

MP3_P1B_Develop_Classifier

October 19, 2020

1 Assignment 3 Part 1: Developing Your Own Classifier

```
[1]: import os
import numpy as np
import torch
import torch.nn as nn
import torchvision

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 SimpleClassifier, Classifier#, AlexNet
from voc_dataloader import VocDataset, VOC_CLASSES

%matplotlib inline
%load_ext autoreload
%autoreload 2
from tqdm.notebook import tqdm
```

2 Part 1B: Design your own network

In this notebook, your task is to create and train your own model for multi-label classification on VOC Pascal.

2.1 What to do

1. You will make change on network architecture in `classifier.py`.
2. You may also want to change other hyperparameters to assist your training to get a better performances. Hints will be given in the below instructions.

2.2 What to submit

Check the submission template for details what to submit.

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

[3]: def test_classifier(test_loader, classifier, criterion, print_ind_classes=True,
    ↪ print_total=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):
            images, labels = images.to(device), labels.to(device)
            logits = classifier(images)
            y_true = np.concatenate((y_true, labels.cpu().numpy()), axis=0)
            y_score = np.concatenate((y_score, logits.cpu().numpy()), axis=0)
            loss = criterion(logits, labels)
            losses.append(loss.item())
    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_CLASSES[i], ap))
        aps.append(ap)

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

```
return mAP, test_loss, aps
```

```
[4]: def plot_losses(train, val, test_frequency, num_epochs):
    plt.plot(train, label="train")
    indices = [i for i in range(num_epochs) if ((i+1)%test_frequency == 0 or i
    ==0)]
    plt.plot(indices, val, label="val")
    plt.title("Loss Plot")
    plt.ylabel("Loss")
    plt.xlabel("Epoch")
    plt.legend()
    plt.show()

def plot_mAP(train, val, test_frequency, num_epochs):
    indices = [i for i in range(num_epochs) if ((i+1)%test_frequency == 0 or i
    ==0)]
    plt.plot(indices, train, label="train")
    plt.plot(indices, val, label="val")
    plt.title("mAP Plot")
    plt.ylabel("mAP")
    plt.xlabel("Epoch")
    plt.legend()
    plt.show()
```

```
[5]: def train(classifier, num_epochs, train_loader, val_loader, criterion,
    optimizer, test_frequency=5):
    train_losses = []
    train_mAPs = []
    val_losses = []
    val_mAPs = []
    mAP_test_thre = 0.35
    test_mAPs = []
    for epoch in tqdm(range(1,num_epochs+1)):
        print("Starting epoch number " + str(epoch))
        train_loss = train_classifier(train_loader, classifier, criterion,
        optimizer)
        train_losses.append(train_loss)
        print("Loss for Training on Epoch " + str(epoch) + " is "+
        str(train_loss))
        if(epoch%test_frequency==0 or epoch==1):
            mAP_train, _, _ = test_classifier(train_loader, classifier,
            criterion, False, False)
            train_mAPs.append(mAP_train)
            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))
        val_losses.append(val_loss)
        val_mAPs.append(mAP_val)
        if epoch >= 30:
            mAP_test, test_loss, test_aps = test_classifier(test_loader,
→classifier, criterion)
            test_mAPs.append(mAP_test)
            if mAP_test > mAP_test_thre:
                torch.save(classifier.state_dict(), './
→voc_my_best_classifier_'+str(epoch)+' .pth')
                output_submission_csv('my_solution_'+str(epoch)+' .csv',
→test_aps)
            print("Max mAP_test achieved", max(test_mAPs), " at epoch ", np.
→argmax(test_mAPs) + 30)
        return classifier, train_losses, val_losses, train_mAPs, val_mAPs

```

3 Developing Your Own Model

3.0.1 Goal

To meet the benchmark for this assignment you will need to improve the network. Note you should have noticed pretrained Alexnet performs really well, but training Alexnet from scratch performs much worse. We hope you can design a better architecture over both the simple classifier and AlexNet to train from scratch.

3.0.2 How to start

You may take inspiration from other published architectures and architectures discussed in lecture. However, you are NOT allowed to use predefined models (e.g. models from torchvision) or use pretrained weights. Training must be done from scratch with your own custom model.

Some hints There are a variety of different approaches you should try to improve performance from the simple classifier:

- Network architecture changes
 - Number of layers: try adding layers to make your network deeper
 - 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 should 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. Feel free to apply more [transforms](#) for data augmentation which can lead to better performance.
- 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

Note We will soon be providing some initial expectations of mAP values as a function of epoch so you can get an early idea whether your implementation works without waiting a long time for training to converge.

3.0.3 What to submit

Submit your best model to Kaggle and save all plots for the writeup.

```
[6]: device = torch.device("cuda:0" if torch.cuda.is_available() else "cpu")
      print(device)
      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.RandomHorizontalFlip(),
          transforms.ToTensor(),
          normalize
      ])

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

      ds_train = VocDataset('VOCdevkit_2007/VOC2007/', 'train', train_transform)
      ds_val = VocDataset('VOCdevkit_2007/VOC2007/', 'val', test_transform)
      ds_test = VocDataset('VOCdevkit_2007/VOC2007test/', 'test', test_transform)
```

cuda:0

```
[7]: num_epochs = 60
      test_frequency = 5
      batch_size = 64
```

```

train_loader = torch.utils.data.DataLoader(dataset=ds_train,
                                           batch_size=batch_size,
                                           shuffle=True,
                                           num_workers=1)

val_loader = torch.utils.data.DataLoader(dataset=ds_val,
                                          batch_size=batch_size,
                                          shuffle=True,
                                          num_workers=1)

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

```

```

[8]: # TODO: Run your own classifier here
classifier = Classifier().to(device)

criterion = nn.MultiLabelSoftMarginLoss()
# optimizer = torch.optim.SGD(classifier.parameters(), lr=0.01, momentum=0.9)
optimizer = torch.optim.Adam(classifier.parameters(), lr=1e-4)

classifier, train_losses, val_losses, train_mAPs, val_mAPs = train(classifier,
↪ num_epochs, train_loader, val_loader, criterion, optimizer, test_frequency)

```

```
HBox(children=(FloatProgress(value=0.0, max=60.0), HTML(value='')))
```

Starting epoch number 1

Loss for Training on Epoch 1 is 0.30058953166007996

-----	Class: aeroplane	AP: 0.0590	-----
-----	Class: bicycle	AP: 0.0681	-----
-----	Class: bird	AP: 0.0637	-----
-----	Class: boat	AP: 0.0485	-----
-----	Class: bottle	AP: 0.0510	-----
-----	Class: bus	AP: 0.0372	-----
-----	Class: car	AP: 0.1312	-----
-----	Class: cat	AP: 0.0751	-----
-----	Class: chair	AP: 0.1656	-----
-----	Class: cow	AP: 0.0280	-----
-----	Class: diningtable	AP: 0.1099	-----
-----	Class: dog	AP: 0.0850	-----
-----	Class: horse	AP: 0.0625	-----
-----	Class: motorbike	AP: 0.0515	-----
-----	Class: person	AP: 0.4282	-----
-----	Class: pottedplant	AP: 0.0908	-----
-----	Class: sheep	AP: 0.0204	-----

-----	Class: sofa	AP:	0.1199	-----
-----	Class: train	AP:	0.0632	-----
-----	Class: tvmonitor	AP:	0.0636	-----

mAP: 0.0911

Avg loss: 0.23592679910361766

Evaluating classifier

Mean Precision Score for Testing on Epoch 1 is 0.09111527672026978

-----	Class: aeroplane	AP:	0.0490	-----
-----	Class: bicycle	AP:	0.0623	-----
-----	Class: bird	AP:	0.0584	-----
-----	Class: boat	AP:	0.0408	-----
-----	Class: bottle	AP:	0.0530	-----
-----	Class: bus	AP:	0.0388	-----
-----	Class: car	AP:	0.1364	-----
-----	Class: cat	AP:	0.0705	-----
-----	Class: chair	AP:	0.1640	-----
-----	Class: cow	AP:	0.0283	-----
-----	Class: diningtable	AP:	0.0916	-----
-----	Class: dog	AP:	0.0863	-----
-----	Class: horse	AP:	0.0584	-----
-----	Class: motorbike	AP:	0.0471	-----
-----	Class: person	AP:	0.4361	-----
-----	Class: pottedplant	AP:	0.0929	-----
-----	Class: sheep	AP:	0.0229	-----
-----	Class: sofa	AP:	0.1054	-----
-----	Class: train	AP:	0.0556	-----
-----	Class: tvmonitor	AP:	0.0515	-----

mAP: 0.0875

Avg loss: 0.23239047366839188

Starting epoch number 2

Loss for Training on Epoch 2 is 0.23466527462005615

Starting epoch number 3

Loss for Training on Epoch 3 is 0.2269515097141266

Starting epoch number 4

Loss for Training on Epoch 4 is 0.22080330550670624

Starting epoch number 5

Loss for Training on Epoch 5 is 0.212558314204216

-----	Class: aeroplane	AP:	0.3877	-----
-----	Class: bicycle	AP:	0.1161	-----
-----	Class: bird	AP:	0.1363	-----
-----	Class: boat	AP:	0.2071	-----
-----	Class: bottle	AP:	0.1023	-----
-----	Class: bus	AP:	0.1002	-----
-----	Class: car	AP:	0.3792	-----
-----	Class: cat	AP:	0.2856	-----
-----	Class: chair	AP:	0.3088	-----
-----	Class: cow	AP:	0.0424	-----
-----	Class: diningtable	AP:	0.1939	-----

-----	Class: dog	AP:	0.2311	-----
-----	Class: horse	AP:	0.2372	-----
-----	Class: motorbike	AP:	0.1172	-----
-----	Class: person	AP:	0.6295	-----
-----	Class: pottedplant	AP:	0.0965	-----
-----	Class: sheep	AP:	0.0986	-----
-----	Class: sofa	AP:	0.1520	-----
-----	Class: train	AP:	0.1472	-----
-----	Class: tvmonitor	AP:	0.0849	-----

mAP: 0.2027

Avg loss: 0.2153635323047638

Evaluating classifier

Mean Precision Score for Testing on Epoch 5 is 0.20268080624671256

Starting epoch number 6

Loss for Training on Epoch 6 is 0.20510569214820862

Starting epoch number 7

Loss for Training on Epoch 7 is 0.19978182017803192

Starting epoch number 8

Loss for Training on Epoch 8 is 0.19734103977680206

Starting epoch number 9

Loss for Training on Epoch 9 is 0.1898534744977951

Starting epoch number 10

Loss for Training on Epoch 10 is 0.18637126684188843

-----	Class: aeroplane	AP:	0.4938	-----
-----	Class: bicycle	AP:	0.2030	-----
-----	Class: bird	AP:	0.1383	-----
-----	Class: boat	AP:	0.1861	-----
-----	Class: bottle	AP:	0.1387	-----
-----	Class: bus	AP:	0.1834	-----
-----	Class: car	AP:	0.4724	-----
-----	Class: cat	AP:	0.3032	-----
-----	Class: chair	AP:	0.3789	-----
-----	Class: cow	AP:	0.0501	-----
-----	Class: diningtable	AP:	0.2546	-----
-----	Class: dog	AP:	0.2622	-----
-----	Class: horse	AP:	0.3444	-----
-----	Class: motorbike	AP:	0.2083	-----
-----	Class: person	AP:	0.6814	-----
-----	Class: pottedplant	AP:	0.1468	-----
-----	Class: sheep	AP:	0.1229	-----
-----	Class: sofa	AP:	0.2075	-----
-----	Class: train	AP:	0.3061	-----
-----	Class: tvmonitor	AP:	0.1857	-----

mAP: 0.2634

Avg loss: 0.20345939733088017

Evaluating classifier

Mean Precision Score for Testing on Epoch 10 is 0.263381770244122

Starting epoch number 11

Loss for Training on Epoch 11 is 0.18191127479076385
 Starting epoch number 12
 Loss for Training on Epoch 12 is 0.17952875792980194
 Starting epoch number 13
 Loss for Training on Epoch 13 is 0.17643849551677704
 Starting epoch number 14
 Loss for Training on Epoch 14 is 0.17711840569972992
 Starting epoch number 15
 Loss for Training on Epoch 15 is 0.1728639155626297

-----	Class: aeroplane	AP:	0.5290	-----
-----	Class: bicycle	AP:	0.1706	-----
-----	Class: bird	AP:	0.1222	-----
-----	Class: boat	AP:	0.2104	-----
-----	Class: bottle	AP:	0.1450	-----
-----	Class: bus	AP:	0.1938	-----
-----	Class: car	AP:	0.5137	-----
-----	Class: cat	AP:	0.3737	-----
-----	Class: chair	AP:	0.3652	-----
-----	Class: cow	AP:	0.0837	-----
-----	Class: diningtable	AP:	0.2442	-----
-----	Class: dog	AP:	0.2330	-----
-----	Class: horse	AP:	0.3292	-----
-----	Class: motorbike	AP:	0.2953	-----
-----	Class: person	AP:	0.7205	-----
-----	Class: pottedplant	AP:	0.1165	-----
-----	Class: sheep	AP:	0.0824	-----
-----	Class: sofa	AP:	0.2476	-----
-----	Class: train	AP:	0.4511	-----
-----	Class: tvmonitor	AP:	0.2262	-----

 mAP: 0.2827
 Avg loss: 0.19787230677902698
 Evaluating classifier
 Mean Precision Score for Testing on Epoch 15 is 0.28266272319961366
 Starting epoch number 16
 Loss for Training on Epoch 16 is 0.16555018723011017
 Starting epoch number 17
 Loss for Training on Epoch 17 is 0.16299913823604584
 Starting epoch number 18
 Loss for Training on Epoch 18 is 0.15933208167552948
 Starting epoch number 19
 Loss for Training on Epoch 19 is 0.15400688350200653
 Starting epoch number 20
 Loss for Training on Epoch 20 is 0.15182310342788696

-----	Class: aeroplane	AP:	0.5467	-----
-----	Class: bicycle	AP:	0.1998	-----
-----	Class: bird	AP:	0.1976	-----
-----	Class: boat	AP:	0.2216	-----
-----	Class: bottle	AP:	0.1169	-----

-----	Class: bus	AP:	0.1957	-----
-----	Class: car	AP:	0.4891	-----
-----	Class: cat	AP:	0.3684	-----
-----	Class: chair	AP:	0.3755	-----
-----	Class: cow	AP:	0.1496	-----
-----	Class: diningtable	AP:	0.2694	-----
-----	Class: dog	AP:	0.2435	-----
-----	Class: horse	AP:	0.4452	-----
-----	Class: motorbike	AP:	0.2903	-----
-----	Class: person	AP:	0.7366	-----
-----	Class: pottedplant	AP:	0.1520	-----
-----	Class: sheep	AP:	0.1112	-----
-----	Class: sofa	AP:	0.2544	-----
-----	Class: train	AP:	0.3231	-----
-----	Class: tvmonitor	AP:	0.1863	-----

mAP: 0.2936

Avg loss: 0.22150178216397762

Evaluating classifier

Mean Precision Score for Testing on Epoch 20 is 0.2936403524216849

Starting epoch number 21

Loss for Training on Epoch 21 is 0.14881746470928192

Starting epoch number 22

Loss for Training on Epoch 22 is 0.1459578573703766

Starting epoch number 23

Loss for Training on Epoch 23 is 0.14258389174938202

Starting epoch number 24

Loss for Training on Epoch 24 is 0.14088647067546844

Starting epoch number 25

Loss for Training on Epoch 25 is 0.13543032109737396

-----	Class: aeroplane	AP:	0.5562	-----
-----	Class: bicycle	AP:	0.3205	-----
-----	Class: bird	AP:	0.2370	-----
-----	Class: boat	AP:	0.2308	-----
-----	Class: bottle	AP:	0.1383	-----
-----	Class: bus	AP:	0.2893	-----
-----	Class: car	AP:	0.5527	-----
-----	Class: cat	AP:	0.3451	-----
-----	Class: chair	AP:	0.4096	-----
-----	Class: cow	AP:	0.1621	-----
-----	Class: diningtable	AP:	0.2945	-----
-----	Class: dog	AP:	0.2746	-----
-----	Class: horse	AP:	0.4984	-----
-----	Class: motorbike	AP:	0.3623	-----
-----	Class: person	AP:	0.7554	-----
-----	Class: pottedplant	AP:	0.1582	-----
-----	Class: sheep	AP:	0.1201	-----
-----	Class: sofa	AP:	0.2874	-----
-----	Class: train	AP:	0.5389	-----

```

----- Class: tvmonitor      AP:  0.2631 -----
mAP: 0.3397
Avg loss: 0.19867889918386936
Evaluating classifier
Mean Precision Score for Testing on Epoch 25 is 0.33972006157349066
Starting epoch number 26
Loss for Training on Epoch 26 is 0.13569967448711395
Starting epoch number 27
Loss for Training on Epoch 27 is 0.1308898627758026
Starting epoch number 28
Loss for Training on Epoch 28 is 0.12807586789131165
Starting epoch number 29
Loss for Training on Epoch 29 is 0.1269540637731552
Starting epoch number 30
Loss for Training on Epoch 30 is 0.1218298077583313
----- Class: aeroplane      AP:  0.5648 -----
----- Class: bicycle        AP:  0.3138 -----
----- Class: bird            AP:  0.2474 -----
----- Class: boat            AP:  0.2602 -----
----- Class: bottle          AP:  0.1576 -----
----- Class: bus              AP:  0.3136 -----
----- Class: car              AP:  0.5388 -----
----- Class: cat              AP:  0.3343 -----
----- Class: chair            AP:  0.4344 -----
----- Class: cow              AP:  0.1364 -----
----- Class: diningtable     AP:  0.3441 -----
----- Class: dog              AP:  0.2779 -----
----- Class: horse            AP:  0.4997 -----
----- Class: motorbike        AP:  0.4056 -----
----- Class: person           AP:  0.7560 -----
----- Class: pottedplant      AP:  0.1371 -----
----- Class: sheep            AP:  0.1182 -----
----- Class: sofa              AP:  0.2155 -----
----- Class: train            AP:  0.5121 -----
----- Class: tvmonitor        AP:  0.2505 -----
mAP: 0.3409
Avg loss: 0.21133783757686614
Evaluating classifier
Mean Precision Score for Testing on Epoch 30 is 0.34090507611724424
----- Class: aeroplane      AP:  0.6022 -----
----- Class: bicycle        AP:  0.2980 -----
----- Class: bird            AP:  0.2515 -----
----- Class: boat            AP:  0.2665 -----
----- Class: bottle          AP:  0.1355 -----
----- Class: bus              AP:  0.2902 -----
----- Class: car              AP:  0.5662 -----
----- Class: cat              AP:  0.3444 -----
----- Class: chair            AP:  0.3938 -----

```

-----	Class: cow	AP:	0.1607	-----
-----	Class: diningtable	AP:	0.2366	-----
-----	Class: dog	AP:	0.2930	-----
-----	Class: horse	AP:	0.5592	-----
-----	Class: motorbike	AP:	0.4372	-----
-----	Class: person	AP:	0.7827	-----
-----	Class: pottedplant	AP:	0.1554	-----
-----	Class: sheep	AP:	0.2148	-----
-----	Class: sofa	AP:	0.2378	-----
-----	Class: train	AP:	0.4831	-----
-----	Class: tvmonitor	AP:	0.2786	-----

mAP: 0.3494

Avg loss: 0.20553213759110525

Starting epoch number 31

Loss for Training on Epoch 31 is 0.11693406105041504

-----	Class: aeroplane	AP:	0.5837	-----
-----	Class: bicycle	AP:	0.2767	-----
-----	Class: bird	AP:	0.2554	-----
-----	Class: boat	AP:	0.2898	-----
-----	Class: bottle	AP:	0.1390	-----
-----	Class: bus	AP:	0.2526	-----
-----	Class: car	AP:	0.5398	-----
-----	Class: cat	AP:	0.3046	-----
-----	Class: chair	AP:	0.3502	-----
-----	Class: cow	AP:	0.1612	-----
-----	Class: diningtable	AP:	0.2429	-----
-----	Class: dog	AP:	0.2787	-----
-----	Class: horse	AP:	0.5890	-----
-----	Class: motorbike	AP:	0.4307	-----
-----	Class: person	AP:	0.7750	-----
-----	Class: pottedplant	AP:	0.1421	-----
-----	Class: sheep	AP:	0.2183	-----
-----	Class: sofa	AP:	0.2303	-----
-----	Class: train	AP:	0.5391	-----
-----	Class: tvmonitor	AP:	0.2608	-----

mAP: 0.3430

Avg loss: 0.20079753815363616

Starting epoch number 32

Loss for Training on Epoch 32 is 0.11348869651556015

-----	Class: aeroplane	AP:	0.5814	-----
-----	Class: bicycle	AP:	0.2732	-----
-----	Class: bird	AP:	0.2426	-----
-----	Class: boat	AP:	0.2334	-----
-----	Class: bottle	AP:	0.1239	-----
-----	Class: bus	AP:	0.3079	-----
-----	Class: car	AP:	0.5753	-----
-----	Class: cat	AP:	0.3507	-----
-----	Class: chair	AP:	0.3911	-----

-----	Class: cow	AP:	0.1479	-----
-----	Class: diningtable	AP:	0.2631	-----
-----	Class: dog	AP:	0.2982	-----
-----	Class: horse	AP:	0.5748	-----
-----	Class: motorbike	AP:	0.3946	-----
-----	Class: person	AP:	0.7830	-----
-----	Class: pottedplant	AP:	0.1414	-----
-----	Class: sheep	AP:	0.2031	-----
-----	Class: sofa	AP:	0.2606	-----
-----	Class: train	AP:	0.5309	-----
-----	Class: tvmonitor	AP:	0.2691	-----

mAP: 0.3473

Avg loss: 0.19767416402315482

Starting epoch number 33

Loss for Training on Epoch 33 is 0.10820420831441879

-----	Class: aeroplane	AP:	0.6113	-----
-----	Class: bicycle	AP:	0.3273	-----
-----	Class: bird	AP:	0.2528	-----
-----	Class: boat	AP:	0.2365	-----
-----	Class: bottle	AP:	0.1498	-----
-----	Class: bus	AP:	0.2907	-----
-----	Class: car	AP:	0.6048	-----
-----	Class: cat	AP:	0.3246	-----
-----	Class: chair	AP:	0.4088	-----
-----	Class: cow	AP:	0.1672	-----
-----	Class: diningtable	AP:	0.2700	-----
-----	Class: dog	AP:	0.2778	-----
-----	Class: horse	AP:	0.5895	-----
-----	Class: motorbike	AP:	0.4376	-----
-----	Class: person	AP:	0.7929	-----
-----	Class: pottedplant	AP:	0.1748	-----
-----	Class: sheep	AP:	0.1962	-----
-----	Class: sofa	AP:	0.2467	-----
-----	Class: train	AP:	0.5067	-----
-----	Class: tvmonitor	AP:	0.2683	-----

mAP: 0.3567

Avg loss: 0.19901316249981904

Starting epoch number 34

Loss for Training on Epoch 34 is 0.1073135957121849

-----	Class: aeroplane	AP:	0.6026	-----
-----	Class: bicycle	AP:	0.3232	-----
-----	Class: bird	AP:	0.2359	-----
-----	Class: boat	AP:	0.2513	-----
-----	Class: bottle	AP:	0.1166	-----
-----	Class: bus	AP:	0.2865	-----
-----	Class: car	AP:	0.5838	-----
-----	Class: cat	AP:	0.3389	-----
-----	Class: chair	AP:	0.3748	-----

-----	Class: cow	AP:	0.1625	-----
-----	Class: diningtable	AP:	0.2136	-----
-----	Class: dog	AP:	0.2263	-----
-----	Class: horse	AP:	0.5460	-----
-----	Class: motorbike	AP:	0.4349	-----
-----	Class: person	AP:	0.7673	-----
-----	Class: pottedplant	AP:	0.1470	-----
-----	Class: sheep	AP:	0.2062	-----
-----	Class: sofa	AP:	0.2506	-----
-----	Class: train	AP:	0.5695	-----
-----	Class: tvmonitor	AP:	0.2691	-----

mAP: 0.3453

Avg loss: 0.21681298525669637

Starting epoch number 35

Loss for Training on Epoch 35 is 0.10468023270368576

-----	Class: aeroplane	AP:	0.5633	-----
-----	Class: bicycle	AP:	0.3058	-----
-----	Class: bird	AP:	0.2123	-----
-----	Class: boat	AP:	0.2542	-----
-----	Class: bottle	AP:	0.1305	-----
-----	Class: bus	AP:	0.2735	-----
-----	Class: car	AP:	0.5394	-----
-----	Class: cat	AP:	0.3314	-----
-----	Class: chair	AP:	0.4038	-----
-----	Class: cow	AP:	0.1720	-----
-----	Class: diningtable	AP:	0.2864	-----
-----	Class: dog	AP:	0.2473	-----
-----	Class: horse	AP:	0.5331	-----
-----	Class: motorbike	AP:	0.3913	-----
-----	Class: person	AP:	0.7501	-----
-----	Class: pottedplant	AP:	0.1497	-----
-----	Class: sheep	AP:	0.1606	-----
-----	Class: sofa	AP:	0.2197	-----
-----	Class: train	AP:	0.5235	-----
-----	Class: tvmonitor	AP:	0.2846	-----

mAP: 0.3366

Avg loss: 0.22667076215147972

Evaluating classifier

Mean Precision Score for Testing on Epoch 35 is 0.3366286586682301

-----	Class: aeroplane	AP:	0.6149	-----
-----	Class: bicycle	AP:	0.2821	-----
-----	Class: bird	AP:	0.2138	-----
-----	Class: boat	AP:	0.2235	-----
-----	Class: bottle	AP:	0.1192	-----
-----	Class: bus	AP:	0.3140	-----
-----	Class: car	AP:	0.5899	-----
-----	Class: cat	AP:	0.3163	-----
-----	Class: chair	AP:	0.3890	-----

-----	Class: cow	AP:	0.1447	-----
-----	Class: diningtable	AP:	0.3074	-----
-----	Class: dog	AP:	0.2667	-----
-----	Class: horse	AP:	0.6013	-----
-----	Class: motorbike	AP:	0.4246	-----
-----	Class: person	AP:	0.7719	-----
-----	Class: pottedplant	AP:	0.1399	-----
-----	Class: sheep	AP:	0.2061	-----
-----	Class: sofa	AP:	0.2410	-----
-----	Class: train	AP:	0.5489	-----
-----	Class: tvmonitor	AP:	0.2690	-----

mAP: 0.3492

Avg loss: 0.219073134355056

Starting epoch number 36

Loss for Training on Epoch 36 is 0.09619826823472977

-----	Class: aeroplane	AP:	0.5747	-----
-----	Class: bicycle	AP:	0.2474	-----
-----	Class: bird	AP:	0.2196	-----
-----	Class: boat	AP:	0.2343	-----
-----	Class: bottle	AP:	0.1222	-----
-----	Class: bus	AP:	0.2528	-----
-----	Class: car	AP:	0.5622	-----
-----	Class: cat	AP:	0.3087	-----
-----	Class: chair	AP:	0.3489	-----
-----	Class: cow	AP:	0.1452	-----
-----	Class: diningtable	AP:	0.1861	-----
-----	Class: dog	AP:	0.2349	-----
-----	Class: horse	AP:	0.5123	-----
-----	Class: motorbike	AP:	0.4053	-----
-----	Class: person	AP:	0.7649	-----
-----	Class: pottedplant	AP:	0.1560	-----
-----	Class: sheep	AP:	0.2011	-----
-----	Class: sofa	AP:	0.2543	-----
-----	Class: train	AP:	0.4645	-----
-----	Class: tvmonitor	AP:	0.2147	-----

mAP: 0.3205

Avg loss: 0.254372880817988

Starting epoch number 37

Loss for Training on Epoch 37 is 0.09276940673589706

-----	Class: aeroplane	AP:	0.5670	-----
-----	Class: bicycle	AP:	0.2505	-----
-----	Class: bird	AP:	0.2498	-----
-----	Class: boat	AP:	0.2255	-----
-----	Class: bottle	AP:	0.1384	-----
-----	Class: bus	AP:	0.2516	-----
-----	Class: car	AP:	0.5611	-----
-----	Class: cat	AP:	0.2940	-----
-----	Class: chair	AP:	0.3247	-----

-----	Class: cow	AP:	0.1662	-----
-----	Class: diningtable	AP:	0.2382	-----
-----	Class: dog	AP:	0.2459	-----
-----	Class: horse	AP:	0.5553	-----
-----	Class: motorbike	AP:	0.2991	-----
-----	Class: person	AP:	0.7825	-----
-----	Class: pottedplant	AP:	0.1415	-----
-----	Class: sheep	AP:	0.2461	-----
-----	Class: sofa	AP:	0.2109	-----
-----	Class: train	AP:	0.5077	-----
-----	Class: tvmonitor	AP:	0.2489	-----

mAP: 0.3253

Avg loss: 0.24094936499993005

Starting epoch number 38

Loss for Training on Epoch 38 is 0.09348646551370621

-----	Class: aeroplane	AP:	0.5971	-----
-----	Class: bicycle	AP:	0.3031	-----
-----	Class: bird	AP:	0.2524	-----
-----	Class: boat	AP:	0.2305	-----
-----	Class: bottle	AP:	0.1233	-----
-----	Class: bus	AP:	0.2699	-----
-----	Class: car	AP:	0.5538	-----
-----	Class: cat	AP:	0.3257	-----
-----	Class: chair	AP:	0.3600	-----
-----	Class: cow	AP:	0.1289	-----
-----	Class: diningtable	AP:	0.2710	-----
-----	Class: dog	AP:	0.2417	-----
-----	Class: horse	AP:	0.5725	-----
-----	Class: motorbike	AP:	0.4385	-----
-----	Class: person	AP:	0.7672	-----
-----	Class: pottedplant	AP:	0.1629	-----
-----	Class: sheep	AP:	0.2089	-----
-----	Class: sofa	AP:	0.2344	-----
-----	Class: train	AP:	0.5531	-----
-----	Class: tvmonitor	AP:	0.2399	-----

mAP: 0.3417

Avg loss: 0.22803406169017157

Starting epoch number 39

Loss for Training on Epoch 39 is 0.09097772091627121

-----	Class: aeroplane	AP:	0.6028	-----
-----	Class: bicycle	AP:	0.2777	-----
-----	Class: bird	AP:	0.2358	-----
-----	Class: boat	AP:	0.2155	-----
-----	Class: bottle	AP:	0.1363	-----
-----	Class: bus	AP:	0.2711	-----
-----	Class: car	AP:	0.5930	-----
-----	Class: cat	AP:	0.3181	-----
-----	Class: chair	AP:	0.3853	-----

-----	Class: cow	AP:	0.1658	-----
-----	Class: diningtable	AP:	0.2861	-----
-----	Class: dog	AP:	0.2492	-----
-----	Class: horse	AP:	0.5605	-----
-----	Class: motorbike	AP:	0.3966	-----
-----	Class: person	AP:	0.7678	-----
-----	Class: pottedplant	AP:	0.1456	-----
-----	Class: sheep	AP:	0.1920	-----
-----	Class: sofa	AP:	0.2634	-----
-----	Class: train	AP:	0.5328	-----
-----	Class: tvmonitor	AP:	0.2538	-----

mAP: 0.3425

Avg loss: 0.22859183374123695

Starting epoch number 40

Loss for Training on Epoch 40 is 0.09320391714572906

-----	Class: aeroplane	AP:	0.5073	-----
-----	Class: bicycle	AP:	0.2569	-----
-----	Class: bird	AP:	0.2427	-----
-----	Class: boat	AP:	0.2279	-----
-----	Class: bottle	AP:	0.1174	-----
-----	Class: bus	AP:	0.1190	-----
-----	Class: car	AP:	0.5433	-----
-----	Class: cat	AP:	0.2924	-----
-----	Class: chair	AP:	0.3464	-----
-----	Class: cow	AP:	0.1509	-----
-----	Class: diningtable	AP:	0.2451	-----
-----	Class: dog	AP:	0.1897	-----
-----	Class: horse	AP:	0.4782	-----
-----	Class: motorbike	AP:	0.4243	-----
-----	Class: person	AP:	0.7262	-----
-----	Class: pottedplant	AP:	0.1489	-----
-----	Class: sheep	AP:	0.1528	-----
-----	Class: sofa	AP:	0.2087	-----
-----	Class: train	AP:	0.4888	-----
-----	Class: tvmonitor	AP:	0.2225	-----

mAP: 0.3045

Avg loss: 0.2690956272184849

Evaluating classifier

Mean Precision Score for Testing on Epoch 40 is 0.3044721273516529

-----	Class: aeroplane	AP:	0.5476	-----
-----	Class: bicycle	AP:	0.2475	-----
-----	Class: bird	AP:	0.2265	-----
-----	Class: boat	AP:	0.2274	-----
-----	Class: bottle	AP:	0.0933	-----
-----	Class: bus	AP:	0.1263	-----
-----	Class: car	AP:	0.6051	-----
-----	Class: cat	AP:	0.2926	-----
-----	Class: chair	AP:	0.3360	-----

-----	Class: cow	AP:	0.1458	-----
-----	Class: diningtable	AP:	0.1862	-----
-----	Class: dog	AP:	0.2056	-----
-----	Class: horse	AP:	0.5288	-----
-----	Class: motorbike	AP:	0.4244	-----
-----	Class: person	AP:	0.7398	-----
-----	Class: pottedplant	AP:	0.1380	-----
-----	Class: sheep	AP:	0.1907	-----
-----	Class: sofa	AP:	0.2312	-----
-----	Class: train	AP:	0.4267	-----
-----	Class: tvmonitor	AP:	0.2030	-----

mAP: 0.3061

Avg loss: 0.26930910635453004

Starting epoch number 41

Loss for Training on Epoch 41 is 0.09097173810005188

-----	Class: aeroplane	AP:	0.6172	-----
-----	Class: bicycle	AP:	0.3082	-----
-----	Class: bird	AP:	0.2355	-----
-----	Class: boat	AP:	0.2513	-----
-----	Class: bottle	AP:	0.1270	-----
-----	Class: bus	AP:	0.2319	-----
-----	Class: car	AP:	0.5655	-----
-----	Class: cat	AP:	0.2936	-----
-----	Class: chair	AP:	0.3671	-----
-----	Class: cow	AP:	0.1466	-----
-----	Class: diningtable	AP:	0.2552	-----
-----	Class: dog	AP:	0.2287	-----
-----	Class: horse	AP:	0.5622	-----
-----	Class: motorbike	AP:	0.4073	-----
-----	Class: person	AP:	0.7643	-----
-----	Class: pottedplant	AP:	0.1480	-----
-----	Class: sheep	AP:	0.1929	-----
-----	Class: sofa	AP:	0.2386	-----
-----	Class: train	AP:	0.5199	-----
-----	Class: tvmonitor	AP:	0.2734	-----

mAP: 0.3367

Avg loss: 0.25109109167869276

Starting epoch number 42

Loss for Training on Epoch 42 is 0.0881408303976059

-----	Class: aeroplane	AP:	0.6178	-----
-----	Class: bicycle	AP:	0.2810	-----
-----	Class: bird	AP:	0.2404	-----
-----	Class: boat	AP:	0.2635	-----
-----	Class: bottle	AP:	0.1279	-----
-----	Class: bus	AP:	0.2731	-----
-----	Class: car	AP:	0.5871	-----
-----	Class: cat	AP:	0.3191	-----
-----	Class: chair	AP:	0.3526	-----

-----	Class: cow	AP:	0.1723	-----
-----	Class: diningtable	AP:	0.2798	-----
-----	Class: dog	AP:	0.2503	-----
-----	Class: horse	AP:	0.5670	-----
-----	Class: motorbike	AP:	0.3349	-----
-----	Class: person	AP:	0.7865	-----
-----	Class: pottedplant	AP:	0.1334	-----
-----	Class: sheep	AP:	0.1992	-----
-----	Class: sofa	AP:	0.2259	-----
-----	Class: train	AP:	0.5107	-----
-----	Class: tvmonitor	AP:	0.2470	-----

mAP: 0.3385

Avg loss: 0.23735365118735877

Starting epoch number 43

Loss for Training on Epoch 43 is 0.07947706431150436

-----	Class: aeroplane	AP:	0.5804	-----
-----	Class: bicycle	AP:	0.3136	-----
-----	Class: bird	AP:	0.2316	-----
-----	Class: boat	AP:	0.2749	-----
-----	Class: bottle	AP:	0.1192	-----
-----	Class: bus	AP:	0.3392	-----
-----	Class: car	AP:	0.5751	-----
-----	Class: cat	AP:	0.2798	-----
-----	Class: chair	AP:	0.3896	-----
-----	Class: cow	AP:	0.1420	-----
-----	Class: diningtable	AP:	0.2219	-----
-----	Class: dog	AP:	0.2583	-----
-----	Class: horse	AP:	0.5946	-----
-----	Class: motorbike	AP:	0.4481	-----
-----	Class: person	AP:	0.7712	-----
-----	Class: pottedplant	AP:	0.1861	-----
-----	Class: sheep	AP:	0.2264	-----
-----	Class: sofa	AP:	0.2623	-----
-----	Class: train	AP:	0.5502	-----
-----	Class: tvmonitor	AP:	0.2506	-----

mAP: 0.3508

Avg loss: 0.2495525299738615

Starting epoch number 44

Loss for Training on Epoch 44 is 0.07498538494110107

-----	Class: aeroplane	AP:	0.5907	-----
-----	Class: bicycle	AP:	0.2663	-----
-----	Class: bird	AP:	0.2056	-----
-----	Class: boat	AP:	0.2890	-----
-----	Class: bottle	AP:	0.0926	-----
-----	Class: bus	AP:	0.2271	-----
-----	Class: car	AP:	0.5592	-----
-----	Class: cat	AP:	0.2591	-----
-----	Class: chair	AP:	0.3293	-----

-----	Class: cow	AP:	0.1269	-----
-----	Class: diningtable	AP:	0.2585	-----
-----	Class: dog	AP:	0.1888	-----
-----	Class: horse	AP:	0.5408	-----
-----	Class: motorbike	AP:	0.4404	-----
-----	Class: person	AP:	0.6763	-----
-----	Class: pottedplant	AP:	0.1742	-----
-----	Class: sheep	AP:	0.1599	-----
-----	Class: sofa	AP:	0.2057	-----
-----	Class: train	AP:	0.5321	-----
-----	Class: tvmonitor	AP:	0.2392	-----

mAP: 0.3181

Avg loss: 0.27883820407665694

Starting epoch number 45

Loss for Training on Epoch 45 is 0.08261450380086899

-----	Class: aeroplane	AP:	0.5493	-----
-----	Class: bicycle	AP:	0.3043	-----
-----	Class: bird	AP:	0.2808	-----
-----	Class: boat	AP:	0.2310	-----
-----	Class: bottle	AP:	0.1231	-----
-----	Class: bus	AP:	0.2370	-----
-----	Class: car	AP:	0.5241	-----
-----	Class: cat	AP:	0.3307	-----
-----	Class: chair	AP:	0.3922	-----
-----	Class: cow	AP:	0.1591	-----
-----	Class: diningtable	AP:	0.2840	-----
-----	Class: dog	AP:	0.2409	-----
-----	Class: horse	AP:	0.5234	-----
-----	Class: motorbike	AP:	0.3509	-----
-----	Class: person	AP:	0.7681	-----
-----	Class: pottedplant	AP:	0.1586	-----
-----	Class: sheep	AP:	0.1101	-----
-----	Class: sofa	AP:	0.2475	-----
-----	Class: train	AP:	0.5280	-----
-----	Class: tvmonitor	AP:	0.2148	-----

mAP: 0.3279

Avg loss: 0.2635257299989462

Evaluating classifier

Mean Precision Score for Testing on Epoch 45 is 0.32790136488779476

-----	Class: aeroplane	AP:	0.5561	-----
-----	Class: bicycle	AP:	0.2778	-----
-----	Class: bird	AP:	0.2657	-----
-----	Class: boat	AP:	0.2304	-----
-----	Class: bottle	AP:	0.1435	-----
-----	Class: bus	AP:	0.2380	-----
-----	Class: car	AP:	0.5395	-----
-----	Class: cat	AP:	0.3013	-----
-----	Class: chair	AP:	0.3689	-----

-----	Class: cow	AP:	0.1538	-----
-----	Class: diningtable	AP:	0.2203	-----
-----	Class: dog	AP:	0.2527	-----
-----	Class: horse	AP:	0.6129	-----
-----	Class: motorbike	AP:	0.3570	-----
-----	Class: person	AP:	0.7807	-----
-----	Class: pottedplant	AP:	0.1558	-----
-----	Class: sheep	AP:	0.1887	-----
-----	Class: sofa	AP:	0.2230	-----
-----	Class: train	AP:	0.5013	-----
-----	Class: tvmonitor	AP:	0.2475	-----

mAP: 0.3308

Avg loss: 0.26168971183972484

Starting epoch number 46

Loss for Training on Epoch 46 is 0.06870776414871216

-----	Class: aeroplane	AP:	0.5940	-----
-----	Class: bicycle	AP:	0.3591	-----
-----	Class: bird	AP:	0.2696	-----
-----	Class: boat	AP:	0.2710	-----
-----	Class: bottle	AP:	0.1384	-----
-----	Class: bus	AP:	0.2881	-----
-----	Class: car	AP:	0.5757	-----
-----	Class: cat	AP:	0.3211	-----
-----	Class: chair	AP:	0.3811	-----
-----	Class: cow	AP:	0.1496	-----
-----	Class: diningtable	AP:	0.2552	-----
-----	Class: dog	AP:	0.2276	-----
-----	Class: horse	AP:	0.5933	-----
-----	Class: motorbike	AP:	0.4058	-----
-----	Class: person	AP:	0.7811	-----
-----	Class: pottedplant	AP:	0.1631	-----
-----	Class: sheep	AP:	0.2130	-----
-----	Class: sofa	AP:	0.2452	-----
-----	Class: train	AP:	0.5446	-----
-----	Class: tvmonitor	AP:	0.2374	-----

mAP: 0.3507

Avg loss: 0.24247017674721205

Starting epoch number 47

Loss for Training on Epoch 47 is 0.057370495051145554

-----	Class: aeroplane	AP:	0.5877	-----
-----	Class: bicycle	AP:	0.2777	-----
-----	Class: bird	AP:	0.2570	-----
-----	Class: boat	AP:	0.2624	-----
-----	Class: bottle	AP:	0.1230	-----
-----	Class: bus	AP:	0.1921	-----
-----	Class: car	AP:	0.5831	-----
-----	Class: cat	AP:	0.2950	-----
-----	Class: chair	AP:	0.3316	-----

-----	Class: cow	AP:	0.1484	-----
-----	Class: diningtable	AP:	0.2444	-----
-----	Class: dog	AP:	0.2161	-----
-----	Class: horse	AP:	0.5700	-----
-----	Class: motorbike	AP:	0.4082	-----
-----	Class: person	AP:	0.7861	-----
-----	Class: pottedplant	AP:	0.1479	-----
-----	Class: sheep	AP:	0.2123	-----
-----	Class: sofa	AP:	0.2220	-----
-----	Class: train	AP:	0.4867	-----
-----	Class: tvmonitor	AP:	0.2189	-----

mAP: 0.3285

Avg loss: 0.28297729274401295

Starting epoch number 48

Loss for Training on Epoch 48 is 0.0537562370300293

-----	Class: aeroplane	AP:	0.5860	-----
-----	Class: bicycle	AP:	0.2739	-----
-----	Class: bird	AP:	0.2503	-----
-----	Class: boat	AP:	0.2257	-----
-----	Class: bottle	AP:	0.1350	-----
-----	Class: bus	AP:	0.2488	-----
-----	Class: car	AP:	0.5830	-----
-----	Class: cat	AP:	0.3001	-----
-----	Class: chair	AP:	0.3646	-----
-----	Class: cow	AP:	0.1216	-----
-----	Class: diningtable	AP:	0.2888	-----
-----	Class: dog	AP:	0.2825	-----
-----	Class: horse	AP:	0.5436	-----
-----	Class: motorbike	AP:	0.3509	-----
-----	Class: person	AP:	0.7759	-----
-----	Class: pottedplant	AP:	0.1321	-----
-----	Class: sheep	AP:	0.1900	-----
-----	Class: sofa	AP:	0.2319	-----
-----	Class: train	AP:	0.5071	-----
-----	Class: tvmonitor	AP:	0.2785	-----

mAP: 0.3335

Avg loss: 0.3038333833981783

Starting epoch number 49

Loss for Training on Epoch 49 is 0.06328260153532028

-----	Class: aeroplane	AP:	0.5726	-----
-----	Class: bicycle	AP:	0.2716	-----
-----	Class: bird	AP:	0.1936	-----
-----	Class: boat	AP:	0.2516	-----
-----	Class: bottle	AP:	0.0990	-----
-----	Class: bus	AP:	0.2630	-----
-----	Class: car	AP:	0.5621	-----
-----	Class: cat	AP:	0.2692	-----
-----	Class: chair	AP:	0.3818	-----

-----	Class: cow	AP:	0.1381	-----
-----	Class: diningtable	AP:	0.2302	-----
-----	Class: dog	AP:	0.1919	-----
-----	Class: horse	AP:	0.5306	-----
-----	Class: motorbike	AP:	0.3227	-----
-----	Class: person	AP:	0.7428	-----
-----	Class: pottedplant	AP:	0.1701	-----
-----	Class: sheep	AP:	0.1851	-----
-----	Class: sofa	AP:	0.2635	-----
-----	Class: train	AP:	0.4512	-----
-----	Class: tvmonitor	AP:	0.2678	-----

mAP: 0.3179

Avg loss: 0.2813145457169948

Starting epoch number 50

Loss for Training on Epoch 50 is 0.07719395309686661

-----	Class: aeroplane	AP:	0.5529	-----
-----	Class: bicycle	AP:	0.3506	-----
-----	Class: bird	AP:	0.2640	-----
-----	Class: boat	AP:	0.2759	-----
-----	Class: bottle	AP:	0.1419	-----
-----	Class: bus	AP:	0.2439	-----
-----	Class: car	AP:	0.5383	-----
-----	Class: cat	AP:	0.2854	-----
-----	Class: chair	AP:	0.3530	-----
-----	Class: cow	AP:	0.1662	-----
-----	Class: diningtable	AP:	0.2825	-----
-----	Class: dog	AP:	0.2307	-----
-----	Class: horse	AP:	0.5016	-----
-----	Class: motorbike	AP:	0.3858	-----
-----	Class: person	AP:	0.7633	-----
-----	Class: pottedplant	AP:	0.1708	-----
-----	Class: sheep	AP:	0.1483	-----
-----	Class: sofa	AP:	0.2289	-----
-----	Class: train	AP:	0.5203	-----
-----	Class: tvmonitor	AP:	0.2160	-----

mAP: 0.3310

Avg loss: 0.267616443708539

Evaluating classifier

Mean Precision Score for Testing on Epoch 50 is 0.33102092195553723

-----	Class: aeroplane	AP:	0.5920	-----
-----	Class: bicycle	AP:	0.3036	-----
-----	Class: bird	AP:	0.2575	-----
-----	Class: boat	AP:	0.2247	-----
-----	Class: bottle	AP:	0.1155	-----
-----	Class: bus	AP:	0.2356	-----
-----	Class: car	AP:	0.5772	-----
-----	Class: cat	AP:	0.2933	-----
-----	Class: chair	AP:	0.3272	-----

-----	Class: cow	AP:	0.1067	-----
-----	Class: diningtable	AP:	0.2568	-----
-----	Class: dog	AP:	0.2257	-----
-----	Class: horse	AP:	0.6101	-----
-----	Class: motorbike	AP:	0.4369	-----
-----	Class: person	AP:	0.7784	-----
-----	Class: pottedplant	AP:	0.1496	-----
-----	Class: sheep	AP:	0.1958	-----
-----	Class: sofa	AP:	0.2189	-----
-----	Class: train	AP:	0.4941	-----
-----	Class: tvmonitor	AP:	0.2333	-----

mAP: 0.3316

Avg loss: 0.26263699374901944

Starting epoch number 51

Loss for Training on Epoch 51 is 0.0628899559378624

-----	Class: aeroplane	AP:	0.6018	-----
-----	Class: bicycle	AP:	0.2953	-----
-----	Class: bird	AP:	0.1823	-----
-----	Class: boat	AP:	0.2603	-----
-----	Class: bottle	AP:	0.0966	-----
-----	Class: bus	AP:	0.3018	-----
-----	Class: car	AP:	0.5606	-----
-----	Class: cat	AP:	0.2861	-----
-----	Class: chair	AP:	0.3669	-----
-----	Class: cow	AP:	0.1240	-----
-----	Class: diningtable	AP:	0.2360	-----
-----	Class: dog	AP:	0.2019	-----
-----	Class: horse	AP:	0.5967	-----
-----	Class: motorbike	AP:	0.2858	-----
-----	Class: person	AP:	0.7586	-----
-----	Class: pottedplant	AP:	0.1368	-----
-----	Class: sheep	AP:	0.1803	-----
-----	Class: sofa	AP:	0.2309	-----
-----	Class: train	AP:	0.5115	-----
-----	Class: tvmonitor	AP:	0.2280	-----

mAP: 0.3221

Avg loss: 0.28487487060901445

Starting epoch number 52

Loss for Training on Epoch 52 is 0.06321920454502106

-----	Class: aeroplane	AP:	0.5568	-----
-----	Class: bicycle	AP:	0.2742	-----
-----	Class: bird	AP:	0.2551	-----
-----	Class: boat	AP:	0.2668	-----
-----	Class: bottle	AP:	0.1247	-----
-----	Class: bus	AP:	0.2925	-----
-----	Class: car	AP:	0.5701	-----
-----	Class: cat	AP:	0.3188	-----
-----	Class: chair	AP:	0.3720	-----

-----	Class: cow	AP:	0.1383	-----
-----	Class: diningtable	AP:	0.3098	-----
-----	Class: dog	AP:	0.2406	-----
-----	Class: horse	AP:	0.5773	-----
-----	Class: motorbike	AP:	0.3989	-----
-----	Class: person	AP:	0.7759	-----
-----	Class: pottedplant	AP:	0.1361	-----
-----	Class: sheep	AP:	0.1831	-----
-----	Class: sofa	AP:	0.2470	-----
-----	Class: train	AP:	0.5017	-----
-----	Class: tvmonitor	AP:	0.2503	-----

mAP: 0.3395

Avg loss: 0.2935065462803229

Starting epoch number 53

Loss for Training on Epoch 53 is 0.05442402884364128

-----	Class: aeroplane	AP:	0.5979	-----
-----	Class: bicycle	AP:	0.2434	-----
-----	Class: bird	AP:	0.2495	-----
-----	Class: boat	AP:	0.2483	-----
-----	Class: bottle	AP:	0.1306	-----
-----	Class: bus	AP:	0.2126	-----
-----	Class: car	AP:	0.5660	-----
-----	Class: cat	AP:	0.3198	-----
-----	Class: chair	AP:	0.3330	-----
-----	Class: cow	AP:	0.1380	-----
-----	Class: diningtable	AP:	0.3147	-----
-----	Class: dog	AP:	0.2264	-----
-----	Class: horse	AP:	0.5389	-----
-----	Class: motorbike	AP:	0.2788	-----
-----	Class: person	AP:	0.7785	-----
-----	Class: pottedplant	AP:	0.1471	-----
-----	Class: sheep	AP:	0.1760	-----
-----	Class: sofa	AP:	0.2000	-----
-----	Class: train	AP:	0.4574	-----
-----	Class: tvmonitor	AP:	0.2084	-----

mAP: 0.3183

Avg loss: 0.3085624023507803

Starting epoch number 54

Loss for Training on Epoch 54 is 0.04285680875182152

-----	Class: aeroplane	AP:	0.5718	-----
-----	Class: bicycle	AP:	0.2805	-----
-----	Class: bird	AP:	0.2622	-----
-----	Class: boat	AP:	0.2378	-----
-----	Class: bottle	AP:	0.1183	-----
-----	Class: bus	AP:	0.2699	-----
-----	Class: car	AP:	0.5673	-----
-----	Class: cat	AP:	0.3057	-----
-----	Class: chair	AP:	0.3513	-----

-----	Class: cow	AP:	0.1398	-----
-----	Class: diningtable	AP:	0.2218	-----
-----	Class: dog	AP:	0.2574	-----
-----	Class: horse	AP:	0.5680	-----
-----	Class: motorbike	AP:	0.4588	-----
-----	Class: person	AP:	0.7777	-----
-----	Class: pottedplant	AP:	0.1347	-----
-----	Class: sheep	AP:	0.2203	-----
-----	Class: sofa	AP:	0.2562	-----
-----	Class: train	AP:	0.5059	-----
-----	Class: tvmonitor	AP:	0.2630	-----

mAP: 0.3384

Avg loss: 0.3118267592329245

Starting epoch number 55

Loss for Training on Epoch 55 is 0.052953243255615234

-----	Class: aeroplane	AP:	0.5703	-----
-----	Class: bicycle	AP:	0.3715	-----
-----	Class: bird	AP:	0.2880	-----
-----	Class: boat	AP:	0.2618	-----
-----	Class: bottle	AP:	0.1148	-----
-----	Class: bus	AP:	0.2355	-----
-----	Class: car	AP:	0.5162	-----
-----	Class: cat	AP:	0.2982	-----
-----	Class: chair	AP:	0.3584	-----
-----	Class: cow	AP:	0.1753	-----
-----	Class: diningtable	AP:	0.3001	-----
-----	Class: dog	AP:	0.2257	-----
-----	Class: horse	AP:	0.5272	-----
-----	Class: motorbike	AP:	0.4044	-----
-----	Class: person	AP:	0.7684	-----
-----	Class: pottedplant	AP:	0.1415	-----
-----	Class: sheep	AP:	0.0973	-----
-----	Class: sofa	AP:	0.2424	-----
-----	Class: train	AP:	0.5003	-----
-----	Class: tvmonitor	AP:	0.1971	-----

mAP: 0.3297

Avg loss: 0.29145172946155073

Evaluating classifier

Mean Precision Score for Testing on Epoch 55 is 0.3297184737762506

-----	Class: aeroplane	AP:	0.5897	-----
-----	Class: bicycle	AP:	0.3277	-----
-----	Class: bird	AP:	0.2382	-----
-----	Class: boat	AP:	0.2356	-----
-----	Class: bottle	AP:	0.1261	-----
-----	Class: bus	AP:	0.2190	-----
-----	Class: car	AP:	0.5741	-----
-----	Class: cat	AP:	0.2960	-----
-----	Class: chair	AP:	0.3216	-----

-----	Class: cow	AP:	0.1366	-----
-----	Class: diningtable	AP:	0.2530	-----
-----	Class: dog	AP:	0.2286	-----
-----	Class: horse	AP:	0.6129	-----
-----	Class: motorbike	AP:	0.4119	-----
-----	Class: person	AP:	0.7851	-----
-----	Class: pottedplant	AP:	0.1361	-----
-----	Class: sheep	AP:	0.1595	-----
-----	Class: sofa	AP:	0.2296	-----
-----	Class: train	AP:	0.4969	-----
-----	Class: tvmonitor	AP:	0.2425	-----

mAP: 0.3310

Avg loss: 0.2848468084747975

Starting epoch number 56

Loss for Training on Epoch 56 is 0.0455513596534729

-----	Class: aeroplane	AP:	0.5781	-----
-----	Class: bicycle	AP:	0.3252	-----
-----	Class: bird	AP:	0.2675	-----
-----	Class: boat	AP:	0.2269	-----
-----	Class: bottle	AP:	0.1160	-----
-----	Class: bus	AP:	0.1807	-----
-----	Class: car	AP:	0.5499	-----
-----	Class: cat	AP:	0.2914	-----
-----	Class: chair	AP:	0.3534	-----
-----	Class: cow	AP:	0.1577	-----
-----	Class: diningtable	AP:	0.2282	-----
-----	Class: dog	AP:	0.2344	-----
-----	Class: horse	AP:	0.5754	-----
-----	Class: motorbike	AP:	0.3824	-----
-----	Class: person	AP:	0.7729	-----
-----	Class: pottedplant	AP:	0.1439	-----
-----	Class: sheep	AP:	0.2065	-----
-----	Class: sofa	AP:	0.2333	-----
-----	Class: train	AP:	0.4350	-----
-----	Class: tvmonitor	AP:	0.2348	-----

mAP: 0.3247

Avg loss: 0.31285236661250776

Starting epoch number 57

Loss for Training on Epoch 57 is 0.06135474517941475

-----	Class: aeroplane	AP:	0.6093	-----
-----	Class: bicycle	AP:	0.3049	-----
-----	Class: bird	AP:	0.2397	-----
-----	Class: boat	AP:	0.2733	-----
-----	Class: bottle	AP:	0.1120	-----
-----	Class: bus	AP:	0.2371	-----
-----	Class: car	AP:	0.5979	-----
-----	Class: cat	AP:	0.3060	-----
-----	Class: chair	AP:	0.3436	-----

-----	Class: cow	AP:	0.1513	-----
-----	Class: diningtable	AP:	0.2469	-----
-----	Class: dog	AP:	0.2414	-----
-----	Class: horse	AP:	0.5658	-----
-----	Class: motorbike	AP:	0.4156	-----
-----	Class: person	AP:	0.7691	-----
-----	Class: pottedplant	AP:	0.1602	-----
-----	Class: sheep	AP:	0.1940	-----
-----	Class: sofa	AP:	0.2533	-----
-----	Class: train	AP:	0.5323	-----
-----	Class: tvmonitor	AP:	0.2548	-----

mAP: 0.3404

Avg loss: 0.3124669752059839

Starting epoch number 58

Loss for Training on Epoch 58 is 0.043130289763212204

-----	Class: aeroplane	AP:	0.5912	-----
-----	Class: bicycle	AP:	0.2358	-----
-----	Class: bird	AP:	0.2381	-----
-----	Class: boat	AP:	0.2453	-----
-----	Class: bottle	AP:	0.1121	-----
-----	Class: bus	AP:	0.2200	-----
-----	Class: car	AP:	0.5439	-----
-----	Class: cat	AP:	0.3016	-----
-----	Class: chair	AP:	0.3468	-----
-----	Class: cow	AP:	0.1218	-----
-----	Class: diningtable	AP:	0.3040	-----
-----	Class: dog	AP:	0.2419	-----
-----	Class: horse	AP:	0.5710	-----
-----	Class: motorbike	AP:	0.3026	-----
-----	Class: person	AP:	0.7558	-----
-----	Class: pottedplant	AP:	0.1353	-----
-----	Class: sheep	AP:	0.1873	-----
-----	Class: sofa	AP:	0.2251	-----
-----	Class: train	AP:	0.5118	-----
-----	Class: tvmonitor	AP:	0.2280	-----

mAP: 0.3210

Avg loss: 0.3261706832891855

Starting epoch number 59

Loss for Training on Epoch 59 is 0.04980778694152832

-----	Class: aeroplane	AP:	0.5740	-----
-----	Class: bicycle	AP:	0.2319	-----
-----	Class: bird	AP:	0.2294	-----
-----	Class: boat	AP:	0.2338	-----
-----	Class: bottle	AP:	0.1240	-----
-----	Class: bus	AP:	0.2638	-----
-----	Class: car	AP:	0.5610	-----
-----	Class: cat	AP:	0.3045	-----
-----	Class: chair	AP:	0.3583	-----

-----	Class: cow	AP:	0.1193	-----
-----	Class: diningtable	AP:	0.2711	-----
-----	Class: dog	AP:	0.2465	-----
-----	Class: horse	AP:	0.6007	-----
-----	Class: motorbike	AP:	0.3917	-----
-----	Class: person	AP:	0.7496	-----
-----	Class: pottedplant	AP:	0.1180	-----
-----	Class: sheep	AP:	0.1882	-----
-----	Class: sofa	AP:	0.2219	-----
-----	Class: train	AP:	0.5439	-----
-----	Class: tvmonitor	AP:	0.2619	-----

mAP: 0.3297

Avg loss: 0.32305784160510087

Starting epoch number 60

Loss for Training on Epoch 60 is 0.0317743681371212

-----	Class: aeroplane	AP:	0.5710	-----
-----	Class: bicycle	AP:	0.2834	-----
-----	Class: bird	AP:	0.2719	-----
-----	Class: boat	AP:	0.3028	-----
-----	Class: bottle	AP:	0.1206	-----
-----	Class: bus	AP:	0.2124	-----
-----	Class: car	AP:	0.5410	-----
-----	Class: cat	AP:	0.2885	-----
-----	Class: chair	AP:	0.4014	-----
-----	Class: cow	AP:	0.1487	-----
-----	Class: diningtable	AP:	0.2830	-----
-----	Class: dog	AP:	0.2518	-----
-----	Class: horse	AP:	0.5191	-----
-----	Class: motorbike	AP:	0.4379	-----
-----	Class: person	AP:	0.7634	-----
-----	Class: pottedplant	AP:	0.1370	-----
-----	Class: sheep	AP:	0.1170	-----
-----	Class: sofa	AP:	0.2123	-----
-----	Class: train	AP:	0.5536	-----
-----	Class: tvmonitor	AP:	0.2628	-----

mAP: 0.3340

Avg loss: 0.32776077538728715

Evaluating classifier

Mean Precision Score for Testing on Epoch 60 is 0.33397612779340025

-----	Class: aeroplane	AP:	0.5926	-----
-----	Class: bicycle	AP:	0.2810	-----
-----	Class: bird	AP:	0.2550	-----
-----	Class: boat	AP:	0.2384	-----
-----	Class: bottle	AP:	0.1309	-----
-----	Class: bus	AP:	0.2873	-----
-----	Class: car	AP:	0.5821	-----
-----	Class: cat	AP:	0.2896	-----
-----	Class: chair	AP:	0.3705	-----

-----	Class: cow	AP:	0.1402	-----
-----	Class: diningtable	AP:	0.2349	-----
-----	Class: dog	AP:	0.2430	-----
-----	Class: horse	AP:	0.5896	-----
-----	Class: motorbike	AP:	0.4539	-----
-----	Class: person	AP:	0.7775	-----
-----	Class: pottedplant	AP:	0.1444	-----
-----	Class: sheep	AP:	0.2067	-----
-----	Class: sofa	AP:	0.2556	-----
-----	Class: train	AP:	0.5437	-----
-----	Class: tvmonitor	AP:	0.2683	-----

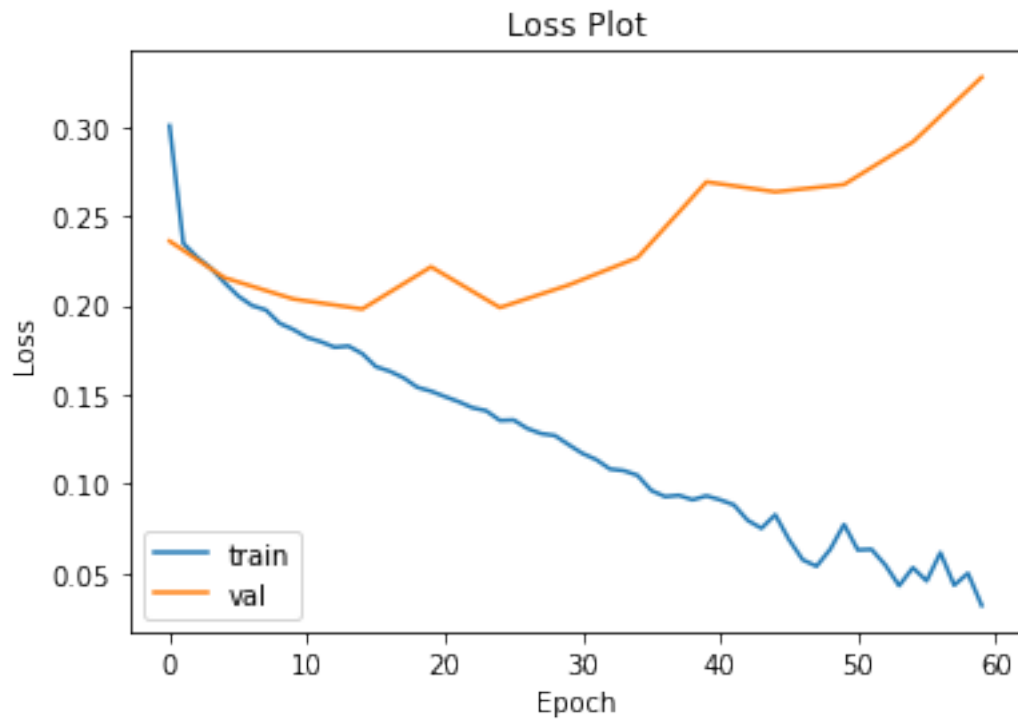
mAP: 0.3443

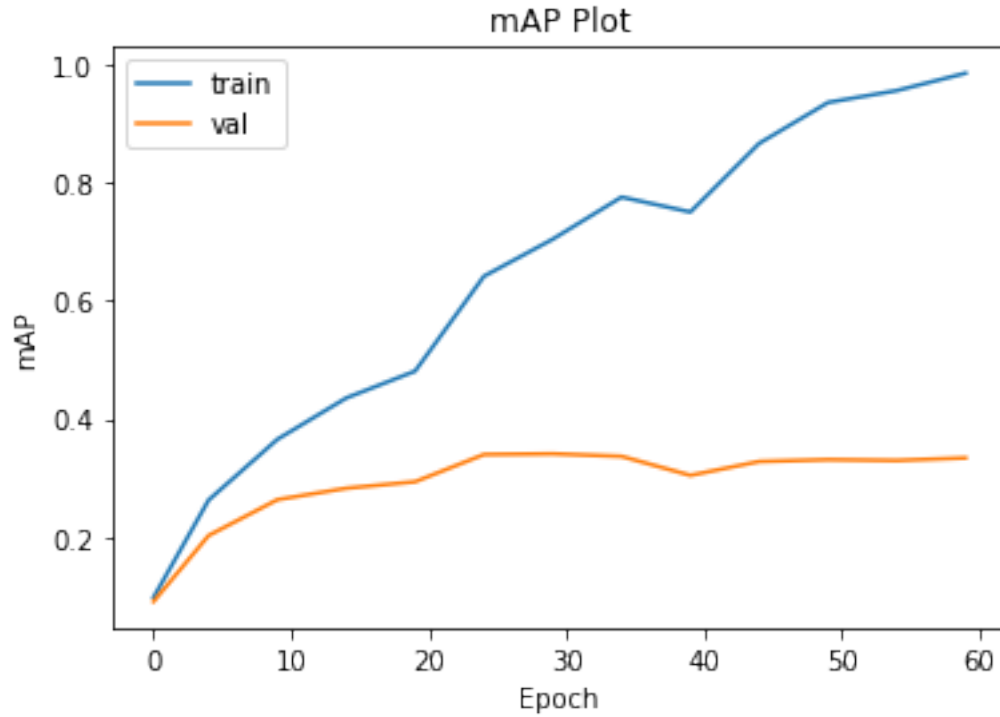
Avg loss: 0.3204586792450685

Max mAP_test achieved 0.3567192820663737 at epoch 34

```
[9]: plot_losses(train_losses, val_losses, test_frequency, num_epochs)

plot_mAP(train_mAPs, val_mAPs, test_frequency, num_epochs)
```





```
[12]: classifier = Classifier().to(device)
classifier.load_state_dict(torch.load('./voc_my_best_classifier_33.pth'))
mAP_test, test_loss, test_aps = test_classifier(test_loader, classifier,
→ criterion)
print(mAP_test)
```

-----	Class: aeroplane	AP: 0.6113	-----
-----	Class: bicycle	AP: 0.3273	-----
-----	Class: bird	AP: 0.2528	-----
-----	Class: boat	AP: 0.2365	-----
-----	Class: bottle	AP: 0.1498	-----
-----	Class: bus	AP: 0.2907	-----
-----	Class: car	AP: 0.6048	-----
-----	Class: cat	AP: 0.3246	-----
-----	Class: chair	AP: 0.4088	-----
-----	Class: cow	AP: 0.1672	-----
-----	Class: diningtable	AP: 0.2700	-----
-----	Class: dog	AP: 0.2778	-----
-----	Class: horse	AP: 0.5895	-----
-----	Class: motorbike	AP: 0.4376	-----
-----	Class: person	AP: 0.7929	-----
-----	Class: pottedplant	AP: 0.1748	-----
-----	Class: sheep	AP: 0.1962	-----
-----	Class: sofa	AP: 0.2467	-----

```
----- Class: train          AP:  0.5067  -----  
----- Class: tvmonitor      AP:  0.2683  -----  
mAP: 0.3567  
Avg loss: 0.19901316249981904  
0.3567192820663737
```

```
[11]: torch.save(classifier.state_dict(), './voc_my_best_classifier.pth')  
      output_submission_csv('my_solution.csv', test_aps)
```