person       AP:   0.6663   -------
-------   Class: pottedplant  AP:   0.1585   -------
-------   Class: sheep        AP:   0.1346   -------
-------   Class: sofa         AP:   0.3246   -------
-------   Class: train        AP:   0.4645   -------
-------   Class: tvmonitor    AP:   0.3213   -------
mAP: 0.3285
Avg loss: 0.19043973088264465
Evaluating classifier
Mean Precision Score for Testing on Epoch 85 is 0.3284815278402385
Starting epoch number 86
Loss for Training on Epoch 86 is 0.1868145912885666
Starting epoch number 87
Loss for Training on Epoch 87 is 0.18811795115470886
Starting epoch number 88
Loss for Training on Epoch 88 is 0.18774712085723877
Starting epoch number 89
Loss for Training on Epoch 89 is 0.18534085154533386
Starting epoch number 90
Loss for Training on Epoch 90 is 0.18643203377723694
-------   Class: aeroplane    AP:   0.5564   -------
-------   Class: bicycle      AP:   0.2472   -------
-------   Class: bird         AP:   0.2118   -------
-------   Class: boat         AP:   0.4017   -------
-------   Class: bottle       AP:   0.1581   -------
-------   Class: bus          AP:   0.2278   -------
-------   Class: car          AP:   0.4970   -------
-------   Class: cat          AP:   0.2919   -------
-------   Class: chair        AP:   0.4055   -------
-------   Class: cow          AP:   0.1396   -------
-------   Class: diningtable  AP:   0.3210   -------
-------   Class: dog          AP:   0.2572   -------
-------   Class: horse        AP:   0.4305   -------
-------   Class: motorbike    AP:   0.3323   -------
-------   Class: person       AP:   0.6696   -------
-------   Class: pottedplant  AP:   0.1689   -------
-------   Class: sheep        AP:   0.1452   -------
-------   Class: sofa         AP:   0.2872   -------
-------   Class: train        AP:   0.4496   -------
-------   Class: tvmonitor    AP:   0.3108   -------
mAP: 0.3255
Avg loss: 0.19089791178703308
Evaluating classifier
Mean Precision Score for Testing on Epoch 90 is 0.32545231133596275
Starting epoch number 91
Loss for Training on Epoch 91 is 0.18476742506027222
Starting epoch number 92
Loss for Training on Epoch 92 is 0.18613475561141968
Starting epoch number 93
Loss for Training on Epoch 93 is 0.1851046234369278
Starting epoch number 94
Loss for Training on Epoch 94 is 0.18485060334205627
Starting epoch number 95
Loss for Training on Epoch 95 is 0.18555617332458496
-------   Class: aeroplane    AP:   0.5655   -------
-------   Class: bicycle      AP:   0.2614   -------
-------   Class: bird         AP:   0.2208   -------
-------   Class: boat         AP:   0.4040   -------
-------   Class: bottle       AP:   0.1465   -------
-------   Class: bus          AP:   0.2255   -------
-------   Class: car          AP:   0.5187   -------
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-------    Class: cat          AP:    0.3303  -------
-------    Class: chair        AP:    0.3959  -------
-------    Class: cow          AP:    0.1351  -------
-------    Class: diningtable  AP:    0.3102  -------
-------    Class: dog          AP:    0.2596  -------
-------    Class: horse        AP:    0.4499  -------
-------    Class: motorbike    AP:    0.3583  -------
-------    Class: person       AP:    0.6702  -------
-------    Class: pottedplant  AP:    0.1593  -------
-------    Class: sheep        AP:    0.1377  -------
-------    Class: sofa         AP:    0.3084  -------
-------    Class: train        AP:    0.4544  -------
-------    Class: tvmonitor    AP:    0.3216  -------
mAP: 0.3317
Avg loss: 0.19198565185070038
Evaluating classifier
Mean Precision Score for Testing on Epoch 95 is 0.33167260438118185
Starting epoch number 96
Loss for Training on Epoch 96 is 0.1867513656616211
Starting epoch number 97
Loss for Training on Epoch 97 is 0.1850033849477768
Starting epoch number 98
Loss for Training on Epoch 98 is 0.18488503992557526
Starting epoch number 99
Loss for Training on Epoch 99 is 0.18635843694210052
Starting epoch number 100
Loss for Training on Epoch 100 is 0.185833141207695
-------    Class: aeroplane    AP:    0.6085  -------
-------    Class: bicycle      AP:    0.2475  -------
-------    Class: bird         AP:    0.1986  -------
-------    Class: boat         AP:    0.4085  -------
-------    Class: bottle       AP:    0.1727  -------
-------    Class: bus          AP:    0.2128  -------
-------    Class: car          AP:    0.5433  -------
-------    Class: cat          AP:    0.3166  -------
-------    Class: chair        AP:    0.4147  -------
-------    Class: cow          AP:    0.1379  -------
-------    Class: diningtable  AP:    0.3486  -------
-------    Class: dog          AP:    0.2756  -------
-------    Class: horse        AP:    0.4120  -------
-------    Class: motorbike    AP:    0.3333  -------
-------    Class: person       AP:    0.6850  -------
-------    Class: pottedplant  AP:    0.1812  -------
-------    Class: sheep        AP:    0.1360  -------
-------    Class: sofa         AP:    0.2905  -------
-------    Class: train        AP:    0.4885  -------
-------    Class: tvmonitor    AP:    0.2868  -------
mAP: 0.3349
Avg loss: 0.1910415142774582
Evaluating classifier
Mean Precision Score for Testing on Epoch 100 is 0.3349315530825578
Starting epoch number 101
Loss for Training on Epoch 101 is 0.1851339042186737
Starting epoch number 102
Loss for Training on Epoch 102 is 0.1845877319574356
Starting epoch number 103
Loss for Training on Epoch 103 is 0.186153218150013885
Starting epoch number 104
Loss for Training on Epoch 104 is 0.1851382553577423
Starting epoch number 105
Loss for Training on Epoch 105 is 0.18383294343948364
-------    Class: aeroplane    AP:    0.5813  -------
-------    Class: bicycle      AP:    0.2622  -------
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-------  Class: bird          AP:  0.2224  -------
-------  Class: boat          AP:  0.4073  -------
-------  Class: bottle        AP:  0.1552  -------
-------  Class: bus           AP:  0.2098  -------
-------  Class: car           AP:  0.5373  -------
-------  Class: cat           AP:  0.3027  -------
-------  Class: chair         AP:  0.4013  -------
-------  Class: cow           AP:  0.1442  -------
-------  Class: diningtable   AP:  0.3380  -------
-------  Class: dog           AP:  0.2933  -------
-------  Class: horse         AP:  0.4498  -------
-------  Class: motorbike     AP:  0.3301  -------
-------  Class: person        AP:  0.6820  -------
-------  Class: pottedplant   AP:  0.1787  -------
-------  Class: sheep         AP:  0.1495  -------
-------  Class: sofa          AP:  0.3003  -------
-------  Class: train         AP:  0.4947  -------
-------  Class: tvmonitor     AP:  0.3311  -------
mAP: 0.3386
Avg loss: 0.18764476478099823
Evaluating classifier
Mean Precision Score for Testing on Epoch 105 is 0.3385587617092284
Starting epoch number 106
Loss for Training on Epoch 106 is 0.18430447578430176
Starting epoch number 107
Loss for Training on Epoch 107 is 0.18384218215942383
Starting epoch number 108
Loss for Training on Epoch 108 is 0.18419496715068817
Starting epoch number 109
Loss for Training on Epoch 109 is 0.18340198695659637
Starting epoch number 110
Loss for Training on Epoch 110 is 0.182875394821167
-------  Class: aeroplane     AP:  0.5324  -------
-------  Class: bicycle       AP:  0.2621  -------
-------  Class: bird          AP:  0.2229  -------
-------  Class: boat          AP:  0.4031  -------
-------  Class: bottle        AP:  0.1338  -------
-------  Class: bus           AP:  0.2201  -------
-------  Class: car           AP:  0.5382  -------
-------  Class: cat           AP:  0.3201  -------
-------  Class: chair         AP:  0.4179  -------
-------  Class: cow           AP:  0.1391  -------
-------  Class: diningtable   AP:  0.3155  -------
-------  Class: dog           AP:  0.2797  -------
-------  Class: horse         AP:  0.4316  -------
-------  Class: motorbike     AP:  0.3720  -------
-------  Class: person        AP:  0.6792  -------
-------  Class: pottedplant   AP:  0.1888  -------
-------  Class: sheep         AP:  0.1364  -------
-------  Class: sofa          AP:  0.3228  -------
-------  Class: train         AP:  0.5024  -------
-------  Class: tvmonitor     AP:  0.3171  -------
mAP: 0.3368
Avg loss: 0.18766579031944275
Evaluating classifier
Mean Precision Score for Testing on Epoch 110 is 0.3367560730198852
Starting epoch number 111
Loss for Training on Epoch 111 is 0.18209770321846008
Starting epoch number 112
Loss for Training on Epoch 112 is 0.1857384294271469
Starting epoch number 113
Loss for Training on Epoch 113 is 0.18222768604755402
Starting epoch number 114
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Loss for Training on Epoch 114 is 0.18285900354385376
Starting epoch number 115
Loss for Training on Epoch 115 is 0.18225882947444916
-------    Class: aeroplane       AP:     0.5829    -------
-------    Class: bicycle         AP:     0.2752    -------
-------    Class: bird            AP:     0.2166    -------
-------    Class: boat            AP:     0.4079    -------
-------    Class: bottle          AP:     0.1472    -------
-------    Class: bus             AP:     0.2379    -------
-------    Class: car             AP:     0.5300    -------
-------    Class: cat             AP:     0.3300    -------
-------    Class: chair           AP:     0.4106    -------
-------    Class: cow             AP:     0.1310    -------
-------    Class: diningtable     AP:     0.3150    -------
-------    Class: dog             AP:     0.2816    -------
-------    Class: horse           AP:     0.4390    -------
-------    Class: motorbike       AP:     0.3837    -------
-------    Class: person          AP:     0.6828    -------
-------    Class: pottedplant     AP:     0.1856    -------
-------    Class: sheep           AP:     0.1302    -------
-------    Class: sofa            AP:     0.3016    -------
-------    Class: train           AP:     0.4967    -------
-------    Class: tvmonitor       AP:     0.3471    -------
mAP: 0.3416
Avg loss: 0.19005991518497467
Evaluating classifier
Mean Precision Score for Testing on Epoch 115 is 0.34161857625124464
Starting epoch number 116
Loss for Training on Epoch 116 is 0.18265250325202942
Starting epoch number 117
Loss for Training on Epoch 117 is 0.18237702548503876
Starting epoch number 118
Loss for Training on Epoch 118 is 0.18312647938728333
Starting epoch number 119
Loss for Training on Epoch 119 is 0.18182267248630524
Starting epoch number 120
Loss for Training on Epoch 120 is 0.18117116391658783
-------    Class: aeroplane       AP:     0.5713    -------
-------    Class: bicycle         AP:     0.2326    -------
-------    Class: bird            AP:     0.2200    -------
-------    Class: boat            AP:     0.3831    -------
-------    Class: bottle          AP:     0.1426    -------
-------    Class: bus             AP:     0.2255    -------
-------    Class: car             AP:     0.5329    -------
-------    Class: cat             AP:     0.3354    -------
-------    Class: chair           AP:     0.4170    -------
-------    Class: cow             AP:     0.1317    -------
-------    Class: diningtable     AP:     0.3226    -------
-------    Class: dog             AP:     0.2794    -------
-------    Class: horse           AP:     0.4365    -------
-------    Class: motorbike       AP:     0.3463    -------
-------    Class: person          AP:     0.6768    -------
-------    Class: pottedplant     AP:     0.1803    -------
-------    Class: sheep           AP:     0.1307    -------
-------    Class: sofa            AP:     0.2842    -------
-------    Class: train           AP:     0.4873    -------
-------    Class: tvmonitor       AP:     0.3129    -------
mAP: 0.3325
Avg loss: 0.1916314959526062
Evaluating classifier
Mean Precision Score for Testing on Epoch 120 is 0.3324604050793729
Starting epoch number 121
Loss for Training on Epoch 121 is 0.18146604550600052
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Starting epoch number 122
Loss for Training on Epoch 122 is 0.18020902574062347
Starting epoch number 123
Loss for Training on Epoch 123 is 0.18271686136722565
Starting epoch number 124
Loss for Training on Epoch 124 is 0.18289686739444733
Starting epoch number 125
Loss for Training on Epoch 125 is 0.18098457157611847
-------   Class: aeroplane      AP:    0.5719  -------
-------   Class: bicycle        AP:    0.2914  -------
-------   Class: bird           AP:    0.1906  -------
-------   Class: boat           AP:    0.3731  -------
-------   Class: bottle         AP:    0.1454  -------
-------   Class: bus            AP:    0.2355  -------
-------   Class: car            AP:    0.5409  -------
-------   Class: cat            AP:    0.3296  -------
-------   Class: chair          AP:    0.4286  -------
-------   Class: cow            AP:    0.1409  -------
-------   Class: diningtable     AP:    0.3440  -------
-------   Class: dog            AP:    0.2729  -------
-------   Class: horse          AP:    0.4340  -------
-------   Class: motorbike      AP:    0.3624  -------
-------   Class: person         AP:    0.6819  -------
-------   Class: pottedplant    AP:    0.1739  -------
-------   Class: sheep          AP:    0.1280  -------
-------   Class: sofa           AP:    0.3092  -------
-------   Class: train          AP:    0.4981  -------
-------   Class: tvmonitor      AP:    0.3185  -------
mAP: 0.3385
Avg loss: 0.19053728878498077
Evaluating classifier
Mean Precision Score for Testing on Epoch 125 is 0.3385442300660104
Starting epoch number 126
Loss for Training on Epoch 126 is 0.18213441967964172
Starting epoch number 127
Loss for Training on Epoch 127 is 0.1824844628572464
Starting epoch number 128
Loss for Training on Epoch 128 is 0.17932967841625214
Starting epoch number 129
Loss for Training on Epoch 129 is 0.1818280965089798
Starting epoch number 130
Loss for Training on Epoch 130 is 0.18142105638980865
-------   Class: aeroplane      AP:    0.5677  -------
-------   Class: bicycle        AP:    0.3017  -------
-------   Class: bird           AP:    0.2208  -------
-------   Class: boat           AP:    0.3947  -------
-------   Class: bottle         AP:    0.1505  -------
-------   Class: bus            AP:    0.2349  -------
-------   Class: car            AP:    0.5360  -------
-------   Class: cat            AP:    0.3343  -------
-------   Class: chair          AP:    0.4412  -------
-------   Class: cow            AP:    0.1438  -------
-------   Class: diningtable     AP:    0.3444  -------
-------   Class: dog            AP:    0.2624  -------
-------   Class: horse          AP:    0.4522  -------
-------   Class: motorbike      AP:    0.3589  -------
-------   Class: person         AP:    0.6827  -------
-------   Class: pottedplant    AP:    0.1566  -------
-------   Class: sheep          AP:    0.1319  -------
-------   Class: sofa           AP:    0.3355  -------
-------   Class: train          AP:    0.4955  -------
-------   Class: tvmonitor      AP:    0.3508  -------
mAP: 0.3448
```

```
Avg loss: 0.18844832479953766
Evaluating classifier
Mean Precision Score for Testing on Epoch 130 is 0.34481506253830985
Starting epoch number 131
Loss for Training on Epoch 131 is 0.17984451353549957
Starting epoch number 132
Loss for Training on Epoch 132 is 0.18210677802562714
Starting epoch number 133
Loss for Training on Epoch 133 is 0.17983956634998322
Starting epoch number 134
Loss for Training on Epoch 134 is 0.18048885464668274
Starting epoch number 135
Loss for Training on Epoch 135 is 0.178923010826111084
-------  Class: aeroplane     AP:   0.6029  -------
-------  Class: bicycle       AP:   0.3374  -------
-------  Class: bird          AP:   0.2409  -------
-------  Class: boat          AP:   0.3993  -------
-------  Class: bottle        AP:   0.1481  -------
-------  Class: bus           AP:   0.2264  -------
-------  Class: car           AP:   0.5464  -------
-------  Class: cat           AP:   0.3215  -------
-------  Class: chair         AP:   0.4385  -------
-------  Class: cow           AP:   0.1406  -------
-------  Class: diningtable    AP:   0.3550  -------
-------  Class: dog           AP:   0.2659  -------
-------  Class: horse         AP:   0.4470  -------
-------  Class: motorbike     AP:   0.4001  -------
-------  Class: person        AP:   0.6883  -------
-------  Class: pottedplant   AP:   0.1676  -------
-------  Class: sheep         AP:   0.1276  -------
-------  Class: sofa          AP:   0.3111  -------
-------  Class: train         AP:   0.4975  -------
-------  Class: tvmonitor     AP:   0.3036  -------
mAP: 0.3483
Avg loss: 0.1891523003578186
Evaluating classifier
Mean Precision Score for Testing on Epoch 135 is 0.3482988195435056
Starting epoch number 136
Loss for Training on Epoch 136 is 0.1800612062215805
Starting epoch number 137
Loss for Training on Epoch 137 is 0.18036478757858276
Starting epoch number 138
Loss for Training on Epoch 138 is 0.17783108353614807
Starting epoch number 139
Loss for Training on Epoch 139 is 0.17963865399360657
Starting epoch number 140
Loss for Training on Epoch 140 is 0.17954662442207336
-------  Class: aeroplane     AP:   0.6088  -------
-------  Class: bicycle       AP:   0.2534  -------
-------  Class: bird          AP:   0.2337  -------
-------  Class: boat          AP:   0.4066  -------
-------  Class: bottle        AP:   0.1469  -------
-------  Class: bus           AP:   0.2344  -------
-------  Class: car           AP:   0.5590  -------
-------  Class: cat           AP:   0.3171  -------
-------  Class: chair         AP:   0.4231  -------
-------  Class: cow           AP:   0.1367  -------
-------  Class: diningtable    AP:   0.3425  -------
-------  Class: dog           AP:   0.2714  -------
-------  Class: horse         AP:   0.4188  -------
-------  Class: motorbike     AP:   0.3799  -------
-------  Class: person        AP:   0.6939  -------
-------  Class: pottedplant   AP:   0.1461  -------
```

```
-------   Class: sheep          AP:    0.1268  -------
-------   Class: sofa           AP:    0.3338  -------
-------   Class: train          AP:    0.5005  -------
-------   Class: tvmonitor      AP:    0.3321  -------
mAP: 0.3433
Avg loss: 0.18823647499084473
Evaluating classifier
Mean Precision Score for Testing on Epoch 140 is 0.34326997416532046
Starting epoch number 141
Loss for Training on Epoch 141 is 0.17985694110393524
Starting epoch number 142
Loss for Training on Epoch 142 is 0.17966331541538239
Starting epoch number 143
Loss for Training on Epoch 143 is 0.18051700294017792
Starting epoch number 144
Loss for Training on Epoch 144 is 0.17916496098041534
Starting epoch number 145
Loss for Training on Epoch 145 is 0.1788344532251358
-------   Class: aeroplane      AP:    0.6099  -------
-------   Class: bicycle        AP:    0.2291  -------
-------   Class: bird           AP:    0.2200  -------
-------   Class: boat           AP:    0.3570  -------
-------   Class: bottle         AP:    0.1427  -------
-------   Class: bus            AP:    0.2507  -------
-------   Class: car            AP:    0.5613  -------
-------   Class: cat            AP:    0.3069  -------
-------   Class: chair          AP:    0.4379  -------
-------   Class: cow            AP:    0.1296  -------
-------   Class: diningtable     AP:    0.3495  -------
-------   Class: dog            AP:    0.2857  -------
-------   Class: horse          AP:    0.4403  -------
-------   Class: motorbike      AP:    0.3601  -------
-------   Class: person         AP:    0.6947  -------
-------   Class: pottedplant    AP:    0.1452  -------
-------   Class: sheep          AP:    0.1288  -------
-------   Class: sofa           AP:    0.3286  -------
-------   Class: train          AP:    0.5130  -------
-------   Class: tvmonitor      AP:    0.3308  -------
mAP: 0.3411
Avg loss: 0.18973113596439362
Evaluating classifier
Mean Precision Score for Testing on Epoch 145 is 0.34108619236999815
Starting epoch number 146
Loss for Training on Epoch 146 is 0.18128395080566406
Starting epoch number 147
Loss for Training on Epoch 147 is 0.1788090169429779
Starting epoch number 148
Loss for Training on Epoch 148 is 0.18010222911834717
Starting epoch number 149
Loss for Training on Epoch 149 is 0.17944417893886566
Starting epoch number 150
Loss for Training on Epoch 150 is 0.17627239227294922
-------   Class: aeroplane      AP:    0.5820  -------
-------   Class: bicycle        AP:    0.3161  -------
-------   Class: bird           AP:    0.2206  -------
-------   Class: boat           AP:    0.4160  -------
-------   Class: bottle         AP:    0.1289  -------
-------   Class: bus            AP:    0.2362  -------
-------   Class: car            AP:    0.5600  -------
-------   Class: cat            AP:    0.3189  -------
-------   Class: chair          AP:    0.4382  -------
-------   Class: cow            AP:    0.1469  -------
-------   Class: diningtable     AP:    0.3465  -------
```

```
-------   Class: dog          AP:    0.2652   -------
-------   Class: horse        AP:    0.4372   -------
-------   Class: motorbike    AP:    0.3629   -------
-------   Class: person       AP:    0.6790   -------
-------   Class: pottedplant  AP:    0.1560   -------
-------   Class: sheep        AP:    0.1280   -------
-------   Class: sofa         AP:    0.3528   -------
-------   Class: train        AP:    0.4854   -------
-------   Class: tvmonitor    AP:    0.3393   -------
mAP: 0.3458
Avg loss: 0.19072452187538147
Evaluating classifier
Mean Precision Score for Testing on Epoch 150 is 0.3457972734305001
```

In [25]:
```python
# Save the classifier network
# Suggestion: you can save checkpoints of your network during training and reload them
  later
torch.save(classifier.state_dict(), './voc_classifierB.pth')
```

## Evaluate on test set

In [26]:
```python
ds_test = VocDataset('VOCdevkit_2007/VOC2007test','test', test_transform)

test_loader = torch.utils.data.DataLoader(dataset=ds_test,
                                          batch_size=50,
                                          shuffle=False,
                                          num_workers=1)

mAP_test, test_loss, test_aps = test_classifier(test_loader, classifier, criterion)
```
```
-------   Class: aeroplane    AP:    0.5622   -------
-------   Class: bicycle      AP:    0.2531   -------
-------   Class: bird         AP:    0.2149   -------
-------   Class: boat         AP:    0.3969   -------
-------   Class: bottle       AP:    0.1346   -------
-------   Class: bus          AP:    0.2229   -------
-------   Class: car          AP:    0.5727   -------
-------   Class: cat          AP:    0.2878   -------
-------   Class: chair        AP:    0.4299   -------
-------   Class: cow          AP:    0.1442   -------
-------   Class: diningtable  AP:    0.2706   -------
-------   Class: dog          AP:    0.2604   -------
-------   Class: horse        AP:    0.5136   -------
-------   Class: motorbike    AP:    0.3546   -------
-------   Class: person       AP:    0.7044   -------
-------   Class: pottedplant  AP:    0.2141   -------
-------   Class: sheep        AP:    0.1710   -------
-------   Class: sofa         AP:    0.2891   -------
-------   Class: train        AP:    0.4916   -------
-------   Class: tvmonitor    AP:    0.3170   -------
mAP: 0.3403
Avg loss: 0.18497443199157715
```

In [27]:
```python
output_submission_csv('my_solution_ClassifierB_150.csv', mAP_test)
```