# FaceMaskSSDMobileNetV3_FINAL_HEROKU_DEPLOYED

October 16, 2021

## 1 Start

[ ]:
```
pip install -U git+https://github.com/albumentations-team/albumentations
```

```
Collecting git+https://github.com/albumentations-team/albumentations
  Cloning https://github.com/albumentations-team/albumentations to /tmp/pip-req-
build-q5pwd9zy
  Running command git clone -q https://github.com/albumentations-
team/albumentations /tmp/pip-req-build-q5pwd9zy
Requirement already satisfied: numpy>=1.11.1 in /usr/local/lib/python3.7/dist-
packages (from albumentations==1.1.0) (1.19.5)
Requirement already satisfied: scipy in /usr/local/lib/python3.7/dist-packages
(from albumentations==1.1.0) (1.4.1)
Requirement already satisfied: scikit-image>=0.16.1 in
/usr/local/lib/python3.7/dist-packages (from albumentations==1.1.0) (0.16.2)
Requirement already satisfied: PyYAML in /usr/local/lib/python3.7/dist-packages
(from albumentations==1.1.0) (3.13)
Requirement already satisfied: qudida>=0.0.4 in /usr/local/lib/python3.7/dist-
packages (from albumentations==1.1.0) (0.0.4)
Requirement already satisfied: opencv-python>=4.1.1 in
/usr/local/lib/python3.7/dist-packages (from albumentations==1.1.0) (4.1.2.30)
Requirement already satisfied: typing-extensions in
/usr/local/lib/python3.7/dist-packages (from
qudida>=0.0.4->albumentations==1.1.0) (3.7.4.3)
Requirement already satisfied: scikit-learn>=0.19.1 in
/usr/local/lib/python3.7/dist-packages (from
qudida>=0.0.4->albumentations==1.1.0) (0.22.2.post1)
Requirement already satisfied: opencv-python-headless>=4.0.1 in
/usr/local/lib/python3.7/dist-packages (from
qudida>=0.0.4->albumentations==1.1.0) (4.5.3.56)
Requirement already satisfied: PyWavelets>=0.4.0 in
/usr/local/lib/python3.7/dist-packages (from scikit-
image>=0.16.1->albumentations==1.1.0) (1.1.1)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.7/dist-
packages (from scikit-image>=0.16.1->albumentations==1.1.0) (2.4.1)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.7/dist-
packages (from scikit-image>=0.16.1->albumentations==1.1.0) (2.6.3)
Requirement already satisfied: matplotlib!=3.0.0,>=2.0.0 in
```

```
/usr/local/lib/python3.7/dist-packages (from scikit-
image>=0.16.1->albumentations==1.1.0) (3.2.2)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.7/dist-
packages (from scikit-image>=0.16.1->albumentations==1.1.0) (7.1.2)
Requirement already satisfied: python-dateutil>=2.1 in
/usr/local/lib/python3.7/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-
image>=0.16.1->albumentations==1.1.0) (2.8.2)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in
/usr/local/lib/python3.7/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-
image>=0.16.1->albumentations==1.1.0) (2.4.7)
Requirement already satisfied: kiwisolver>=1.0.1 in
/usr/local/lib/python3.7/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-
image>=0.16.1->albumentations==1.1.0) (1.3.2)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.7/dist-
packages (from matplotlib!=3.0.0,>=2.0.0->scikit-
image>=0.16.1->albumentations==1.1.0) (0.10.0)
Requirement already satisfied: six in /usr/local/lib/python3.7/dist-packages
(from cycler>=0.10->matplotlib!=3.0.0,>=2.0.0->scikit-
image>=0.16.1->albumentations==1.1.0) (1.15.0)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.7/dist-
packages (from scikit-learn>=0.19.1->qudida>=0.0.4->albumentations==1.1.0)
(1.0.1)
```

[ ]:
```
from google.colab import drive
drive.mount("/content/gdrive")
```

```
Drive already mounted at /content/gdrive; to attempt to forcibly remount, call
drive.mount("/content/gdrive", force_remount=True).
```

[ ]:
```
!nvidia-smi
```

```
Thu Oct 14 15:21:18 2021
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 470.74       Driver Version: 460.32.03    CUDA Version: 11.2     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|                               |                      |               MIG M. |
|===============================+======================+======================|
|   0  Tesla P100-PCIE…  Off  | 00000000:00:04.0 Off |                    0 |
| N/A   46C    P0    28W / 250W |      0MiB / 16280MiB |      0%      Default |
|                               |                      |                  N/A |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                                  |
|  GPU   GI   CI        PID   Type   Process name                  GPU Memory |
|        ID   ID                                                   Usage      |
```

```
|===============================================================================|
|  No running processes found                                                   |
+-------------------------------------------------------------------------------+
```

## 2 Modules

[ ]:
```
# image
import cv2
import matplotlib.pyplot as plt
import seaborn as sns

# DL
import torch
import torchvision
from torch.utils.data import Dataset, DataLoader
from torch import nn as nn

# file
from glob import glob
import pandas as pd
import numpy as np
import os
import xml.etree.ElementTree as ET
from sklearn.model_selection import train_test_split
from tqdm import tqdm
import json

# augmentation
import albumentations as A
```

## 3 Data Extraction

[ ]:
```
!mkdir csvFolder
```

### 3.1 Data 1

https://www.kaggle.com/andrewmvd/face-mask-detection

[ ]:
```

```

```
!curl --header 'Host: storage.googleapis.com' --user-agent 'Mozilla/5.0 (X11;␣
↪Ubuntu; Linux x86_64; rv:93.0) Gecko/20100101 Firefox/93.0' --header 'Accept:
↪ text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/
↪webp,*/*;q=0.8' --header 'Accept-Language: en-US,en;q=0.5' --referer 'https:/
↪/www.kaggle.com/' --header 'DNT: 1' --header 'Upgrade-Insecure-Requests: 1'␣
↪--header 'Sec-Fetch-Dest: document' --header 'Sec-Fetch-Mode: navigate'␣
↪--header 'Sec-Fetch-Site: cross-site' --header 'Sec-Fetch-User: ?1' 'https://
↪storage.googleapis.com/kaggle-data-sets/667889/1176415/bundle/archive.zip?
↪X-Goog-Algorithm=GOOG4-RSA-SHA256&X-Goog-Credential=gcp-kaggle-com%40kaggle-161607.
↪iam.gserviceaccount.
↪com%2F20211014%2Fauto%2Fstorage%2Fgoog4_request&X-Goog-Date=20211014T112923Z&X-Goog-Expires
↪--output 'archive.zip'
```

```
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100  397M  100  397M    0     0  46.2M      0  0:00:08  0:00:08 --:--:-- 48.9M
```

[ ]:
```
!unzip /content/archive.zip -d /content/data1
```

[ ]:
```
!rm /content/archive.zip
```

[ ]:
```
dataOneImagesPath = "/content/data1/images/"
dataOneAnnotationPath = "/content/data1/annotations/"
```

[ ]:
```
import xml.etree.ElementTree as ET


#convert the object annotation from XML file to a dataframe
def xml_to_df(path):

    xml_list = []
    for xml_file in glob(path + '/*.xml'):
        tree = ET.parse(xml_file)
        root = tree.getroot()
        for member in root.findall('object'):

            ## chnage object index number, chnages with xml file

            xmin = float(member[5][0].text)
            ymin = float(member[5][1].text)
            xmax = float(member[5][2].text)
            ymax = float(member[5][3].text)

            img_width = float(root.find('size')[0].text)
            img_height = float(root.find('size')[1].text)
            aspectRatio = img_width / img_height
```

```
            box_width = (xmax-xmin)
            box_height = (ymax-ymin)
            bboxArea = box_width * box_height



            if xmax <= img_width and ymax <= img_height and bboxArea > 400:

                value = (dataOneImagesPath + root.find('filename').text,
                        member[0].text,
                        xmin,
                        ymin,
                        xmax,
                        ymax,
                        )

                xml_list.append(value)

    column_name = ['filename',
                   'class', 'xmin', 'ymin', 'xmax', 'ymax']


    xml_df = pd.DataFrame(xml_list, columns=column_name)
    return xml_df


df1 = xml_to_df(dataOneAnnotationPath)

df1.to_csv(os.path.join("/content/csvFolder", "data1.csv"), index=False)
```

[ ]:
```
df1.shape
```

[ ]:
```
(2346, 6)
```

[ ]:
```
df1['class'].value_counts()
```

[ ]:
```
with_mask               1926
without_mask             337
mask_weared_incorrect     83
Name: class, dtype: int64
```

### 3.2 Data 2

https://www.kaggle.com/wobotintelligence/face-mask-detection-dataset

[ ]:

```
!curl --header 'Host: storage.googleapis.com' --user-agent 'Mozilla/5.0 (X11;␣
↪Ubuntu; Linux x86_64; rv:93.0) Gecko/20100101 Firefox/93.0' --header 'Accept:
↪ text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/
↪webp,*/*;q=0.8' --header 'Accept-Language: en-US,en;q=0.5' --referer 'https:/
↪/www.kaggle.com/' --header 'DNT: 1' --header 'Alt-Used: storage.googleapis.
↪com' --header 'Upgrade-Insecure-Requests: 1' --header 'Sec-Fetch-Dest:␣
↪document' --header 'Sec-Fetch-Mode: navigate' --header 'Sec-Fetch-Site:␣
↪cross-site' --header 'Sec-Fetch-User: ?1' 'https://storage.googleapis.com/
↪kaggle-data-sets/710024/1246711/bundle/archive.zip?
↪X-Goog-Algorithm=GOOG4-RSA-SHA256&X-Goog-Credential=gcp-kaggle-com%40kaggle-161607.
↪iam.gserviceaccount.
↪com%2F20211014%2Fauto%2Fstorage%2Fgoog4_request&X-Goog-Date=20211014T112951Z&X-Goog-Expires
↪--output 'archive.zip'
```

```
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 2558M  100 2558M    0     0  54.2M      0  0:00:47  0:00:47 --:--:-- 68.4M
```

[ ]:
```
!unzip /content/archive.zip -d /content/data2
```

[ ]:
```
!rm /content/archive.zip
```

[ ]:
```
dataTwoImagesPath = "/content/data2/Medical mask/Medical mask/Medical Mask/
↪images"
dataTwoAnnotationPath = "/content/data2/Medical mask/Medical mask/Medical Mask/
↪annotations"
```

[ ]:
```
def dataTwoJson2DF(path):

    rowList = []

    for file in glob(os.path.join(path, "*")):


        f = open(file)
        jsonDict = json.load(f)

        filename = os.path.join(dataTwoImagesPath, jsonDict['FileName'])
        noOfAnno = jsonDict['NumOfAnno']
        Annotations = jsonDict['Annotations']
        for i in range(noOfAnno):
            classname = Annotations[i]['classname']
            bbox = Annotations[i]['BoundingBox']
            xmin = float(bbox[0])
            ymin = float(bbox[1])
            xmax = float(bbox[2])
            ymax = float(bbox[3])
```

```
            value = (
                filename, classname, xmin, ymin, xmax, ymax
            )

            boxArea = (ymax-ymin) * (xmax-xmin)

            if boxArea > 400.0:
                rowList.append(value)


    column_name = ['filename', 'class', 'xmin', 'ymin', 'xmax', 'ymax']

    return pd.DataFrame(rowList, columns=column_name)

# convert data2 to df

df2 = dataTwoJson2DF(dataTwoAnnotationPath)
```

[ ]:
```
df2.shape
```

[ ]:
```
(15178, 6)
```

[ ]:
```
df2["class"].replace({"face_with_mask_incorrect": "mask_weared_incorrect",
                          "face_with_mask": "with_mask",
                          "mask_surgical":"removeCat",
                          "mask_colorful":"removeCat",
                          "face_no_mask":"without_mask",
                          "gas_mask":"removeCat",

                          "balaclava_ski_mask":"removeCat",
                          "turban":"removeCat",
                          "hood":"removeCat",
                          "other":"removeCat",
                          "goggles":"removeCat",
                          "scarf_bandana":"removeCat",
                          "hair_net":"removeCat",
                          "sunglasses":"removeCat",
                          "hat":"removeCat",
                          "face_other_covering":"removeCat",
                          "hijab_niqab":"removeCat",
                          "face_shield":"removeCat",
                          "eyeglasses":"removeCat",
                          "helmet":"removeCat",

                          },
```

```
                          inplace=True)
```

[ ]:
```
df2 = df2[df2['class'] != "removeCat"]
```

[ ]:
```
df2.to_csv("/content/csvFolder/data2.csv", index=False)
```

[ ]:
```
df2['class'].value_counts()
```

[ ]:
```
with_mask               4167
without_mask            1562
mask_weared_incorrect    148
Name: class, dtype: int64
```

## 4 Merge Dataset

[ ]:
```
df1['class'].value_counts()
```

[ ]:
```
with_mask               1926
without_mask             337
mask_weared_incorrect     83
Name: class, dtype: int64
```

[ ]:
```
df2['class'].value_counts()
```

[ ]:
```
with_mask               4167
without_mask            1562
mask_weared_incorrect    148
Name: class, dtype: int64
```

[ ]:
```
DF = df1.append(df2, ignore_index=True)
```

[ ]:
```
DF.shape
```

[ ]:
```
(8223, 6)
```

[ ]:
```
DF['class'].value_counts()
```

[ ]:
```
with_mask               6093
without_mask            1899
mask_weared_incorrect    231
Name: class, dtype: int64
```

## 5 Import Scripts

[ ]:
```
!git clone https://github.com/pytorch/vision.git
```

```
Cloning into 'vision'…
remote: Enumerating objects: 42731, done.
remote: Counting objects: 100% (8207/8207), done.
remote: Compressing objects: 100% (2126/2126), done.
remote: Total 42731 (delta 6356), reused 7562 (delta 5921), pack-reused 34524
Receiving objects: 100% (42731/42731), 65.11 MiB | 28.59 MiB/s, done.
Resolving deltas: 100% (32907/32907), done.
```

[ ]:
```
# import a python file as a module in Notebook

!ln -s ./vision/references/detection/engine.py engine.py
!ln -s ./vision/references/detection/train.py train.py
!ln -s ./vision/references/detection/utils.py utils.py
!ln -s ./vision/references/detection/coco_utils.py coco_utils.py
!ln -s ./vision/references/detection/group_by_aspect_ratio.py␣
↪group_by_aspect_ratio.py
!ln -s ./vision/references/detection/presets.py presets.py
!ln -s ./vision/references/detection/coco_eval.py coco_eval.py
!ln -s ./vision/references/detection/transforms.py transforms.py
```

[ ]:
```
# to use pyprotocols
!pip install -q pycocotools
```

## 6 Train Eval Split

[ ]:
```
from sklearn.model_selection import train_test_split
```

[ ]:
```
filenames = DF['filename'].unique().tolist()

TRAIN_IMAGES, VALID_IMAGES = train_test_split(filenames, test_size=0.2)

len(TRAIN_IMAGES), len(VALID_IMAGES)
```

[ ]:
```
(3406, 852)
```

[ ]:
```
def get_dataframe_from_Images(DF, images):
    for i, image in enumerate(images):
        if i == 0:
            first_df = DF[DF['filename']==image]
            return_df = first_df
        else:
            temp_df = DF[DF['filename']==image]
```

```
            return_df = return_df.append(temp_df, ignore_index=True)

    return return_df

TRAIN_DF = get_dataframe_from_Images(DF, TRAIN_IMAGES)
VALID_DF = get_dataframe_from_Images(DF, VALID_IMAGES)
```

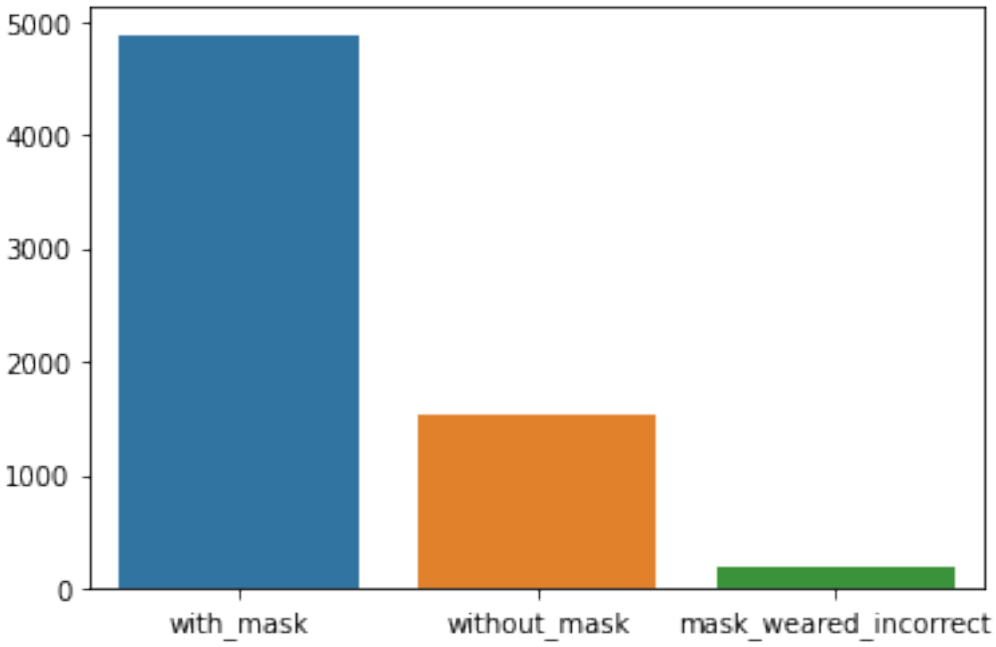
[ ]:
```
TRAIN_DF['filename'].unique().shape, VALID_DF['filename'].unique().shape
```

[ ]:
```
((3406,), (852,))
```

[ ]:
```
sns.barplot(TRAIN_DF['class'].value_counts().index, TRAIN_DF['class'].
↪value_counts().values)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning:
Pass the following variables as keyword args: x, y. From version 0.12, the only
valid positional argument will be `data`, and passing other arguments without an
explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f17d44cc3d0>
```

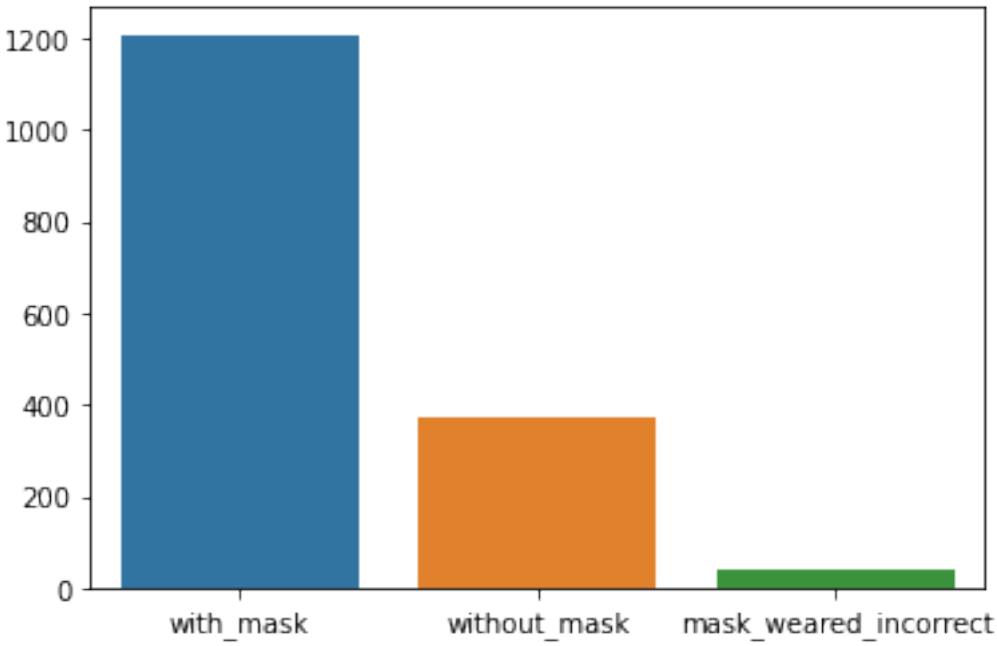



[ ]:
```
sns.barplot(VALID_DF['class'].value_counts().index, VALID_DF['class'].
↪value_counts().values)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning:
```

```
Pass the following variables as keyword args: x, y. From version 0.12, the only
valid positional argument will be `data`, and passing other arguments without an
explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f17d340ab10>
```




## 7 Visualize Dataset

[ ]:
```
from albumentations.pytorch.transforms import ToTensorV2
```

[ ]:
```
# A.Resize(512, 512, always_apply=True)

def get_aug_pipeline():

    transforms = []
    # transforms.append( )
    transforms.append(ToTensorV2(p=1))

    return A.Compose(
        transforms, bbox_params=A.BboxParams(format='pascal_voc',␣
↪label_fields=['labels']),
    )
```

[ ]:
```
from matplotlib import pyplot as plt
import matplotlib.patches as patches


def show_output_with_bbox(filename, bboxes, labels, transform):

    # image = plt.imread(filename)

    image = cv2.imread(filename, cv2.IMREAD_ANYCOLOR) # cv2.IMREAD_COLOR
    image = cv2.cvtColor(image, cv2.COLOR_BGRA2RGB).astype(np.float32)
    image = image/255.0

    aug_pipeline = get_aug_pipeline()
    transformed = aug_pipeline(image=image, bboxes=bboxes, labels=labels)

    img = transformed['image']
    bboxes = torch.as_tensor(transformed['bboxes'])
    bboxes = bboxes.detach().numpy()
    labels = transformed['labels']


    print(img.shape)

    img_height = img.shape[1]
    img_width = img.shape[2]

    fig, ax = plt.subplots(figsize=(5,5))

    ax.imshow(img.permute(1,2,0).numpy())

    for bbox, class_name in zip(bboxes, labels):
        xmin = bbox[0]
        ymin = bbox [1]
        width = bbox[2] - xmin
        height = bbox[3] - ymin

        # xmin, ymin, width, height = [x for x in [(xcenter-(width/2)),␣
↪(ycenter-(height/2)), width, height]]
        rect = patches.Rectangle((xmin, ymin), width, height, linewidth=1,␣
↪edgecolor='r', facecolor='none')
        ax.add_patch(rect)
        ax.text(xmin, ymin, class_name, color='w')


    plt.show()
```

```
#################################################################################

trainFiles = TRAIN_DF['filename'].unique().tolist()
trainFiles = trainFiles[:50]

for filename in trainFiles:
    records = TRAIN_DF[TRAIN_DF['filename']==filename]

    bboxes = records[['xmin', 'ymin', 'xmax', 'ymax']].values
    labels = records[['class']].values
    labels = [x[0] for x in labels]
    area = (bboxes[:,2]-bboxes[:,0]) * (bboxes[:,3]-bboxes[:,1])
    print(area)

    show_output_with_bbox(filename, bboxes, labels, get_aug_pipeline())
```

[ ]:
```
# Image Verification

trainFiles = TRAIN_DF['filename'].unique().tolist()

for filename in trainFiles:

    if filename == "/content/data1/images/maksssksksss719.png":

        records = TRAIN_DF[TRAIN_DF['filename']==filename]

        bboxes = records[['xmin', 'ymin', 'xmax', 'ymax']].values
        labels = records[['class']].values
        labels = [x[0] for x in labels]
        area = (bboxes[:,2]-bboxes[:,0]) * (bboxes[:,3]-bboxes[:,1])
        print(area)

        show_output_with_bbox(filename, bboxes, labels, get_aug_pipeline())

        break
```

```
[ 616.  540.  900. 1512.]
torch.Size([3, 226, 400])
```


## 8 Dataset and Dataloader

[ ]:
```
import random
# random.seed(7)
```

[ ]:
```
from albumentations.pytorch.transforms import ToTensorV2

# https://albumentations.ai/docs/getting_started/bounding_boxes_augmentation/
# https://albumentations.ai/docs/api_reference/core/composition/


global class_int_dict
class_int_dict = {
    "background":0,
    "with_mask":1,
    "without_mask":2,
    "mask_weared_incorrect":3
}
```

[ ]:
```
def get_geometric_aug(aug):
    return A.Compose([A.Resize(320, 320, p=1.0),
                      aug,
                      A.Resize(320, 320, p=1.0),
                      ToTensorV2(p=1)],
                     bbox_params=A.BboxParams(format='pascal_voc', min_area=0.
 ↪0, min_visibility=0.0, label_fields=['labels']))

def get_noise_aug(aug):
    return A.Compose([A.Resize(320, 320, p=1.0),
```

```
                    aug,
                    ToTensorV2(p=1)],
                   bbox_params=A.BboxParams(format='pascal_voc', min_area=0.
↪0, min_visibility=0.0, label_fields=['labels']))

def get_resize_aug():
    return A.Compose([A.Resize(320, 320, p=1.0),
                    ToTensorV2(p=1)],
                    bbox_params=A.BboxParams(format='pascal_voc', min_area=0.
↪0, min_visibility=0.0, label_fields=['labels']))
```

[ ]:
```
class FacemaskDataset(Dataset):

    def __init__(self, DF, train):

        self.train = train
        self.DF = DF
        self.filenames = self.DF['filename'].unique()

        self.resize = get_resize_aug()
        self.rotate = get_geometric_aug(A.Rotate(limit = 10, p=1.0))
        self.transpose = get_geometric_aug(A.Transpose(p=1.0))
        self.h_flip = get_geometric_aug(A.HorizontalFlip(p=1.0))
        self.rand_flip = get_geometric_aug(A.Flip(p=1.0))
        self.center_crop_400 = get_geometric_aug(A.CenterCrop(height=400,␣
↪width=400, p=1.0))
        self.crop_pad_zoom_in_10 = get_geometric_aug(A.CropAndPad(percent=-0.
↪08, p=1))
        self.crop_pad_zoom_out_10 = get_geometric_aug(A.CropAndPad(percent=0.
↪10, p=1))

        self.gaussian_blur = get_noise_aug(A.GaussianBlur(blur_limit=(5, 7),␣
↪sigma_limit=0, always_apply=True, p=1))
        self.med_blur = get_noise_aug(A.MedianBlur(blur_limit=5,␣
↪always_apply=True, p=1))
        self.glass_blur = get_noise_aug(A.GlassBlur(p=1))
        self.mult_noise = get_noise_aug(A.MultiplicativeNoise(multiplier=(1.1,␣
↪2.1), p=1))
        self.gaussian_noise = get_noise_aug(A.GaussNoise(p=1))
        self.gray = get_noise_aug(A.ToGray(p=1))
        self.rand_contrast = get_noise_aug(A.
↪RandomBrightnessContrast(brightness_limit=0.2, contrast_limit=0.7, p=1))
        self.aa_sharpen = get_noise_aug(A.Sharpen(alpha=(0.1, 1), lightness=(0.
↪8, 1.0), p=1.0))

        self.transforms = None
```

```
    def __len__(self):
        return len(self.filenames)

    def load_images_boxes(self, index):

        image_id = self.filenames[index]

        records = self.DF[self.DF['filename'] == image_id]
        img = cv2.imread(image_id, cv2.IMREAD_ANYCOLOR) # cv2.IMREAD_COLOR
        img = cv2.cvtColor(img, cv2.COLOR_BGRA2RGB).astype(np.float32)
        img = img/255.0

        bboxes = records[['xmin', 'ymin', 'xmax', 'ymax']].values.tolist()
        class_labels = records[['class']].values.reshape(1, -1)[0]
        class_labels = [class_int_dict[i] for i in class_labels]

        return img, bboxes, class_labels

    def __getitem__(self, index):


        img, bboxes, class_labels = self.load_images_boxes(index)

        rand_number = np.round(random.random(), 3)

        # print(f"random number: {rand_number}")

        if self.train:

            if rand_number >= 0.65:
                # print("iaa_sharpen")
                self.transforms = self.aa_sharpen
                transformed = self.transforms(image=img, bboxes=bboxes,␣
↪labels=class_labels)

            elif rand_number >= 0.52:
                # print("gray")
                self.transforms = self.gray
                transformed = self.transforms(image=img, bboxes=bboxes,␣
↪labels=class_labels)

            elif rand_number >= 0.39:
                # print("h_flip")
                self.transforms = self.h_flip
```

```
                transformed = self.transforms(image=img, bboxes=bboxes,␣
↪labels=class_labels)

            elif rand_number >= 0.26:
                # print("gaussian_blur")
                self.transforms = self.gaussian_blur
                transformed = self.transforms(image=img, bboxes=bboxes,␣
↪labels=class_labels)

            elif rand_number >= 0.13:
                # print("rotate")
                self.transforms = self.rotate
                transformed = self.transforms(image=img, bboxes=bboxes,␣
↪labels=class_labels)

            elif rand_number >= 0.0:
                # print("med_blur")
                self.transforms = self.med_blur
                transformed = self.transforms(image=img, bboxes=bboxes,␣
↪labels=class_labels)

        else:
            self.transforms = self.resize
            transformed = self.transforms(image=img, bboxes=bboxes,␣
↪labels=class_labels)


        img = transformed['image']
        bboxes = torch.as_tensor(transformed['bboxes'], dtype=torch.float32)

        num_objs = len(bboxes)
        iscrowd = torch.zeros((num_objs,), dtype=torch.int64)
        class_label = torch.tensor(transformed['labels'])
        iscrowd = torch.zeros((num_objs,), dtype=torch.int64)

        target = {}
        target["labels"] = class_label # tensor
        target["boxes"] = bboxes # tensor
        target['image_id'] = torch.tensor([index]) # string
        target['iscrowd'] = iscrowd
        target['area'] = (bboxes[:, 3] - bboxes[:, 1]) * (bboxes[:, 2] -␣
↪bboxes[:, 0])

        return img, target
```

[ ]:
```
train_dataset = FacemaskDataset(DF=TRAIN_DF, train=True)

valid_dataset = FacemaskDataset(DF=VALID_DF, train=False)


def collate_fn(batch):
    return tuple(zip(*batch))

train_data_loader = DataLoader(
    train_dataset,
    batch_size = 30,
    shuffle = True,
    num_workers = 2,
    collate_fn = collate_fn
)


valid_data_loader = DataLoader(
    valid_dataset,
    batch_size = 20,
    shuffle = True,
    num_workers = 2,
    collate_fn = collate_fn
)
```

[ ]:
```
for i in range(len(train_data_loader)):
    train_dataset[i]
```

[ ]:
```
from matplotlib import pyplot as plt
import matplotlib.patches as patches


class_dict = {
    0:"background",
    1:"with_mask",
    2:"without_mask",
    3:"mask_weared_incorrect"
}


def show_output_with_bbox(img_tensor, bbox_tensor, labels_tensor):
    img = img_tensor.permute(1,2,0).detach().cpu().numpy()
    bboxes = bbox_tensor.detach().cpu().numpy()
    labels = labels_tensor.detach().cpu().numpy()


    fig, ax = plt.subplots(figsize=(5,5))
```

```
    ax.imshow(img)

    for bbox, label in zip(bboxes, labels):

        class_name = class_dict[label]
        xmin = bbox[0]
        ymin = bbox [1]
        width = bbox[2] - xmin
        height = bbox[3] - ymin

        rect = patches.Rectangle((xmin, ymin), width, height, linewidth=1,␣
↪edgecolor='r', facecolor='none')
        ax.add_patch(rect)
        ax.text(xmin, ymin, class_name, color='w')

        # print(f"class: {class_name}, area: {height*width}")


    plt.show()



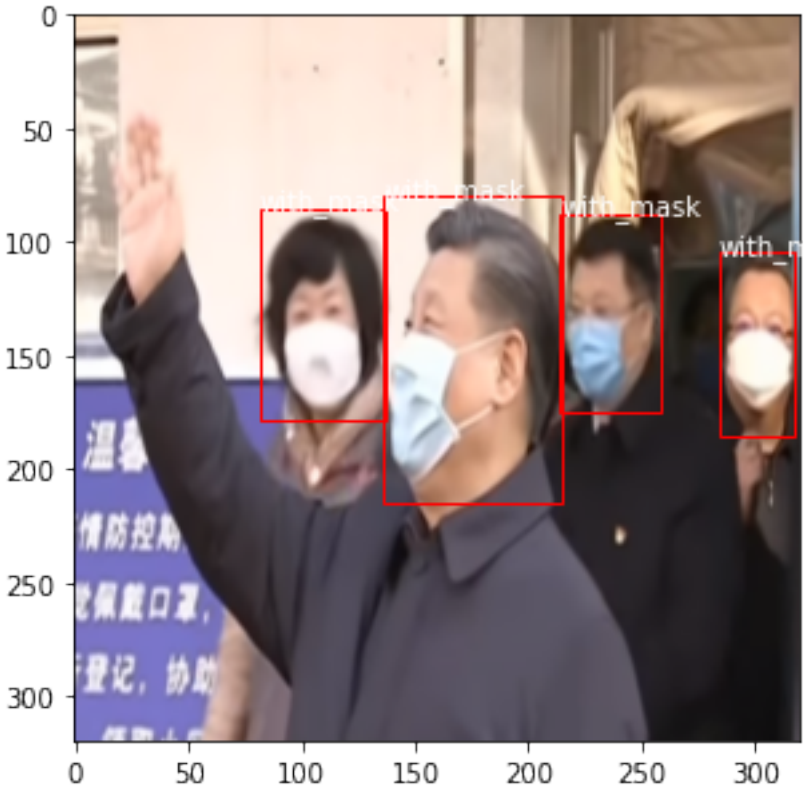

################################################################################

for i in range(TRAIN_DF.shape[0]):
    image, target = train_dataset[i]
    bboxes = target['boxes']
    labels = target['labels']
    print(target['area'])

    show_output_with_bbox(image, bboxes, labels)

    if i == 10:
        break
```

```
tensor([ 5128.9180, 10574.6387,  3902.8801,  2738.6248])
```

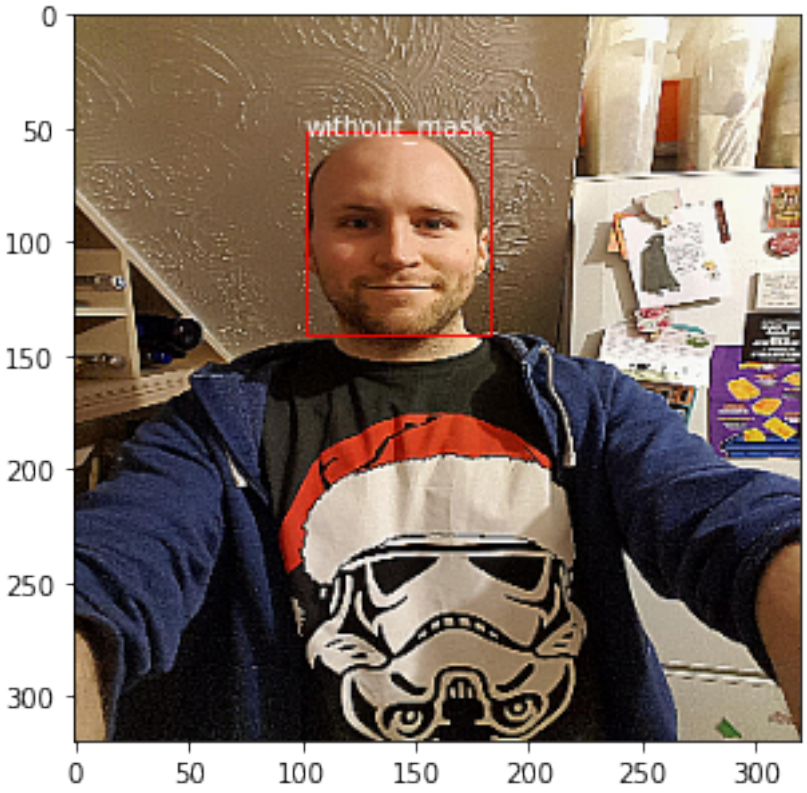



```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
```

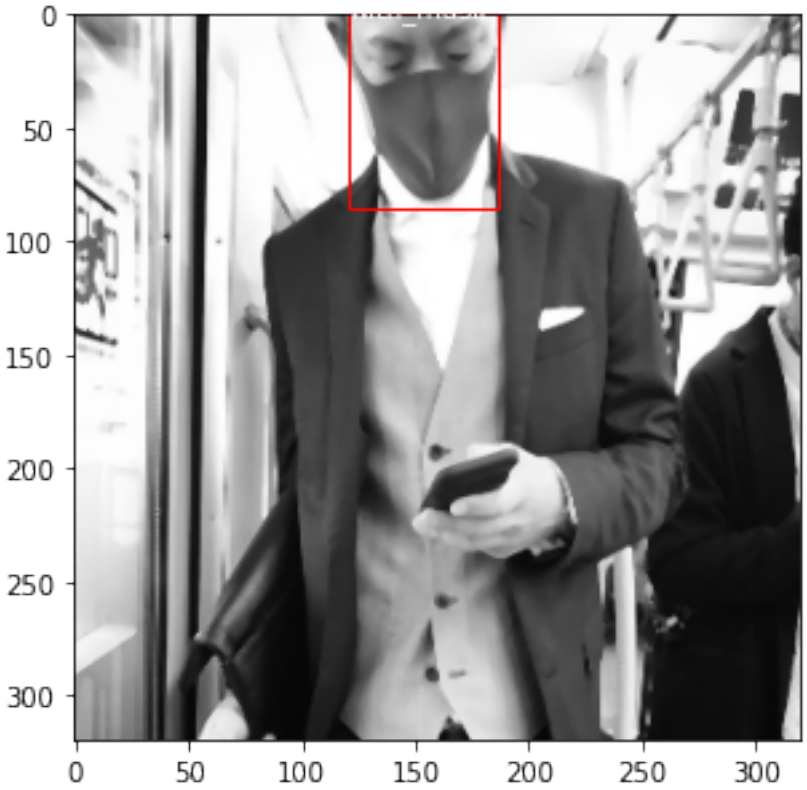
```
tensor([10915.2666,  3541.3977])
```


```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
```

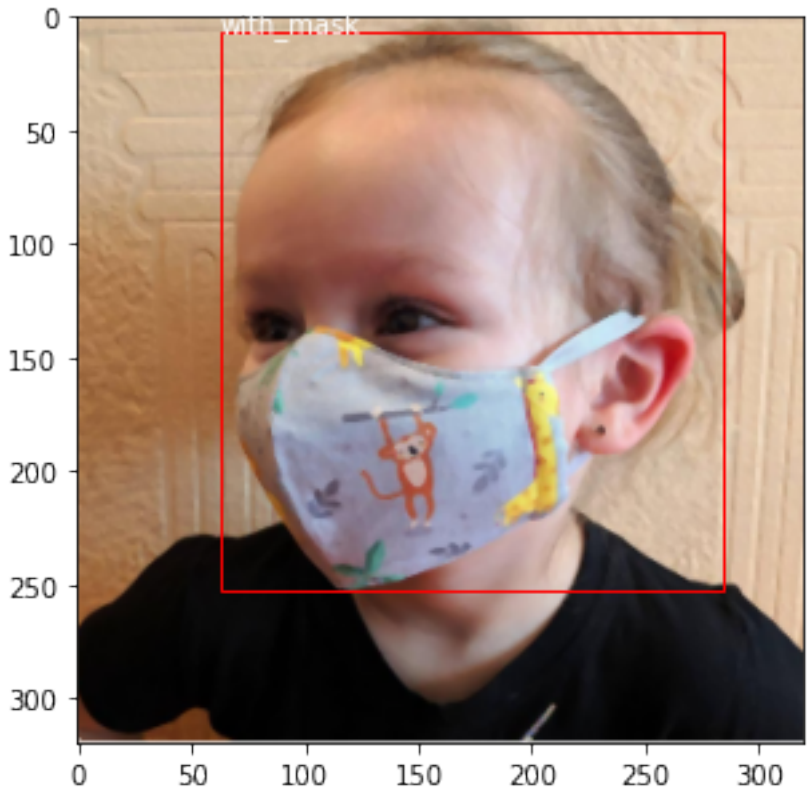
```
tensor([7242.7974])
```



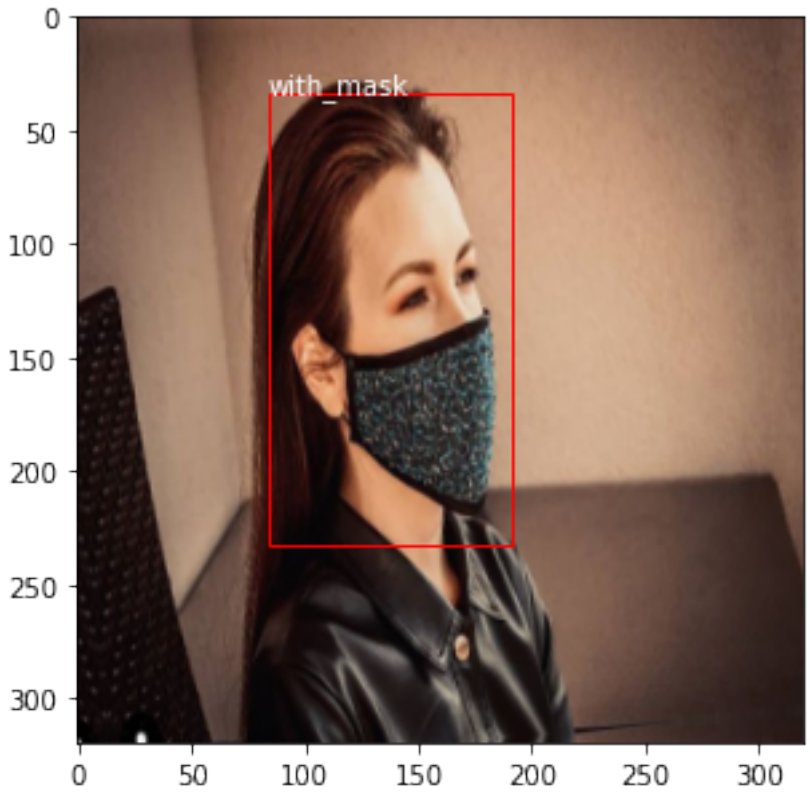

```
tensor([5629.1323])
```



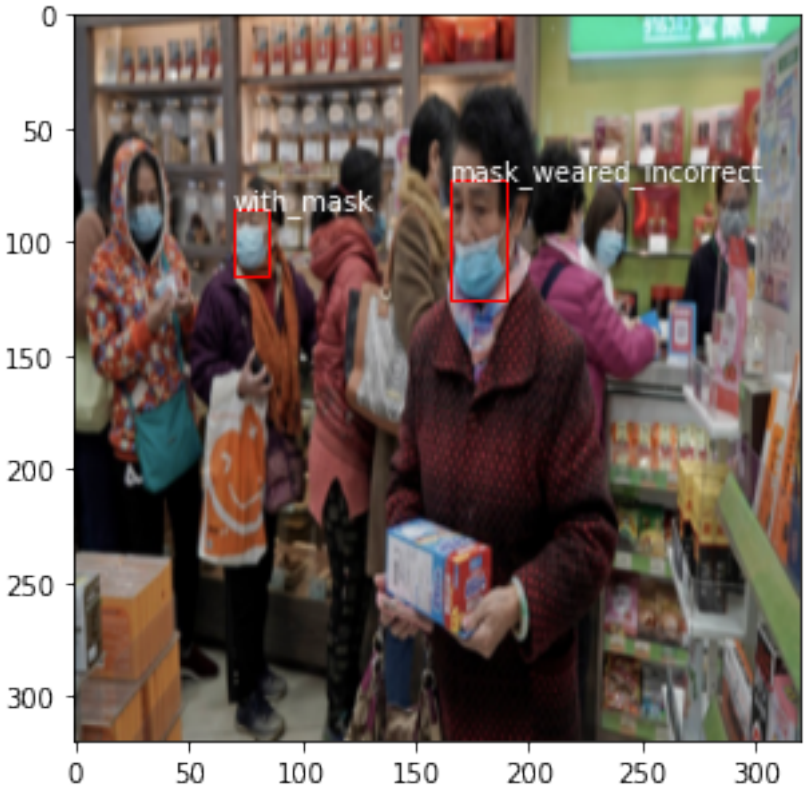

```
tensor([54700.5156])
```



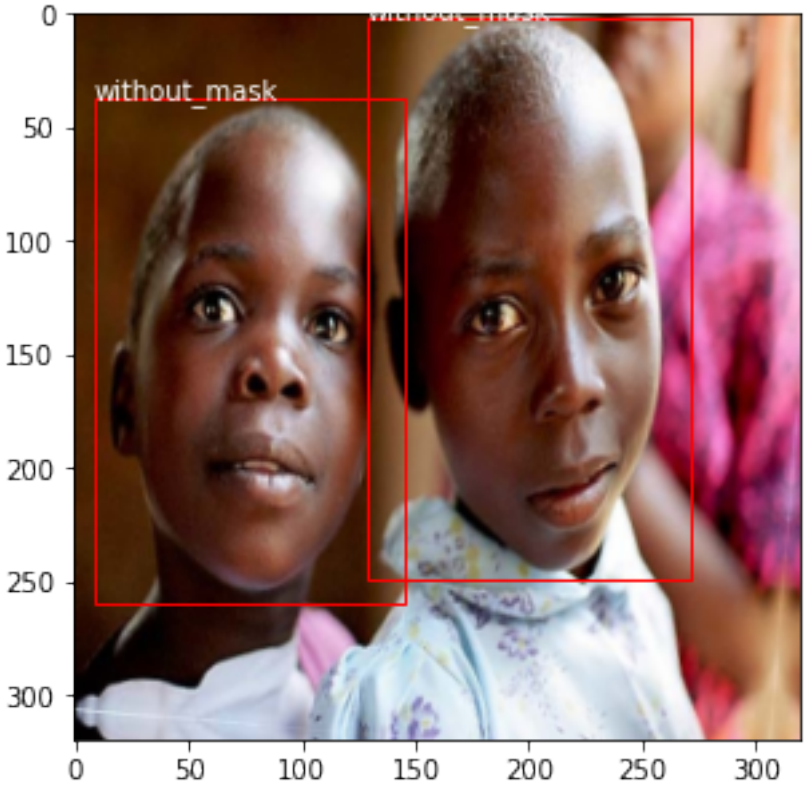

```
tensor([21445.1914])
```




```
tensor([1377.4155,  475.7522])
```

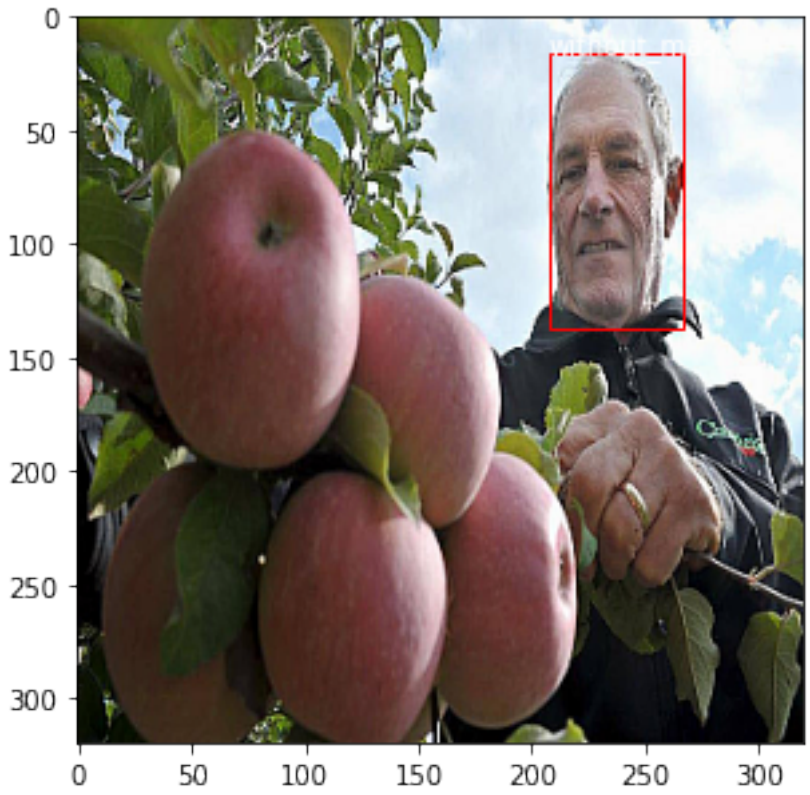



```
tensor([35510.5898, 30364.7734])
```



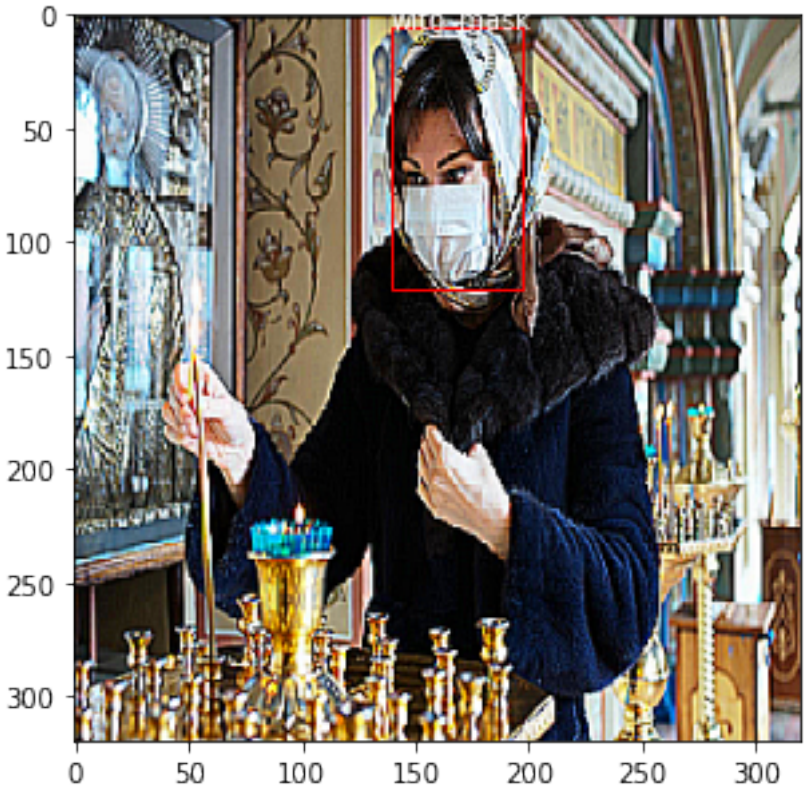

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
```

```
tensor([7104.6934])
```

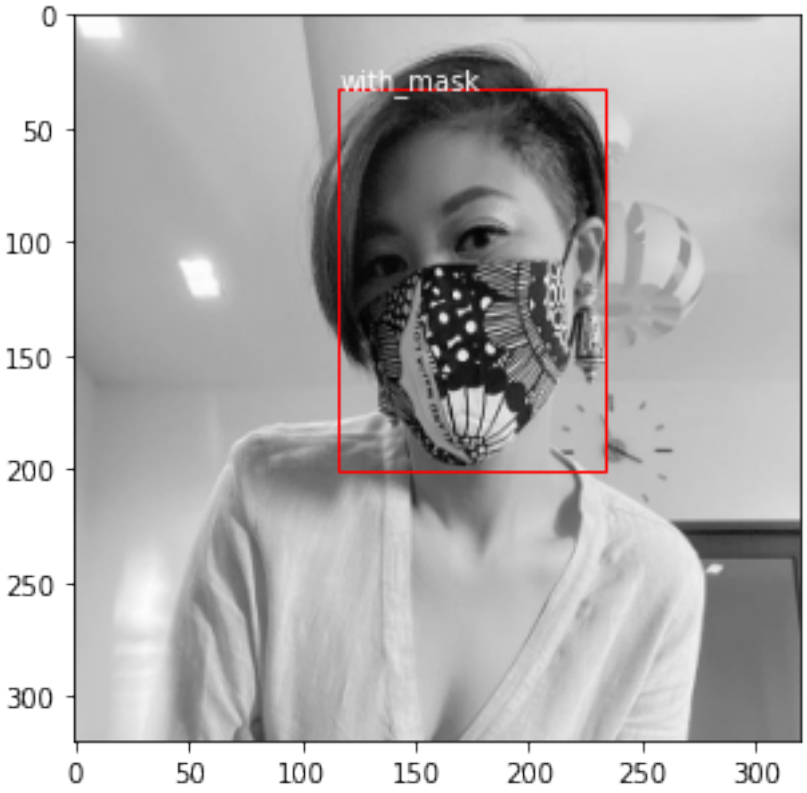



```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
```

```
tensor([6751.7690])
```




```
tensor([19875.0781])
```




[ ]:
```
!nvidia-smi
```

```
Thu Oct 14 15:24:02 2021
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 470.74       Driver Version: 460.32.03    CUDA Version: 11.2     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|                               |                      |               MIG M. |
|===============================+======================+======================|
|   0  Tesla P100-PCIE…  Off  | 00000000:00:04.0 Off |                    0 |
| N/A   46C    P0    28W / 250W |      0MiB / 16280MiB |      0%      Default |
|                               |                      |                  N/A |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                                  |
|  GPU   GI   CI        PID   Type   Process name                  GPU Memory |
|        ID   ID                                                   Usage      |
|=============================================================================|
|  No running processes found                                                 |
+-----------------------------------------------------------------------------+
```

## 9 Device

[ ]:
```
def getDevice():
    return torch.device("cuda") if torch.cuda.is_available() else torch.
↪device("cpu")
```

## 10 Weighted Loss SSD

[ ]:
```
TRAIN_DF['class'].value_counts()
```

[ ]:
```
with_mask               5525
without_mask            1718
mask_weared_incorrect    206
Name: class, dtype: int64
```

[ ]:
```
total = 5525 + 1718 + 206
total
```

[ ]:
```
7449
```

[ ]:
```

```

[ ]:
```
global classWeight

classWeight = torch.tensor([1, 1.3, 4.3, 36.16], dtype=torch.float32,␣
↪device=getDevice())
```

[ ]:
```
from typing import Any, Dict, List, Optional, Tuple
from torch import nn
import torch.nn.functional as F
from collections import OrderedDict
import torch
import torchvision
import torchvision.models.detection._utils as det_utils
from torch import nn, Tensor
from torchvision.ops import boxes as box_ops
```

[ ]:
```
# Weighted SSD Implementation


class WeightedLossSSD(nn.Module):
    """
    Implements SSD architecture from `"SSD: Single Shot MultiBox Detector"␣
↪<https://arxiv.org/abs/1512.02325>`_.
```

```
    The input to the model is expected to be a list of tensors, each of shape␣
↪[C, H, W], one for each
    image, and should be in 0-1 range. Different images can have different␣
↪sizes but they will be resized
    to a fixed size before passing it to the backbone.

    The behavior of the model changes depending if it is in training or␣
↪evaluation mode.

    During training, the model expects both the input tensors, as well as a␣
↪targets (list of dictionary),
    containing:
        - boxes (``FloatTensor[N, 4]``): the ground-truth boxes in ``[x1, y1,␣
↪x2, y2]`` format, with
          ``0 <= x1 < x2 <= W`` and ``0 <= y1 < y2 <= H``.
        - labels (Int64Tensor[N]): the class label for each ground-truth box

    The model returns a Dict[Tensor] during training, containing the␣
↪classification and regression
    losses.

    During inference, the model requires only the input tensors, and returns␣
↪the post-processed
    predictions as a List[Dict[Tensor]], one for each input image. The fields␣
↪of the Dict are as
    follows, where ``N`` is the number of detections:

        - boxes (``FloatTensor[N, 4]``): the predicted boxes in ``[x1, y1, x2,␣
↪y2]`` format, with
          ``0 <= x1 < x2 <= W`` and ``0 <= y1 < y2 <= H``.
        - labels (Int64Tensor[N]): the predicted labels for each detection
        - scores (Tensor[N]): the scores for each detection

    Args:
        backbone (nn.Module): the network used to compute the features for the␣
↪model.
            It should contain an out_channels attribute with the list of the␣
↪output channels of
            each feature map. The backbone should return a single Tensor or an␣
↪OrderedDict[Tensor].
        anchor_generator (DefaultBoxGenerator): module that generates the␣
↪default boxes for a
            set of feature maps.
        size (Tuple[int, int]): the width and height to which images will be␣
↪rescaled before feeding them
            to the backbone.
```

```
        num_classes (int): number of output classes of the model (excluding the␣
↪background).
        image_mean (Tuple[float, float, float]): mean values used for input␣
↪normalization.
            They are generally the mean values of the dataset on which the␣
↪backbone has been trained
            on
        image_std (Tuple[float, float, float]): std values used for input␣
↪normalization.
            They are generally the std values of the dataset on which the␣
↪backbone has been trained on
        head (nn.Module, optional): Module run on top of the backbone features.␣
↪Defaults to a module containing
            a classification and regression module.
        score_thresh (float): Score threshold used for postprocessing the␣
↪detections.
        nms_thresh (float): NMS threshold used for postprocessing the␣
↪detections.
        detections_per_img (int): Number of best detections to keep after NMS.
        iou_thresh (float): minimum IoU between the anchor and the GT box so␣
↪that they can be
            considered as positive during training.
        topk_candidates (int): Number of best detections to keep before NMS.
        positive_fraction (float): a number between 0 and 1 which indicates the␣
↪proportion of positive
            proposals used during the training of the classification head. It␣
↪is used to estimate the negative to
            positive ratio.
    """
    __annotations__ = {
        'box_coder': det_utils.BoxCoder,
        'proposal_matcher': det_utils.Matcher,
    }

    def __init__(self, backbone: nn.Module, anchor_generator: torchvision.
↪models.detection.anchor_utils.DefaultBoxGenerator,
                 size: Tuple[int, int], num_classes: int,
                 image_mean: Optional[List[float]] = None, image_std:␣
↪Optional[List[float]] = None,
                 head: Optional[nn.Module] = None,
                 score_thresh: float = 0.01,
                 nms_thresh: float = 0.45,
                 detections_per_img: int = 200,
                 iou_thresh: float = 0.5,
                 topk_candidates: int = 400,
                 positive_fraction: float = 0.25):
```

```
        super().__init__()

        self.backbone = backbone

        self.anchor_generator = anchor_generator

        self.box_coder = torchvision.models.detection._utils.
↪BoxCoder(weights=(10., 10., 5., 5.))

        if head is None:
            if hasattr(backbone, 'out_channels'):
                out_channels = backbone.out_channels
            else:
                out_channels = det_utils.retrieve_out_channels(backbone, size)

            assert len(out_channels) == len(anchor_generator.aspect_ratios)

            num_anchors = self.anchor_generator.num_anchors_per_location()
            head = torchvision.models.detection.ssd.SSDHead(out_channels,␣
↪num_anchors, num_classes)
        self.head = head

        self.proposal_matcher = det_utils.SSDMatcher(iou_thresh)

        if image_mean is None:
            image_mean = [0.485, 0.456, 0.406]
        if image_std is None:
            image_std = [0.229, 0.224, 0.225]
        self.transform = torchvision.models.detection.transform.
↪GeneralizedRCNNTransform(min(size), max(size), image_mean, image_std,
                                                  size_divisible=1,␣
↪fixed_size=size)

        self.score_thresh = score_thresh
        self.nms_thresh = nms_thresh
        self.detections_per_img = detections_per_img
        self.topk_candidates = topk_candidates
        self.neg_to_pos_ratio = (1.0 - positive_fraction) / positive_fraction

        # used only on torchscript mode
        self._has_warned = False

    @torch.jit.unused
    def eager_outputs(self, losses: Dict[str, Tensor],
                      detections: List[Dict[str, Tensor]]) -> Tuple[Dict[str,␣
↪Tensor], List[Dict[str, Tensor]]]:
        if self.training:
```

```
            return losses

        return detections

    def compute_loss(self, targets: List[Dict[str, Tensor]], head_outputs:␣
↪Dict[str, Tensor], anchors: List[Tensor],
                     matched_idxs: List[Tensor]) -> Dict[str, Tensor]:
        bbox_regression = head_outputs['bbox_regression']
        cls_logits = head_outputs['cls_logits']

        # Match original targets with default boxes
        num_foreground = 0
        bbox_loss = []
        cls_targets = []
        for (targets_per_image, bbox_regression_per_image,␣
↪cls_logits_per_image, anchors_per_image,
             matched_idxs_per_image) in zip(targets, bbox_regression,␣
↪cls_logits, anchors, matched_idxs):
            # produce the matching between boxes and targets
            foreground_idxs_per_image = torch.where(matched_idxs_per_image >=␣
↪0)[0]
            foreground_matched_idxs_per_image =␣
↪matched_idxs_per_image[foreground_idxs_per_image]
            num_foreground += foreground_matched_idxs_per_image.numel()

            # Calculate regression loss
            matched_gt_boxes_per_image =␣
↪targets_per_image['boxes'][foreground_matched_idxs_per_image]
            bbox_regression_per_image =␣
↪bbox_regression_per_image[foreground_idxs_per_image, :]
            anchors_per_image = anchors_per_image[foreground_idxs_per_image, :]
            target_regression = self.box_coder.
↪encode_single(matched_gt_boxes_per_image, anchors_per_image)
            bbox_loss.append(torch.nn.functional.smooth_l1_loss(
                bbox_regression_per_image,
                target_regression,
                reduction='sum'
            ))

            # Estimate ground truth for class targets
            gt_classes_target = torch.zeros((cls_logits_per_image.size(0), ),␣
↪dtype=targets_per_image['labels'].dtype,
                                            device=targets_per_image['labels'].
↪device)
            gt_classes_target[foreground_idxs_per_image] = \
                targets_per_image['labels'][foreground_matched_idxs_per_image]
```

```
            cls_targets.append(gt_classes_target)

        bbox_loss = torch.stack(bbox_loss)
        cls_targets = torch.stack(cls_targets)

        # Calculate classification loss
        num_classes = cls_logits.size(-1)
        cls_loss = F.cross_entropy(
            cls_logits.view(-1, num_classes),
            cls_targets.view(-1),
            weight=classWeight,
            reduction='none'
        ).view(cls_targets.size())

        # Hard Negative Sampling
        foreground_idxs = cls_targets > 0
        num_negative = self.neg_to_pos_ratio * foreground_idxs.sum(1,␣
↪keepdim=True)
        # num_negative[num_negative < self.neg_to_pos_ratio] = self.
↪neg_to_pos_ratio
        negative_loss = cls_loss.clone()
        negative_loss[foreground_idxs] = -float('inf')  # use -inf to detect␣
↪positive values that creeped in the sample
        values, idx = negative_loss.sort(1, descending=True)
        # background_idxs = torch.logical_and(idx.sort(1)[1] < num_negative,␣
↪torch.isfinite(values))
        background_idxs = idx.sort(1)[1] < num_negative

        N = max(1, num_foreground)
        return {
            'bbox_regression': bbox_loss.sum() / N,
            'classification': (cls_loss[foreground_idxs].sum() +␣
↪cls_loss[background_idxs].sum()) / N,
        }

    def forward(self, images: List[Tensor],
                targets: Optional[List[Dict[str, Tensor]]] = None) ->␣
↪Tuple[Dict[str, Tensor], List[Dict[str, Tensor]]]:
        if self.training and targets is None:
            raise ValueError("In training mode, targets should be passed")

        if self.training:
            assert targets is not None
            for target in targets:
                boxes = target["boxes"]
                if isinstance(boxes, torch.Tensor):
```

```
                    if len(boxes.shape) != 2 or boxes.shape[-1] != 4:
                        raise ValueError("Expected target boxes to be a tensor"
                                         "of shape [N, 4], got {:}.".format(
                                             boxes.shape))
                else:
                    raise ValueError("Expected target boxes to be of type "
                                     "Tensor, got {:}.".format(type(boxes)))

        # get the original image sizes
        original_image_sizes: List[Tuple[int, int]] = []
        for img in images:
            val = img.shape[-2:]
            assert len(val) == 2
            original_image_sizes.append((val[0], val[1]))

        # transform the input
        images, targets = self.transform(images, targets)

        # Check for degenerate boxes
        if targets is not None:
            for target_idx, target in enumerate(targets):
                boxes = target["boxes"]
                degenerate_boxes = boxes[:, 2:] <= boxes[:, :2]
                if degenerate_boxes.any():
                    bb_idx = torch.where(degenerate_boxes.any(dim=1))[0][0]
                    degen_bb: List[float] = boxes[bb_idx].tolist()
                    raise ValueError("All bounding boxes should have positive␣
↪height and width."
                                     " Found invalid box {} for target at index␣
↪{}."
                                     .format(degen_bb, target_idx))

        # get the features from the backbone
        features = self.backbone(images.tensors)
        if isinstance(features, torch.Tensor):
            features = OrderedDict([('0', features)])

        features = list(features.values())

        # compute the ssd heads outputs using the features
        head_outputs = self.head(features)

        # create the set of anchors
        anchors = self.anchor_generator(images, features)

        losses = {}
        detections: List[Dict[str, Tensor]] = []
```

```
        if self.training:
            assert targets is not None

            matched_idxs = []
            for anchors_per_image, targets_per_image in zip(anchors, targets):
                if targets_per_image['boxes'].numel() == 0:
                    matched_idxs.append(torch.full((anchors_per_image.
↪size(0),), -1, dtype=torch.int64,
                                                   device=anchors_per_image.
↪device))
                    continue

                match_quality_matrix = box_ops.
↪box_iou(targets_per_image['boxes'], anchors_per_image)
                matched_idxs.append(self.proposal_matcher(match_quality_matrix))

            losses = self.compute_loss(targets, head_outputs, anchors,␣
↪matched_idxs)
        else:
            detections = self.postprocess_detections(head_outputs, anchors,␣
↪images.image_sizes)
            detections = self.transform.postprocess(detections, images.
↪image_sizes, original_image_sizes)

        if torch.jit.is_scripting():
            if not self._has_warned:
                warnings.warn("SSD always returns a (Losses, Detections) tuple␣
↪in scripting")
                self._has_warned = True
            return losses, detections
        return self.eager_outputs(losses, detections)

    def postprocess_detections(self, head_outputs: Dict[str, Tensor],␣
↪image_anchors: List[Tensor],
                               image_shapes: List[Tuple[int, int]]) ->␣
↪List[Dict[str, Tensor]]:
        bbox_regression = head_outputs['bbox_regression']
        pred_scores = F.softmax(head_outputs['cls_logits'], dim=-1)

        num_classes = pred_scores.size(-1)
        device = pred_scores.device

        detections: List[Dict[str, Tensor]] = []

        for boxes, scores, anchors, image_shape in zip(bbox_regression,␣
↪pred_scores, image_anchors, image_shapes):
```

```
            boxes = self.box_coder.decode_single(boxes, anchors)
            boxes = box_ops.clip_boxes_to_image(boxes, image_shape)

            image_boxes = []
            image_scores = []
            image_labels = []
            for label in range(1, num_classes):
                score = scores[:, label]

                keep_idxs = score > self.score_thresh
                score = score[keep_idxs]
                box = boxes[keep_idxs]

                # keep only topk scoring predictions
                num_topk = min(self.topk_candidates, score.size(0))
                score, idxs = score.topk(num_topk)
                box = box[idxs]

                image_boxes.append(box)
                image_scores.append(score)
                image_labels.append(torch.full_like(score, fill_value=label,␣
↪dtype=torch.int64, device=device))

            image_boxes = torch.cat(image_boxes, dim=0)
            image_scores = torch.cat(image_scores, dim=0)
            image_labels = torch.cat(image_labels, dim=0)

            # non-maximum suppression
            keep = box_ops.batched_nms(image_boxes, image_scores, image_labels,␣
↪self.nms_thresh)
            keep = keep[:self.detections_per_img]

            detections.append({
                'boxes': image_boxes[keep],
                'scores': image_scores[keep],
                'labels': image_labels[keep],
            })
        return detections
```

[ ]:
```
def _xavier_normal_init(conv: nn.Module):
    for layer in conv.modules():
        if isinstance(layer, nn.Conv2d):
            torch.nn.init.xavier_normal_(layer.weight)
            if layer.bias is not None:
                torch.nn.init.constant_(layer.bias, 0.0)

def _kaiming_normal_init(conv: nn.Module):
```

```
    for layer in conv.modules():
        if isinstance(layer, nn.Conv2d):
            torch.nn.init.kaiming_normal_(layer.weight)
            if layer.bias is not None:
                torch.nn.init.constant_(layer.bias, 0.0)


# MobileNetV3 Custom build for facemask classification
class CustomMV3(nn.Module):
    def __init__(self, base):
        super().__init__()

        self.features = base.features
        self.avgPool = base.avgpool
        self.flatten = nn.Flatten()
        self.classfier = nn.Sequential(

            nn.Linear(960, 1280, bias=True),
            nn.Hardswish(inplace=False),
            nn.Dropout(p=0.2, inplace=True),
            nn.Linear(in_features=1280, out_features=3, bias=True)

        )


    def forward(self, x):
        out = self.features(x)
        out = self.avgPool(out)
        out = self.flatten(out)
        out = self.classfier(out)
        return out

class SSDFeatureExtractorMobilenetV3(torch.nn.Module):
    """
    create 6: feature extraction layers.
    1. from base model itself from middle layers, [ Take from middle, it;s a␣
 ↪experiment.]
    2. get last layer, add some conv layers to it.
    3. add 4 custom sequential layer(conv, relu, conv, relu)

    Total: 6 number of feature will be @param: returned OrderDict("0":
 ↪feature_map)


    """

    def __init__(self, base):
```

```
        super(SSDFeatureExtractorMobilenetV3, self).__init__()

        self.featuresOneFromBase = nn.Sequential(
            *base[:5]
        )

        self.featuresTwoFromBase = nn.Sequential(
            *base[5:10]  # until InvertedResidual 9
        )

        self.featuresThreeFromBase = nn.Sequential(
            *base[10:]  # until InvertedResidual 10 --> 16
        )

        """
        VGG16 bakbone has put - 4 extra blocks plus 1 for high res image
        MobileNetV3 backbone has put - 3 extra blocks plus 1 for 1024 res image

        [(n+2p-k) / (s)] + 1

        keeping HxW = 16x16, channels: decreasing

        """

        fc1 = nn.Sequential(
            nn.Conv2d(in_channels=960, out_channels=64, kernel_size=1,␣
↪padding=0, stride=1),  # FC6 with atrous
            nn.BatchNorm2d(num_features=64),
            nn.Hardswish(inplace=True),

            nn.Conv2d(in_channels=64, out_channels=128, kernel_size=1,␣
↪padding=0, stride=1),  # FC6 with atrous
            nn.BatchNorm2d(num_features=128),
            nn.Hardswish(inplace=True),

            nn.Conv2d(in_channels=128, out_channels=256, kernel_size=1,␣
↪padding=0, stride=1),  # FC6 with atrous
            nn.BatchNorm2d(num_features=256),

            )

        fc2 = nn.Sequential(
                nn.Conv2d(256, 32, kernel_size=1, padding=0, stride=2),
                nn.BatchNorm2d(num_features=32),
                nn.Hardswish(inplace=True),

                nn.Conv2d(32, 64, kernel_size=1, padding=0, stride=2),
```

```
            nn.BatchNorm2d(num_features=64),
            nn.Hardswish(inplace=True),

            nn.Conv2d(64, 128, kernel_size=1, padding=0, stride=2),
            nn.BatchNorm2d(num_features=128),
        )
        fc3 = nn.Sequential(
            nn.Conv2d(128, 64, kernel_size=1, padding=0, stride=2),
            nn.BatchNorm2d(num_features=64),
            nn.Hardswish(inplace=True),
        )
        fc4 = nn.Sequential(
            nn.Conv2d(64, 32, kernel_size=1, padding=0, stride=1),
            nn.BatchNorm2d(num_features=32),
            nn.Hardswish(inplace=True),
        )
        fc5 = nn.Sequential(
            nn.Conv2d(32, 16, kernel_size=1, padding=0, stride=2),
            nn.BatchNorm2d(num_features=16),
            nn.Hardswish(inplace=True),
        )

        _xavier_normal_init(fc1)
        _xavier_normal_init(fc2)
        _xavier_normal_init(fc3)
        _xavier_normal_init(fc4)
        _xavier_normal_init(fc5)

        self.extra = nn.ModuleList([ fc1, fc2, fc3, fc4, fc5])

        self.scale_weight = nn.Parameter(torch.ones(960) * 200)

    def forward(self, x):
        output = []

        outOne = self.featuresOneFromBase(x)
        output.append(outOne)

        out = self.featuresTwoFromBase(outOne)
        output.append(out)

        out = self.featuresThreeFromBase(out)
        output.append(out)

        for i, block in enumerate(self.extra):
            out = block(out)
            output.append(out)
```

```
        return OrderedDict([(str(i), v) for i, v in enumerate(output)])


def loadMobileNetV3(path, model):

    model.load_state_dict(torch.load(path, map_location=getDevice()))
    model.train()
    return model


def get_ssd_backbone():

    pretrainedMobilenetV3 = torchvision.models.
 ↪mobilenet_v3_large(pretrained=True)

    # pretrainedMobilenetV3 = CustomMV3(pretrainedMobilenetV3)
    # path = "/content/gdrive/MyDrive/facemask_detection/save_model/
 ↪classificationMobileNetV3_512x512.pth"
    # pretrainedMobilenetV3 = loadMobileNetV3(path, pretrainedMobilenetV3)

    pretrainedMobilenetV3 = pretrainedMobilenetV3.features

    for i, b in enumerate(pretrainedMobilenetV3):
        for param in b.parameters():
            param.requires_grad = True

    # TODO: freeze initial layers of MobileNetV3
    return SSDFeatureExtractorMobilenetV3(pretrainedMobilenetV3)


def get_ssd_model(num_classes, size):

    backbone = get_ssd_backbone()
    # total no. of features = 5
    # for highres features = 6, change aspect ration numbers accordingly
    anchor_generator = torchvision.models.detection.anchor_utils.
 ↪DefaultBoxGenerator([[2, 3],
 ↪       [2, 3],
 ↪       [2, 3],
 ↪       [2, 3],
```

```
↪      [2, 3],
↪      [2, 3],
↪      [2, 3], [2]],
                                          scales=[0.07, 0.15, 0.33, 0.51, 0.
↪69, 0.87, 1.05, 1.3, 1.5])

   print(f"number of anchors per grid for each features: {anchor_generator.
↪num_anchors_per_location()}")



   defaults = {
       # Rescale the input in a way compatible to the backbone


       "image_mean": [0.48235, 0.45882, 0.40784],
       "image_std": [1.0 / 255.0, 1.0 / 255.0, 1.0 / 255.0]
       # undo the 0-1 scaling of toTensor
   }

   kwargs = {**defaults}
   SSD_CUSTOM = WeightedLossSSD(backbone, anchor_generator, (size, size),␣
↪num_classes, **kwargs)

   return SSD_CUSTOM
```

[ ]:
```
SSD_MODEL = get_ssd_model(num_classes=4, size=512)
```

```
Downloading:
"https://download.pytorch.org/models/mobilenet_v3_large-8738ca79.pth" to
/root/.cache/torch/hub/checkpoints/mobilenet_v3_large-8738ca79.pth

  0%|          | 0.00/21.1M [00:00<?, ?B/s]

number of anchors per grid for each features: [6, 6, 6, 6, 6, 6, 6, 4]
```

[ ]:
```
SSD_MODEL
```

## 11 SSD MobileNet Inbuilt

[ ]:
```
SSD_MODEL = torchvision.models.detection.
↪ssdlite320_mobilenet_v3_large(pretrained=True)
```

## 12 Train (Inbuilt SSD)

[ ]:
```
device = getDevice()
device
```

[ ]:
```
device(type='cuda')
```

[ ]:
```
from engine import train_one_epoch, evaluate
import utils

if torch.cuda.is_available():
    torch.cuda.empty_cache()

print(f"Training on {device}")
SSD_MODEL.to(device)

# construct an optimizer
params = [p for p in SSD_MODEL.parameters() if p.requires_grad]
optimizer = torch.optim.SGD(params, lr=0.01, momentum=0.9, weight_decay=0.0005)
# optimizer = torch.optim.Adam(params=params, lr=0.01, betas=(0.9, 0.009))

lr_scheduler_step_lr = torch.optim.lr_scheduler.StepLR(optimizer,
                                                       step_size=200,
                                                       gamma=0.7,)

lr_scheduler_cosine_annealing = torch.optim.lr_scheduler.
 ↪CosineAnnealingLR(optimizer, T_max=10)

# https://pytorch.org/docs/stable/generated/torch.optim.lr_scheduler.
 ↪ReduceLROnPlateau.html
lr_scheduler_platau_reduce = torch.optim.lr_scheduler.
 ↪ReduceLROnPlateau(optimizer, 'min', factor=0.01, patience=2)


num_epochs = 200

##########################################################################################

loss_list = []

for epoch in range(num_epochs):
    # train for one epoch, printing every 10 iterations
    # logger = train_one_epoch(SSD_MODEL, optimizer, train_data_loader, device,␣
 ↪epoch, print_freq=100)
    # TRAINING BATCH OF DATA
    epoch_loss = []
    SSD_MODEL.train()
```

```
    for i, data in enumerate(train_data_loader):

      # data of each batch
      images, targets = data

      # copy data to cuda
      inputs = list(image.to(device) for image in images)
      targets = [{k: v.to(device) for k, v in t.items()} for t in targets]

      # set gradients to 0
      optimizer.zero_grad()

      # pass input to model
      loss_dict = SSD_MODEL(inputs, targets)

      # loss
      losses = sum(loss for loss in loss_dict.values())
      epoch_loss.append(losses.item())

      # backprop
      losses.backward()

      # update weights
      optimizer.step()
      #------==========-----#



    # update the learning rate
    # lr_scheduler_step_lr.step()

    # Epoch end
    train_loss_epoch = np.mean(epoch_loss)
    print("\n")
    print(f"epoch: {epoch}, training loss: {train_loss_epoch}, lr: {optimizer.
↪param_groups[0]['lr']} ") # shows every training loss and parameters
    loss_list.append(train_loss_epoch)

    if epoch > 100:
        if loss_list[epoch] > loss_list[epoch-10]:

            torch.save({
            'epoch': epoch,
            'model_state_dict': SSD_MODEL.state_dict(),
            'optimizer_state_dict': optimizer.state_dict(),
            }, "/content/gdrive/MyDrive/facemask_detection/save_model/
↪facemaskDetectionSSD_320x320_38MAP.pth")
```

```
            break


    # evaluate on the test dataset
    coco_evaluater = evaluate(SSD_MODEL, valid_data_loader, device=device)

    # reduce lr on platau, after validation
    # lr_scheduler_platau_reduce.step(train_loss_epoch)

    print(coco_evaluater.coco_eval)



    torch.save({
            'epoch': epoch,
            'model_state_dict': SSD_MODEL.state_dict(),
            'optimizer_state_dict': optimizer.state_dict(),
            }, "/content/gdrive/MyDrive/facemask_detection/save_model/
↪facemaskDetectionSSD_320x320_38MAP.pth")

    if epoch > 30:
        optimizer.param_groups[0]['lr'] = 0.001 * 0.1
```

```
Training on cuda
```

```
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at
0x7f698179b050>
Traceback (most recent call last):
  File "/usr/local/lib/python3.7/dist-packages/torch/utils/data/dataloader.py",
line 1328, in __del__
    self._shutdown_workers()
  File "/usr/local/lib/python3.7/dist-packages/torch/utils/data/dataloader.py",
line 1320, in _shutdown_workers
    if w.is_alive():
  File "/usr/lib/python3.7/multiprocessing/process.py", line 151, in is_alive
    assert self._parent_pid == os.getpid(), 'can only test a child process'
AssertionError: can only test a child process
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at
0x7f698179b050>
Traceback (most recent call last):
  File "/usr/local/lib/python3.7/dist-packages/torch/utils/data/dataloader.py",
line 1328, in __del__
    self._shutdown_workers()
  File "/usr/local/lib/python3.7/dist-packages/torch/utils/data/dataloader.py",
line 1320, in _shutdown_workers
    if w.is_alive():
```

```
  File "/usr/lib/python3.7/multiprocessing/process.py", line 151, in is_alive
    assert self._parent_pid == os.getpid(), 'can only test a child process'
AssertionError: can only test a child process



epoch: 0, training loss: 3.186100948601961, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:49  model_time: 1.1894 (1.1894)  evaluator_time:
0.2984 (0.2984)  time: 2.2656  data: 0.7615  max mem: 5550
Test:  [21/22]  eta: 0:00:01  model_time: 0.7167 (0.7430)  evaluator_time:
0.1709 (0.2303)  time: 0.9663  data: 0.0672  max mem: 5550
Test: Total time: 0:00:24 (1.1024 s / it)
Averaged stats: model_time: 0.7167 (0.7430)  evaluator_time: 0.1709 (0.2303)
Accumulating evaluation results…
DONE (t=0.76s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.246
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.433
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.253
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.025
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.222
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.453
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.270
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.410
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.452
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.137
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.457
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.692
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69735b8650>}



epoch: 1, training loss: 2.359612367115915, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:04  model_time: 1.2637 (1.2637)  evaluator_time:
0.3787 (0.3787)  time: 2.9462  data: 1.2812  max mem: 5550
Test:  [21/22]  eta: 0:00:01  model_time: 0.6775 (0.7108)  evaluator_time:
0.1803 (0.2358)  time: 0.9811  data: 0.0604  max mem: 5550
Test: Total time: 0:00:23 (1.0833 s / it)
Averaged stats: model_time: 0.6775 (0.7108)  evaluator_time: 0.1803 (0.2358)
Accumulating evaluation results…
DONE (t=0.81s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.293
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.493
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.321
```

```
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.053
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.265
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.521
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.276
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.447
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.482
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.181
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.492
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.700
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6962ade050>}


epoch: 2, training loss: 2.0934839230030775, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:11  model_time: 1.4479 (1.4479)  evaluator_time:
0.5906 (0.5906)  time: 3.2723  data: 1.2170  max mem: 5550
Test:  [21/22]  eta: 0:00:01  model_time: 0.6975 (0.7349)  evaluator_time:
0.1850 (0.2524)  time: 0.9968  data: 0.0588  max mem: 5550
Test: Total time: 0:00:24 (1.1180 s / it)
Averaged stats: model_time: 0.6975 (0.7349)  evaluator_time: 0.1850 (0.2524)
Accumulating evaluation results…
DONE (t=0.92s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.292
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.517
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.303
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.044
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.282
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.495
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.310
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.465
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.501
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.204
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.504
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.732
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6972344350>}


epoch: 3, training loss: 1.9617709023877978, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:43  model_time: 0.9125 (0.9125)  evaluator_time:
0.2731 (0.2731)  time: 1.9692  data: 0.7736  max mem: 5550
Test:  [21/22]  eta: 0:00:01  model_time: 0.6891 (0.7058)  evaluator_time:
0.2238 (0.2531)  time: 1.0332  data: 0.0652  max mem: 5550
Test: Total time: 0:00:23 (1.0731 s / it)
Averaged stats: model_time: 0.6891 (0.7058)  evaluator_time: 0.2238 (0.2531)
```

```
Accumulating evaluation results…
DONE (t=0.83s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.302
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.526
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.300
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.047
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.278
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.537
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.293
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.455
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.490
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.221
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.497
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.689
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697234fe10>}


epoch: 4, training loss: 1.8344742273911834, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:56  model_time: 0.9836 (0.9836)  evaluator_time:
0.2860 (0.2860)  time: 2.5598  data: 1.2804  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5733 (0.5983)  evaluator_time:
0.1836 (0.2425)  time: 0.8733  data: 0.0603  max mem: 5550
Test: Total time: 0:00:21 (0.9711 s / it)
Averaged stats: model_time: 0.5733 (0.5983)  evaluator_time: 0.1836 (0.2425)
Accumulating evaluation results…
DONE (t=0.69s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.310
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.531
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.299
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.062
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.306
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.501
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.294
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.435
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.460
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.222
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.461
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.647
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6972395410>}


epoch: 5, training loss: 1.71666428912431, lr: 0.01
creating index…
index created!
```

```
Test:  [ 0/22]  eta: 0:01:07  model_time: 1.0615 (1.0615)  evaluator_time:
0.6913 (0.6913)  time: 3.0752  data: 1.3053  max mem: 5550
Test:  [21/22]  eta: 0:00:01  model_time: 0.6565 (0.6466)  evaluator_time:
0.2036 (0.2584)  time: 0.9278  data: 0.0569  max mem: 5550
Test: Total time: 0:00:22 (1.0420 s / it)
Averaged stats: model_time: 0.6565 (0.6466)  evaluator_time: 0.2036 (0.2584)
Accumulating evaluation results…
DONE (t=0.82s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.328
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.558
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.340
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.056
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.324
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.535
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.313
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.482
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.519
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.264
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.542
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.680
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6972395590>}


epoch: 6, training loss: 1.6804218059405684, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:50  model_time: 0.9336 (0.9336)  evaluator_time:
0.4453 (0.4453)  time: 2.2803  data: 0.8815  max mem: 5550
Test:  [21/22]  eta: 0:00:01  model_time: 0.6100 (0.6563)  evaluator_time:
0.2080 (0.2549)  time: 0.9292  data: 0.0608  max mem: 5550
Test: Total time: 0:00:22 (1.0271 s / it)
Averaged stats: model_time: 0.6100 (0.6563)  evaluator_time: 0.2080 (0.2549)
Accumulating evaluation results…
DONE (t=0.80s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.339
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.576
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.355
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.096
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.328
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.549
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.334
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.489
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.527
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.239
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.530
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.748
```

```
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697234f5d0>}


epoch: 7, training loss: 1.6146570211276412, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:21  model_time: 0.9658 (0.9658)  evaluator_time:
0.6012 (0.6012)  time: 3.6845  data: 2.0914  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5532 (0.5952)  evaluator_time:
0.2232 (0.2335)  time: 0.8651  data: 0.0610  max mem: 5550
Test: Total time: 0:00:21 (0.9977 s / it)
Averaged stats: model_time: 0.5532 (0.5952)  evaluator_time: 0.2232 (0.2335)
Accumulating evaluation results…
DONE (t=0.74s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.313
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.530
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.334
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.072
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.284
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.539
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.299
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.466
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.498
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.225
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.497
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.719
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6962ade0d0>}


epoch: 8, training loss: 1.5138298412784934, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:01  model_time: 0.5983 (0.5983)  evaluator_time:
0.3235 (0.3235)  time: 2.8097  data: 1.8782  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5724 (0.5750)  evaluator_time:
0.2098 (0.2449)  time: 0.8749  data: 0.0617  max mem: 5550
Test: Total time: 0:00:21 (0.9779 s / it)
Averaged stats: model_time: 0.5724 (0.5750)  evaluator_time: 0.2098 (0.2449)
Accumulating evaluation results…
DONE (t=0.77s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.330
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.565
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.358
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.048
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.296
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.592
```

```
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.308
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.457
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.502
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.175
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.535
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.700
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6973569ad0>}


epoch: 9, training loss: 1.490667070262134, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:04  model_time: 0.5753 (0.5753)  evaluator_time:
0.3841 (0.3841)  time: 2.9528  data: 1.9804  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5953 (0.5715)  evaluator_time:
0.2564 (0.2591)  time: 0.8890  data: 0.0608  max mem: 5550
Test: Total time: 0:00:21 (0.9929 s / it)
Averaged stats: model_time: 0.5953 (0.5715)  evaluator_time: 0.2564 (0.2591)
Accumulating evaluation results…
DONE (t=0.80s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.338
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.595
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.337
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.062
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.318
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.591
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.306
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.453
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.482
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.231
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.455
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.731
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6962784dd0>}


epoch: 10, training loss: 1.4149223840795457, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:53  model_time: 1.0953 (1.0953)  evaluator_time:
0.5397 (0.5397)  time: 2.4366  data: 0.7841  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5084 (0.5634)  evaluator_time:
0.2272 (0.2566)  time: 0.8336  data: 0.0664  max mem: 5550
Test: Total time: 0:00:20 (0.9397 s / it)
Averaged stats: model_time: 0.5084 (0.5634)  evaluator_time: 0.2272 (0.2566)
Accumulating evaluation results…
DONE (t=0.74s).
IoU metric: bbox
```

```
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.340
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.567
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.366
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.057
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.342
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.556
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.320
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.481
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.509
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.238
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.492
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.754
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697219fe90>}


epoch: 11, training loss: 1.3522069291211665, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:53  model_time: 1.0701 (1.0701)  evaluator_time:
0.5136 (0.5136)  time: 2.4098  data: 0.8082  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5842 (0.6257)  evaluator_time:
0.1885 (0.2493)  time: 0.8945  data: 0.0642  max mem: 5550
Test: Total time: 0:00:21 (0.9915 s / it)
Averaged stats: model_time: 0.5842 (0.6257)  evaluator_time: 0.1885 (0.2493)
Accumulating evaluation results…
DONE (t=0.81s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.347
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.579
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.363
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.072
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.331
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.580
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.333
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.491
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.538
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.239
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.561
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.731
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69711c2210>}


epoch: 12, training loss: 1.3577878116630018, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:46  model_time: 0.9629 (0.9629)  evaluator_time:
0.2134 (0.2134)  time: 2.1229  data: 0.9285  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5563 (0.6085)  evaluator_time:
```

```
0.2072 (0.2530)  time: 0.9142  data: 0.0650  max mem: 5550
Test: Total time: 0:00:21 (0.9825 s / it)
Averaged stats: model_time: 0.5563 (0.6085)  evaluator_time: 0.2072 (0.2530)
Accumulating evaluation results…
DONE (t=0.79s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.349
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.573
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.382
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.061
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.344
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.574
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.319
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.489
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.540
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.254
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.575
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.701
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69626d9110>}


epoch: 13, training loss: 1.309306944720447, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:43  model_time: 0.7828 (0.7828)  evaluator_time:
0.4282 (0.4282)  time: 1.9839  data: 0.7570  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4709 (0.5370)  evaluator_time:
0.2094 (0.2459)  time: 0.8389  data: 0.0681  max mem: 5550
Test: Total time: 0:00:19 (0.9010 s / it)
Averaged stats: model_time: 0.4709 (0.5370)  evaluator_time: 0.2094 (0.2459)
Accumulating evaluation results…
DONE (t=0.65s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.297
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.509
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.309
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.062
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.277
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.510
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.311
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.463
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.492
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.206
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.492
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.720
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69661bc750>}
```

```
epoch: 14, training loss: 1.2380990898236632, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:50  model_time: 0.4606 (0.4606)  evaluator_time:
0.3363 (0.3363)  time: 2.2732  data: 1.4666  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5109 (0.5349)  evaluator_time:
0.2191 (0.2518)  time: 0.8496  data: 0.0627  max mem: 5550
Test: Total time: 0:00:20 (0.9286 s / it)
Averaged stats: model_time: 0.5109 (0.5349)  evaluator_time: 0.2191 (0.2518)
Accumulating evaluation results…
DONE (t=0.73s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.315
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.543
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.323
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.055
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.301
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.541
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.309
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.460
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.495
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.229
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.478
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.736
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f696f1d5bd0>}


epoch: 15, training loss: 1.2387789157219231, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:47  model_time: 0.8071 (0.8071)  evaluator_time:
0.4555 (0.4555)  time: 2.1471  data: 0.8741  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4823 (0.5552)  evaluator_time:
0.1883 (0.2603)  time: 0.8431  data: 0.0641  max mem: 5550
Test: Total time: 0:00:20 (0.9317 s / it)
Averaged stats: model_time: 0.4823 (0.5552)  evaluator_time: 0.1883 (0.2603)
Accumulating evaluation results…
DONE (t=0.76s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.364
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.601
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.413
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.074
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.349
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.612
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.330
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.505
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.527
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 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.257
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.517
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.758
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69628efe10>}


epoch: 16, training loss: 1.2595119569450617, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:50  model_time: 1.0183 (1.0183)  evaluator_time:
0.3202 (0.3202)  time: 2.3113  data: 0.9556  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5156 (0.5521)  evaluator_time:
0.3000 (0.2827)  time: 0.8773  data: 0.0689  max mem: 5550
Test: Total time: 0:00:21 (0.9586 s / it)
Averaged stats: model_time: 0.5156 (0.5521)  evaluator_time: 0.3000 (0.2827)
Accumulating evaluation results…
DONE (t=0.79s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.345
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.585
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.348
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.072
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.350
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.542
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.327
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.502
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.532
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.266
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.521
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.759
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697234f090>}


epoch: 17, training loss: 1.170159401372075, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:05  model_time: 0.5757 (0.5757)  evaluator_time:
0.2992 (0.2992)  time: 2.9855  data: 2.1010  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5201 (0.5638)  evaluator_time:
0.2068 (0.2241)  time: 0.8311  data: 0.0587  max mem: 5550
Test: Total time: 0:00:20 (0.9539 s / it)
Averaged stats: model_time: 0.5201 (0.5638)  evaluator_time: 0.2068 (0.2241)
Accumulating evaluation results…
DONE (t=0.69s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.357
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.602
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.375
```

```
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.072
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.353
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.588
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.319
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.504
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.523
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.233
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.528
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.742
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6961fef2d0>}


epoch: 18, training loss: 1.1530232704244554, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:51  model_time: 0.8195 (0.8195)  evaluator_time:
0.5892 (0.5892)  time: 2.3456  data: 0.9192  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5223 (0.5672)  evaluator_time:
0.2176 (0.2682)  time: 0.8886  data: 0.0665  max mem: 5550
Test: Total time: 0:00:21 (0.9608 s / it)
Averaged stats: model_time: 0.5223 (0.5672)  evaluator_time: 0.2176 (0.2682)
Accumulating evaluation results…
DONE (t=0.73s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.371
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.613
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.403
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.071
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.348
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.621
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.318
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.497
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.526
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.267
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.516
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.747
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69628e0e10>}


epoch: 19, training loss: 1.123286777175963, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:09  model_time: 0.5776 (0.5776)  evaluator_time:
0.3394 (0.3394)  time: 3.1705  data: 2.2375  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4908 (0.4963)  evaluator_time:
0.2199 (0.2508)  time: 0.7928  data: 0.0625  max mem: 5550
Test: Total time: 0:00:20 (0.9232 s / it)
Averaged stats: model_time: 0.4908 (0.4963)  evaluator_time: 0.2199 (0.2508)
```

```
Accumulating evaluation results…
DONE (t=0.72s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.321
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.561
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.315
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.086
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.314
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.553
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.320
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.489
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.519
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.334
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.498
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.702
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6971255550>}


epoch: 20, training loss: 1.0867871632799506, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:32  model_time: 0.5654 (0.5654)  evaluator_time:
0.4584 (0.4584)  time: 4.1992  data: 3.1653  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5318 (0.5200)  evaluator_time:
0.1789 (0.2166)  time: 0.7907  data: 0.0560  max mem: 5550
Test: Total time: 0:00:20 (0.9469 s / it)
Averaged stats: model_time: 0.5318 (0.5200)  evaluator_time: 0.1789 (0.2166)
Accumulating evaluation results…
DONE (t=0.69s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.349
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.583
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.382
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.090
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.329
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.597
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.329
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.473
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.521
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.288
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.509
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.727
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6971257610>}


epoch: 21, training loss: 1.0863277269527316, lr: 0.01
creating index…
index created!
```

```
Test:  [ 0/22]  eta: 0:00:47  model_time: 0.8751 (0.8751)  evaluator_time:
0.3930 (0.3930)  time: 2.1780  data: 0.8905  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4928 (0.5344)  evaluator_time:
0.1895 (0.2384)  time: 0.8052  data: 0.0619  max mem: 5550
Test: Total time: 0:00:19 (0.8891 s / it)
Averaged stats: model_time: 0.4928 (0.5344)  evaluator_time: 0.1895 (0.2384)
Accumulating evaluation results…
DONE (t=0.63s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.346
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.579
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.361
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.073
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.327
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.583
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.309
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.469
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.492
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.241
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.474
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.725
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6a8ef6d750>}


epoch: 22, training loss: 1.0624138824641705, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:09  model_time: 0.6297 (0.6297)  evaluator_time:
0.5183 (0.5183)  time: 3.1746  data: 2.0096  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4672 (0.5393)  evaluator_time:
0.1980 (0.2375)  time: 0.8187  data: 0.0621  max mem: 5550
Test: Total time: 0:00:20 (0.9420 s / it)
Averaged stats: model_time: 0.4672 (0.5393)  evaluator_time: 0.1980 (0.2375)
Accumulating evaluation results…
DONE (t=0.71s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.366
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.596
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.415
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.080
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.364
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.569
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.323
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.492
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.527
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.291
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.520
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.723
```

```
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6962784b90>}


epoch: 23, training loss: 1.0344882323406637, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:44  model_time: 0.7480 (0.7480)  evaluator_time:
0.3626 (0.3626)  time: 2.0202  data: 0.8834  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5180 (0.5205)  evaluator_time:
0.2069 (0.2315)  time: 0.7856  data: 0.0563  max mem: 5550
Test: Total time: 0:00:20 (0.9212 s / it)
Averaged stats: model_time: 0.5180 (0.5205)  evaluator_time: 0.2069 (0.2315)
Accumulating evaluation results…
DONE (t=0.67s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.347
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.578
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.349
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.074
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.355
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.550
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.322
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.498
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.541
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.294
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.527
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.757
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f696209d390>}


epoch: 24, training loss: 1.073603137396276, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:51  model_time: 0.7724 (0.7724)  evaluator_time:
0.2871 (0.2871)  time: 2.3367  data: 1.2612  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4641 (0.5188)  evaluator_time:
0.2173 (0.2392)  time: 0.8011  data: 0.0632  max mem: 5550
Test: Total time: 0:00:19 (0.8919 s / it)
Averaged stats: model_time: 0.4641 (0.5188)  evaluator_time: 0.2173 (0.2392)
Accumulating evaluation results…
DONE (t=0.64s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.335
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.560
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.365
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.095
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.318
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.579
```

```
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.343
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.495
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.531
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.273
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.526
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.743
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6962bbe8d0>}


epoch: 25, training loss: 1.0194266475737095, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:51  model_time: 0.8765 (0.8765)  evaluator_time:
0.5664 (0.5664)  time: 2.3333  data: 0.8724  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4668 (0.5326)  evaluator_time:
0.2082 (0.2652)  time: 0.8114  data: 0.0583  max mem: 5550
Test: Total time: 0:00:20 (0.9223 s / it)
Averaged stats: model_time: 0.4668 (0.5326)  evaluator_time: 0.2082 (0.2652)
Accumulating evaluation results…
DONE (t=0.66s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.348
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.577
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.367
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.079
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.346
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.567
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.320
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.462
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.530
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.328
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.542
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.667
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69710c02d0>}


epoch: 26, training loss: 0.9851195416413248, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:47  model_time: 0.7315 (0.7315)  evaluator_time:
0.4646 (0.4646)  time: 2.1713  data: 0.9579  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4635 (0.5369)  evaluator_time:
0.2316 (0.2556)  time: 0.8610  data: 0.0681  max mem: 5550
Test: Total time: 0:00:20 (0.9176 s / it)
Averaged stats: model_time: 0.4635 (0.5369)  evaluator_time: 0.2316 (0.2556)
Accumulating evaluation results…
DONE (t=0.75s).
IoU metric: bbox
```

```
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.339
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.561
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.355
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.086
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.331
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.575
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.324
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.478
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.542
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.319
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.528
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.739
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69713cdc50>}


epoch: 27, training loss: 0.9502438558265567, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:45  model_time: 0.8496 (0.8496)  evaluator_time:
0.4357 (0.4357)  time: 2.0837  data: 0.7772  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5175 (0.5465)  evaluator_time:
0.1929 (0.2482)  time: 0.8403  data: 0.0668  max mem: 5550
Test: Total time: 0:00:20 (0.9174 s / it)
Averaged stats: model_time: 0.5175 (0.5465)  evaluator_time: 0.1929 (0.2482)
Accumulating evaluation results…
DONE (t=0.63s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.375
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.614
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.427
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.078
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.336
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.645
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.350
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.511
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.559
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.288
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.563
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.764
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6962bbefd0>}


epoch: 28, training loss: 0.9401585757732391, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:57  model_time: 0.4816 (0.4816)  evaluator_time:
0.2620 (0.2620)  time: 2.6205  data: 1.8670  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4707 (0.4990)  evaluator_time:
```

```
0.2238 (0.2356)  time: 0.7922  data: 0.0624  max mem: 5550
Test: Total time: 0:00:19 (0.8939 s / it)
Averaged stats: model_time: 0.4707 (0.4990)  evaluator_time: 0.2238 (0.2356)
Accumulating evaluation results…
DONE (t=0.58s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.360
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.577
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.379
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.079
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.360
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.350
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.498
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.533
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.286
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.538
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.715
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697112b3d0>}


epoch: 29, training loss: 0.992657536175102, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:41  model_time: 0.8072 (0.8072)  evaluator_time:
0.2491 (0.2491)  time: 1.8664  data: 0.7921  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5005 (0.5326)  evaluator_time:
0.2079 (0.2344)  time: 0.8206  data: 0.0781  max mem: 5550
Test: Total time: 0:00:19 (0.8960 s / it)
Averaged stats: model_time: 0.5005 (0.5326)  evaluator_time: 0.2079 (0.2344)
Accumulating evaluation results…
DONE (t=0.59s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.334
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.546
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.355
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.065
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.311
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.575
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.324
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.461
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.503
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.277
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.507
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.672
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697109b1d0>}
```

```
epoch: 30, training loss: 0.9635079335421324, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:48  model_time: 0.8621 (0.8621)  evaluator_time:
0.2282 (0.2282)  time: 2.1888  data: 1.0762  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4928 (0.5240)  evaluator_time:
0.2602 (0.2552)  time: 0.8309  data: 0.0658  max mem: 5550
Test: Total time: 0:00:20 (0.9091 s / it)
Averaged stats: model_time: 0.4928 (0.5240)  evaluator_time: 0.2602 (0.2552)
Accumulating evaluation results…
DONE (t=0.68s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.343
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.554
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.357
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.086
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.345
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.536
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.337
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.506
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.554
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.334
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.567
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.697
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69735acf90>}


epoch: 31, training loss: 0.9568158886395395, lr: 0.01
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:52  model_time: 0.7099 (0.7099)  evaluator_time:
0.4941 (0.4941)  time: 2.4026  data: 1.1792  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4442 (0.5151)  evaluator_time:
0.1962 (0.2197)  time: 0.7633  data: 0.0682  max mem: 5550
Test: Total time: 0:00:19 (0.8704 s / it)
Averaged stats: model_time: 0.4442 (0.5151)  evaluator_time: 0.1962 (0.2197)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.324
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.532
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.364
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.059
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.281
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.605
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.314
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.463
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.516
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```
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.242
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.529
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.712
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6967058310>}


epoch: 32, training loss: 0.8973044506274164, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:17  model_time: 0.6748 (0.6748)  evaluator_time:
0.4370 (0.4370)  time: 3.5086  data: 2.3870  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4804 (0.5052)  evaluator_time:
0.1564 (0.2183)  time: 0.7810  data: 0.0658  max mem: 5550
Test: Total time: 0:00:20 (0.9108 s / it)
Averaged stats: model_time: 0.4804 (0.5052)  evaluator_time: 0.1564 (0.2183)
Accumulating evaluation results…
DONE (t=0.61s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.370
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.604
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.421
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.082
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.355
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.618
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.355
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.520
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.548
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.322
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.542
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.734
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6973560fd0>}


epoch: 33, training loss: 0.8478483376093209, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:54  model_time: 0.9338 (0.9338)  evaluator_time:
0.6664 (0.6664)  time: 2.4605  data: 0.8425  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4896 (0.5176)  evaluator_time:
0.2115 (0.2608)  time: 0.8210  data: 0.0686  max mem: 5550
Test: Total time: 0:00:19 (0.9035 s / it)
Averaged stats: model_time: 0.4896 (0.5176)  evaluator_time: 0.2115 (0.2608)
Accumulating evaluation results…
DONE (t=0.62s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.379
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.616
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.430
```

```
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.085
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.365
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.620
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.356
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.523
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.550
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.319
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.547
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.735
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69722ed050>}


epoch: 34, training loss: 0.8454588232561946, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:24  model_time: 0.6664 (0.6664)  evaluator_time:
0.5725 (0.5725)  time: 3.8198  data: 2.5632  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4774 (0.4927)  evaluator_time:
0.1871 (0.2307)  time: 0.7695  data: 0.0696  max mem: 5550
Test: Total time: 0:00:20 (0.9201 s / it)
Averaged stats: model_time: 0.4774 (0.4927)  evaluator_time: 0.1871 (0.2307)
Accumulating evaluation results…
DONE (t=0.64s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.380
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.619
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.430
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.088
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.368
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.617
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.357
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.523
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.550
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.317
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.548
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.736
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69712028d0>}


epoch: 35, training loss: 0.8241126104258001, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:52  model_time: 0.8398 (0.8398)  evaluator_time:
0.7029 (0.7029)  time: 2.4029  data: 0.8405  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4699 (0.5199)  evaluator_time:
0.1719 (0.2464)  time: 0.7927  data: 0.0674  max mem: 5550
Test: Total time: 0:00:19 (0.8886 s / it)
Averaged stats: model_time: 0.4699 (0.5199)  evaluator_time: 0.1719 (0.2464)
```

```
Accumulating evaluation results…
DONE (t=0.62s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.383
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.621
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.436
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.091
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.370
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.617
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.360
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.526
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.552
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.313
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.741
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6971207810>}


epoch: 36, training loss: 0.8183679520152509, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:50  model_time: 0.7588 (0.7588)  evaluator_time:
0.4941 (0.4941)  time: 2.2865  data: 1.0235  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4681 (0.5095)  evaluator_time:
0.1829 (0.2376)  time: 0.7852  data: 0.0621  max mem: 5550
Test: Total time: 0:00:20 (0.9145 s / it)
Averaged stats: model_time: 0.4681 (0.5095)  evaluator_time: 0.1829 (0.2376)
Accumulating evaluation results…
DONE (t=0.64s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.385
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.625
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.436
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.092
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.371
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.619
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.358
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.526
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.564
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.313
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.576
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.739
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6972041290>}


epoch: 37, training loss: 0.78047746559605, lr: 0.0001
creating index…
index created!
```

```
Test:  [ 0/22]  eta: 0:01:04  model_time: 0.5404 (0.5404)  evaluator_time:
0.4253 (0.4253)  time: 2.9338  data: 1.9575  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4823 (0.5013)  evaluator_time:
0.2182 (0.2481)  time: 0.8109  data: 0.0606  max mem: 5550
Test: Total time: 0:00:20 (0.9140 s / it)
Averaged stats: model_time: 0.4823 (0.5013)  evaluator_time: 0.2182 (0.2481)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.385
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.627
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.437
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.092
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.371
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.618
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.350
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.520
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.559
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.314
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.567
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.736
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69735824d0>}


epoch: 38, training loss: 0.775688661262393, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:43  model_time: 0.7959 (0.7959)  evaluator_time:
0.3981 (0.3981)  time: 1.9843  data: 0.7730  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4941 (0.5247)  evaluator_time:
0.2286 (0.2587)  time: 0.8050  data: 0.0673  max mem: 5550
Test: Total time: 0:00:19 (0.9036 s / it)
Averaged stats: model_time: 0.4941 (0.5247)  evaluator_time: 0.2286 (0.2587)
Accumulating evaluation results…
DONE (t=0.61s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.386
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.435
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.092
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.374
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.617
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.352
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.517
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.555
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.316
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.560
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.736
```

```
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69672a5f50>}


epoch: 39, training loss: 0.7727686730213463, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:55  model_time: 1.0758 (1.0758)  evaluator_time:
0.4522 (0.4522)  time: 2.5221  data: 0.9771  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4517 (0.5428)  evaluator_time:
0.1946 (0.2573)  time: 0.7979  data: 0.0598  max mem: 5550
Test: Total time: 0:00:20 (0.9175 s / it)
Averaged stats: model_time: 0.4517 (0.5428)  evaluator_time: 0.1946 (0.2573)
Accumulating evaluation results…
DONE (t=0.67s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.385
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.430
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.093
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.375
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.618
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.348
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.510
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.557
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.343
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.548
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.741
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697359ea50>}


epoch: 40, training loss: 0.7794302888214588, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:37  model_time: 0.6913 (0.6913)  evaluator_time:
0.1953 (0.1953)  time: 1.7182  data: 0.8138  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4646 (0.5191)  evaluator_time:
0.2434 (0.2426)  time: 0.8056  data: 0.0656  max mem: 5550
Test: Total time: 0:00:19 (0.8798 s / it)
Averaged stats: model_time: 0.4646 (0.5191)  evaluator_time: 0.2434 (0.2426)
Accumulating evaluation results…
DONE (t=0.61s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.386
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.628
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.433
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.095
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.371
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.620
```

```
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.350
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.507
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.324
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.540
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.749
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6973592dd0>}


epoch: 41, training loss: 0.7754894639365375, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:47  model_time: 0.8508 (0.8508)  evaluator_time:
0.4560 (0.4560)  time: 2.1442  data: 0.8190  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4983 (0.5272)  evaluator_time:
0.2120 (0.2440)  time: 0.8302  data: 0.0679  max mem: 5550
Test: Total time: 0:00:19 (0.8930 s / it)
Averaged stats: model_time: 0.4983 (0.5272)  evaluator_time: 0.2120 (0.2440)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.386
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.431
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.093
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.376
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.621
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.344
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.509
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.316
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.542
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.755
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69611031d0>}


epoch: 42, training loss: 0.7545679155737162, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:44  model_time: 0.4828 (0.4828)  evaluator_time:
0.2548 (0.2548)  time: 2.0312  data: 1.2832  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4634 (0.4868)  evaluator_time:
0.2057 (0.2473)  time: 0.7932  data: 0.0719  max mem: 5550
Test: Total time: 0:00:19 (0.8746 s / it)
Averaged stats: model_time: 0.4634 (0.4868)  evaluator_time: 0.2057 (0.2473)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
```

```
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.388
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.432
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.093
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.377
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.622
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.346
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.510
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.556
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.321
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.552
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.751
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6972344210>}


epoch: 43, training loss: 0.7503184089437127, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:12  model_time: 0.5184 (0.5184)  evaluator_time:
0.2466 (0.2466)  time: 3.2964  data: 2.5213  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4728 (0.4772)  evaluator_time:
0.1963 (0.2314)  time: 0.7634  data: 0.0630  max mem: 5550
Test: Total time: 0:00:19 (0.8964 s / it)
Averaged stats: model_time: 0.4728 (0.4772)  evaluator_time: 0.1963 (0.2314)
Accumulating evaluation results…
DONE (t=0.57s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.389
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.433
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.094
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.377
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.622
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.344
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.507
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.553
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.323
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.546
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.750
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6a7518d050>}


epoch: 44, training loss: 0.7427291590720415, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:01  model_time: 0.7865 (0.7865)  evaluator_time:
0.3900 (0.3900)  time: 2.8007  data: 1.6014  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4726 (0.4939)  evaluator_time:
```

```
0.1969 (0.2383)  time: 0.7545  data: 0.0638  max mem: 5550
Test: Total time: 0:00:19 (0.8811 s / it)
Averaged stats: model_time: 0.4726 (0.4939)  evaluator_time: 0.1969 (0.2383)
Accumulating evaluation results…
DONE (t=0.62s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.389
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.630
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.435
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.095
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.379
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.621
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.345
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.502
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.547
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.326
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.542
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.729
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69628d9c10>}


epoch: 45, training loss: 0.7431679600849748, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:00  model_time: 0.8131 (0.8131)  evaluator_time:
0.4544 (0.4544)  time: 2.7395  data: 1.4530  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4847 (0.5148)  evaluator_time:
0.1785 (0.2276)  time: 0.7535  data: 0.0636  max mem: 5550
Test: Total time: 0:00:19 (0.8941 s / it)
Averaged stats: model_time: 0.4847 (0.5148)  evaluator_time: 0.1785 (0.2276)
Accumulating evaluation results…
DONE (t=0.59s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.389
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.632
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.430
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.095
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.378
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.621
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.344
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.508
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.553
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.312
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.545
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.755
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69735f9210>}
```

```
epoch: 46, training loss: 0.7368227518163621, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:47  model_time: 0.7986 (0.7986)  evaluator_time:
0.4565 (0.4565)  time: 2.1642  data: 0.8934  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4657 (0.4950)  evaluator_time:
0.1718 (0.2409)  time: 0.7615  data: 0.0548  max mem: 5550
Test: Total time: 0:00:19 (0.8926 s / it)
Averaged stats: model_time: 0.4657 (0.4950)  evaluator_time: 0.1718 (0.2409)
Accumulating evaluation results…
DONE (t=0.59s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.387
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.429
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.096
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.378
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.621
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.344
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.514
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.561
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.344
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.548
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.755
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69735fd250>}


epoch: 47, training loss: 0.7472575001884252, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:52  model_time: 0.7414 (0.7414)  evaluator_time:
0.2899 (0.2899)  time: 2.3824  data: 1.3301  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5011 (0.5166)  evaluator_time:
0.1709 (0.2262)  time: 0.7798  data: 0.0673  max mem: 5550
Test: Total time: 0:00:19 (0.8862 s / it)
Averaged stats: model_time: 0.5011 (0.5166)  evaluator_time: 0.1709 (0.2262)
Accumulating evaluation results…
DONE (t=0.59s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.390
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.630
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.431
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.093
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.380
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.621
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.345
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.509
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.556
```

```
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.316
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.755
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6972231710>}


epoch: 48, training loss: 0.7292201286181808, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:11  model_time: 0.7323 (0.7323)  evaluator_time:
0.2957 (0.2957)  time: 3.2667  data: 2.2211  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4699 (0.4887)  evaluator_time:
0.1795 (0.2230)  time: 0.7410  data: 0.0615  max mem: 5550
Test: Total time: 0:00:19 (0.8871 s / it)
Averaged stats: model_time: 0.4699 (0.4887)  evaluator_time: 0.1795 (0.2230)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.389
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.628
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.430
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.093
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.376
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.622
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.346
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.503
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.318
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.552
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.734
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697206d110>}


epoch: 49, training loss: 0.7317307190969586, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:49  model_time: 0.9977 (0.9977)  evaluator_time:
0.3256 (0.3256)  time: 2.2720  data: 0.9299  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4871 (0.5228)  evaluator_time:
0.1829 (0.2217)  time: 0.7857  data: 0.0571  max mem: 5550
Test: Total time: 0:00:19 (0.9001 s / it)
Averaged stats: model_time: 0.4871 (0.5228)  evaluator_time: 0.1829 (0.2217)
Accumulating evaluation results…
DONE (t=0.63s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.390
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.628
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.432
```

```
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.095
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.380
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.623
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.348
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.506
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.552
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.321
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.735
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6961100ad0>}


epoch: 50, training loss: 0.7309305733069777, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:10  model_time: 0.7068 (0.7068)  evaluator_time:
0.1920 (0.1920)  time: 3.2100  data: 2.2938  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4760 (0.5002)  evaluator_time:
0.1670 (0.2077)  time: 0.7337  data: 0.0629  max mem: 5550
Test: Total time: 0:00:19 (0.8875 s / it)
Averaged stats: model_time: 0.4760 (0.5002)  evaluator_time: 0.1670 (0.2077)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.388
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.627
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.430
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.095
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.377
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.623
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.347
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.509
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.556
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.345
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.548
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.735
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6962ac0050>}


epoch: 51, training loss: 0.723961332347244, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:43  model_time: 0.7600 (0.7600)  evaluator_time:
0.3551 (0.3551)  time: 1.9644  data: 0.8257  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4563 (0.5271)  evaluator_time:
0.1912 (0.2378)  time: 0.7945  data: 0.0682  max mem: 5550
Test: Total time: 0:00:19 (0.8886 s / it)
Averaged stats: model_time: 0.4563 (0.5271)  evaluator_time: 0.1912 (0.2378)
```

```
Accumulating evaluation results…
DONE (t=0.59s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.391
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.628
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.430
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.096
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.377
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.626
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.349
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.505
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.552
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.323
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.734
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697359ea50>}


epoch: 52, training loss: 0.7230595569126308, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:01  model_time: 0.8615 (0.8615)  evaluator_time:
0.2962 (0.2962)  time: 2.8005  data: 1.6268  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4872 (0.5255)  evaluator_time:
0.1812 (0.2262)  time: 0.7697  data: 0.0618  max mem: 5550
Test: Total time: 0:00:19 (0.8993 s / it)
Averaged stats: model_time: 0.4872 (0.5255)  evaluator_time: 0.1812 (0.2262)
Accumulating evaluation results…
DONE (t=0.59s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.390
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.431
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.096
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.376
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.622
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.346
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.506
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.552
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.324
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.550
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.735
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697233bb10>}


epoch: 53, training loss: 0.735398753080517, lr: 0.0001
creating index…
index created!
```

```
Test:  [ 0/22]  eta: 0:01:14  model_time: 0.6500 (0.6500)  evaluator_time:
0.3308 (0.3308)  time: 3.3874  data: 2.3971  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4674 (0.5087)  evaluator_time:
0.1892 (0.2116)  time: 0.7721  data: 0.0592  max mem: 5550
Test: Total time: 0:00:19 (0.8999 s / it)
Averaged stats: model_time: 0.4674 (0.5087)  evaluator_time: 0.1892 (0.2116)
Accumulating evaluation results…
DONE (t=0.63s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.392
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.630
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.427
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.096
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.381
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.630
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.348
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.513
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.558
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.347
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.549
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.741
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69720478d0>}


epoch: 54, training loss: 0.7226636332925409, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:42  model_time: 0.7082 (0.7082)  evaluator_time:
0.3100 (0.3100)  time: 1.9358  data: 0.8988  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4527 (0.5163)  evaluator_time:
0.1756 (0.2397)  time: 0.8054  data: 0.0755  max mem: 5550
Test: Total time: 0:00:19 (0.8866 s / it)
Averaged stats: model_time: 0.4527 (0.5163)  evaluator_time: 0.1756 (0.2397)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.388
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.412
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.096
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.373
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.627
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.346
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.503
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.548
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.321
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.544
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.735
```

```
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69735d9250>}


epoch: 55, training loss: 0.6978816972114146, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:51  model_time: 0.8910 (0.8910)  evaluator_time:
0.4527 (0.4527)  time: 2.3183  data: 0.9550  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4664 (0.4974)  evaluator_time:
0.2010 (0.2564)  time: 0.7899  data: 0.0600  max mem: 5550
Test: Total time: 0:00:19 (0.8877 s / it)
Averaged stats: model_time: 0.4664 (0.4974)  evaluator_time: 0.2010 (0.2564)
Accumulating evaluation results…
DONE (t=0.61s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.390
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.626
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.430
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.094
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.375
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.627
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.349
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.505
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.550
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.319
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.549
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.735
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69721ecc90>}


epoch: 56, training loss: 0.7311661839485168, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:40  model_time: 0.6678 (0.6678)  evaluator_time:
0.2169 (0.2169)  time: 1.8515  data: 0.9523  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5091 (0.5281)  evaluator_time:
0.1983 (0.2362)  time: 0.8135  data: 0.0729  max mem: 5550
Test: Total time: 0:00:19 (0.8940 s / it)
Averaged stats: model_time: 0.5091 (0.5281)  evaluator_time: 0.1983 (0.2362)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.391
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.428
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.097
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.376
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.629
```

```
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.349
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.512
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.556
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.345
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.549
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.735
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69720c4dd0>}


epoch: 57, training loss: 0.7259415695443749, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:02  model_time: 0.9089 (0.9089)  evaluator_time:
0.3746 (0.3746)  time: 2.8269  data: 1.5265  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4837 (0.5387)  evaluator_time:
0.1900 (0.2207)  time: 0.8041  data: 0.0667  max mem: 5550
Test: Total time: 0:00:19 (0.9068 s / it)
Averaged stats: model_time: 0.4837 (0.5387)  evaluator_time: 0.1900 (0.2207)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.389
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.627
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.421
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.098
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.373
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.625
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.345
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.505
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.323
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.547
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.736
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6961100190>}


epoch: 58, training loss: 0.7125398677308112, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:46  model_time: 0.8457 (0.8457)  evaluator_time:
0.3994 (0.3994)  time: 2.1183  data: 0.8554  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4844 (0.5245)  evaluator_time:
0.1657 (0.2258)  time: 0.7868  data: 0.0702  max mem: 5550
Test: Total time: 0:00:19 (0.9017 s / it)
Averaged stats: model_time: 0.4844 (0.5245)  evaluator_time: 0.1657 (0.2258)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
```

```
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.391
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.419
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.095
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.376
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.629
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.348
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.506
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.552
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.319
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.739
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6973583410>}


epoch: 59, training loss: 0.7150231753475964, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:52  model_time: 0.7241 (0.7241)  evaluator_time:
0.3517 (0.3517)  time: 2.3727  data: 1.2858  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4642 (0.5254)  evaluator_time:
0.1773 (0.2215)  time: 0.7839  data: 0.0635  max mem: 5550
Test: Total time: 0:00:19 (0.8813 s / it)
Averaged stats: model_time: 0.4642 (0.5254)  evaluator_time: 0.1773 (0.2215)
Accumulating evaluation results…
DONE (t=0.59s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.389
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.628
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.432
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.095
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.374
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.623
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.346
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.512
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.557
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.349
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.548
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.736
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697118add0>}


epoch: 60, training loss: 0.7208215785212815, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:43  model_time: 0.8371 (0.8371)  evaluator_time:
0.3782 (0.3782)  time: 1.9853  data: 0.7482  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4806 (0.5240)  evaluator_time:
```

```
0.1942 (0.2373)  time: 0.7971  data: 0.0664  max mem: 5550
Test: Total time: 0:00:19 (0.8816 s / it)
Averaged stats: model_time: 0.4806 (0.5240)  evaluator_time: 0.1942 (0.2373)
Accumulating evaluation results…
DONE (t=0.58s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.391
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.631
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.420
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.094
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.374
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.629
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.348
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.505
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.326
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.545
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.740
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6973648150>}


epoch: 61, training loss: 0.7082522052805871, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:42  model_time: 0.7316 (0.7316)  evaluator_time:
0.2982 (0.2982)  time: 1.9507  data: 0.9044  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4529 (0.5255)  evaluator_time:
0.1648 (0.2227)  time: 0.7510  data: 0.0611  max mem: 5550
Test: Total time: 0:00:19 (0.8788 s / it)
Averaged stats: model_time: 0.4529 (0.5255)  evaluator_time: 0.1648 (0.2227)
Accumulating evaluation results…
DONE (t=0.57s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.389
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.416
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.094
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.371
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.629
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.348
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.507
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.552
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.329
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.545
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.741
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69710c0d90>}
```

```
epoch: 62, training loss: 0.7075089241843671, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:45  model_time: 0.7093 (0.7093)  evaluator_time:
0.2765 (0.2765)  time: 2.0874  data: 1.0901  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5229 (0.5179)  evaluator_time:
0.2105 (0.2444)  time: 0.8327  data: 0.0769  max mem: 5550
Test: Total time: 0:00:19 (0.8994 s / it)
Averaged stats: model_time: 0.5229 (0.5179)  evaluator_time: 0.2105 (0.2444)
Accumulating evaluation results…
DONE (t=0.61s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.387
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.630
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.417
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.094
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.373
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.622
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.348
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.505
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.550
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.331
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.545
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.734
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69735f9210>}


epoch: 63, training loss: 0.7019422589801252, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:52  model_time: 0.9637 (0.9637)  evaluator_time:
0.5118 (0.5118)  time: 2.3815  data: 0.8849  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4672 (0.5189)  evaluator_time:
0.1902 (0.2318)  time: 0.7766  data: 0.0689  max mem: 5550
Test: Total time: 0:00:19 (0.8880 s / it)
Averaged stats: model_time: 0.4672 (0.5189)  evaluator_time: 0.1902 (0.2318)
Accumulating evaluation results…
DONE (t=0.58s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.390
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.631
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.417
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.097
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.373
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.628
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.346
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.513
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.558
```

```
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.357
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.544
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.740
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6966144f10>}


epoch: 64, training loss: 0.7096419697627425, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:14  model_time: 0.5039 (0.5039)  evaluator_time:
0.1837 (0.1837)  time: 3.3782  data: 2.6810  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4651 (0.4851)  evaluator_time:
0.1855 (0.2183)  time: 0.7650  data: 0.0652  max mem: 5550
Test: Total time: 0:00:19 (0.9017 s / it)
Averaged stats: model_time: 0.4651 (0.4851)  evaluator_time: 0.1855 (0.2183)
Accumulating evaluation results…
DONE (t=0.58s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.390
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.630
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.429
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.095
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.376
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.622
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.348
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.507
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.553
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.323
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.549
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.742
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69735ba390>}


epoch: 65, training loss: 0.7018594392575324, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:49  model_time: 0.9476 (0.9476)  evaluator_time:
0.3778 (0.3778)  time: 2.2355  data: 0.8929  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4575 (0.5308)  evaluator_time:
0.1792 (0.2383)  time: 0.7679  data: 0.0675  max mem: 5550
Test: Total time: 0:00:19 (0.8941 s / it)
Averaged stats: model_time: 0.4575 (0.5308)  evaluator_time: 0.1792 (0.2383)
Accumulating evaluation results…
DONE (t=0.59s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.389
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.418
```

```
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.094
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.374
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.623
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.346
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.506
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.553
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.322
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.549
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.743
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6973543350>}


epoch: 66, training loss: 0.6957095521502197, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:44  model_time: 0.6620 (0.6620)  evaluator_time:
0.3595 (0.3595)  time: 2.0183  data: 0.9801  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4726 (0.5161)  evaluator_time:
0.2148 (0.2528)  time: 0.8022  data: 0.0651  max mem: 5550
Test: Total time: 0:00:19 (0.8931 s / it)
Averaged stats: model_time: 0.4726 (0.5161)  evaluator_time: 0.2148 (0.2528)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.389
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.416
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.096
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.376
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.622
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.345
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.506
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.553
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.326
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.549
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.739
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697107af50>}


epoch: 67, training loss: 0.6778616174124181, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:48  model_time: 0.8188 (0.8188)  evaluator_time:
0.4623 (0.4623)  time: 2.1825  data: 0.8911  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4785 (0.5332)  evaluator_time:
0.1751 (0.2459)  time: 0.7942  data: 0.0744  max mem: 5550
Test: Total time: 0:00:20 (0.9097 s / it)
Averaged stats: model_time: 0.4785 (0.5332)  evaluator_time: 0.1751 (0.2459)
```

```
Accumulating evaluation results…
DONE (t=0.61s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.391
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.631
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.418
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.094
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.378
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.622
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.346
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.507
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.554
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.322
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.741
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f692c88e5d0>}


epoch: 68, training loss: 0.7089858367107809, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:44  model_time: 0.8045 (0.8045)  evaluator_time:
0.3349 (0.3349)  time: 2.0202  data: 0.8699  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4783 (0.5177)  evaluator_time:
0.2135 (0.2305)  time: 0.8133  data: 0.0825  max mem: 5550
Test: Total time: 0:00:19 (0.8870 s / it)
Averaged stats: model_time: 0.4783 (0.5177)  evaluator_time: 0.2135 (0.2305)
Accumulating evaluation results…
DONE (t=0.58s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.388
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.631
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.416
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.095
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.374
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.624
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.345
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.505
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.321
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.547
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.741
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69735ae310>}


epoch: 69, training loss: 0.7045988992322236, lr: 0.0001
creating index…
index created!
```

```
Test:  [ 0/22]  eta: 0:00:40  model_time: 0.7351 (0.7351)  evaluator_time:
0.3034 (0.3034)  time: 1.8514  data: 0.7959  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4836 (0.5165)  evaluator_time:
0.1926 (0.2428)  time: 0.7967  data: 0.0644  max mem: 5550
Test: Total time: 0:00:19 (0.8762 s / it)
Averaged stats: model_time: 0.4836 (0.5165)  evaluator_time: 0.1926 (0.2428)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.390
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.631
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.419
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.097
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.377
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.621
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.341
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.511
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.558
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.353
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.549
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.734
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6971115f10>}


epoch: 70, training loss: 0.6852119578979909, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:48  model_time: 0.6545 (0.6545)  evaluator_time:
0.2560 (0.2560)  time: 2.2247  data: 1.3005  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4883 (0.5144)  evaluator_time:
0.1839 (0.2334)  time: 0.7780  data: 0.0647  max mem: 5550
Test: Total time: 0:00:19 (0.8851 s / it)
Averaged stats: model_time: 0.4883 (0.5144)  evaluator_time: 0.1839 (0.2334)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.391
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.631
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.418
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.095
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.379
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.623
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.341
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.506
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.554
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.322
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.552
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.739
```

```
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6961100a90>}


epoch: 71, training loss: 0.688182502053678, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:03  model_time: 0.8013 (0.8013)  evaluator_time:
0.3912 (0.3912)  time: 2.8872  data: 1.6837  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4626 (0.5040)  evaluator_time:
0.2217 (0.2205)  time: 0.8029  data: 0.0879  max mem: 5550
Test: Total time: 0:00:19 (0.8982 s / it)
Averaged stats: model_time: 0.4626 (0.5040)  evaluator_time: 0.2217 (0.2205)
Accumulating evaluation results…
DONE (t=0.59s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.391
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.631
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.420
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.097
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.379
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.623
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.341
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.507
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.554
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.326
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.550
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.739
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6971231810>}


epoch: 72, training loss: 0.7010308583267033, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:42  model_time: 0.8364 (0.8364)  evaluator_time:
0.3282 (0.3282)  time: 1.9485  data: 0.7693  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.5006 (0.5277)  evaluator_time:
0.2113 (0.2264)  time: 0.8079  data: 0.0538  max mem: 5550
Test: Total time: 0:00:19 (0.8914 s / it)
Averaged stats: model_time: 0.5006 (0.5277)  evaluator_time: 0.2113 (0.2264)
Accumulating evaluation results…
DONE (t=0.61s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.389
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.416
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.098
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.378
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.622
```

```
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.341
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.505
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.552
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.325
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.550
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.734
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69735ca750>}


epoch: 73, training loss: 0.6900442542973906, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:19  model_time: 0.9341 (0.9341)  evaluator_time:
0.3925 (0.3925)  time: 3.6047  data: 2.2603  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4562 (0.5127)  evaluator_time:
0.1703 (0.2035)  time: 0.7503  data: 0.0612  max mem: 5550
Test: Total time: 0:00:19 (0.8927 s / it)
Averaged stats: model_time: 0.4562 (0.5127)  evaluator_time: 0.1703 (0.2035)
Accumulating evaluation results…
DONE (t=0.58s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.391
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.418
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.098
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.379
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.624
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.341
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.506
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.554
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.324
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.555
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.735
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6962784890>}


epoch: 74, training loss: 0.6928675111848861, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:01  model_time: 0.5542 (0.5542)  evaluator_time:
0.2285 (0.2285)  time: 2.7762  data: 1.9835  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4284 (0.4980)  evaluator_time:
0.2220 (0.2262)  time: 0.7910  data: 0.0629  max mem: 5550
Test: Total time: 0:00:19 (0.8904 s / it)
Averaged stats: model_time: 0.4284 (0.4980)  evaluator_time: 0.2220 (0.2262)
Accumulating evaluation results…
DONE (t=0.58s).
IoU metric: bbox
```

```
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.391
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.630
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.418
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.093
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.379
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.624
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.342
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.507
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.554
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.328
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.552
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.735
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69744ba450>}


epoch: 75, training loss: 0.6810111734084785, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:46  model_time: 0.7736 (0.7736)  evaluator_time:
0.4158 (0.4158)  time: 2.1112  data: 0.9043  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4695 (0.5266)  evaluator_time:
0.2104 (0.2357)  time: 0.8142  data: 0.0697  max mem: 5550
Test: Total time: 0:00:19 (0.8912 s / it)
Averaged stats: model_time: 0.4695 (0.5266)  evaluator_time: 0.2104 (0.2357)
Accumulating evaluation results…
DONE (t=0.57s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.391
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.420
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.096
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.377
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.623
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.342
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.507
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.555
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.325
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.556
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.735
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6960f82b50>}


epoch: 76, training loss: 0.6898893732577562, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:01:05  model_time: 0.4910 (0.4910)  evaluator_time:
0.2134 (0.2134)  time: 2.9908  data: 2.2763  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4802 (0.5101)  evaluator_time:
```

```
0.1751 (0.2150)  time: 0.7792  data: 0.0651  max mem: 5550
Test: Total time: 0:00:19 (0.9064 s / it)
Averaged stats: model_time: 0.4802 (0.5101)  evaluator_time: 0.1751 (0.2150)
Accumulating evaluation results…
DONE (t=0.59s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.392
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.628
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.430
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.091
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.383
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.623
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.349
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.510
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.553
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.329
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.548
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.739
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697360a7d0>}


epoch: 77, training loss: 0.6910979349631816, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:47  model_time: 0.5197 (0.5197)  evaluator_time:
0.2465 (0.2465)  time: 2.1583  data: 1.3822  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4600 (0.5116)  evaluator_time:
0.1766 (0.2445)  time: 0.7957  data: 0.0609  max mem: 5550
Test: Total time: 0:00:19 (0.8928 s / it)
Averaged stats: model_time: 0.4600 (0.5116)  evaluator_time: 0.1766 (0.2445)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.390
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.629
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.419
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.093
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.380
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.622
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.342
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.501
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.548
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.296
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.553
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.739
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6962b02750>}
```

```
epoch: 78, training loss: 0.6775415851734579, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:52  model_time: 0.8828 (0.8828)  evaluator_time:
0.5119 (0.5119)  time: 2.3862  data: 0.9743  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4948 (0.5277)  evaluator_time:
0.1613 (0.2263)  time: 0.7608  data: 0.0611  max mem: 5550
Test: Total time: 0:00:19 (0.8977 s / it)
Averaged stats: model_time: 0.4948 (0.5277)  evaluator_time: 0.1613 (0.2263)
Accumulating evaluation results…
DONE (t=0.59s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.390
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.627
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.430
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.092
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.379
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.623
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.349
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.507
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.554
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.322
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.553
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.741
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f697360a7d0>}


epoch: 79, training loss: 0.6817199701908976, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:45  model_time: 0.6886 (0.6886)  evaluator_time:
0.2486 (0.2486)  time: 2.0613  data: 1.1068  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4933 (0.5205)  evaluator_time:
0.1960 (0.2533)  time: 0.8325  data: 0.0814  max mem: 5550
Test: Total time: 0:00:20 (0.9176 s / it)
Averaged stats: model_time: 0.4933 (0.5205)  evaluator_time: 0.1960 (0.2533)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.390
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.626
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.417
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.095
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.378
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.622
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.348
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.500
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.547
```

```
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.299
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.551
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.734
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6971086fd0>}


epoch: 80, training loss: 0.6823933951091021, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:50  model_time: 0.7129 (0.7129)  evaluator_time:
0.3560 (0.3560)  time: 2.3032  data: 1.2165  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4845 (0.5181)  evaluator_time:
0.1952 (0.2282)  time: 0.7616  data: 0.0671  max mem: 5550
Test: Total time: 0:00:19 (0.8850 s / it)
Averaged stats: model_time: 0.4845 (0.5181)  evaluator_time: 0.1952 (0.2282)
Accumulating evaluation results…
DONE (t=0.58s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.391
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.627
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.429
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.093
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.381
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.624
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.349
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.503
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.549
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.297
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.554
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.740
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f6962ae0e10>}


epoch: 81, training loss: 0.6852330153342336, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:46  model_time: 0.8172 (0.8172)  evaluator_time:
0.3514 (0.3514)  time: 2.1078  data: 0.9229  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4814 (0.5234)  evaluator_time:
0.1560 (0.2317)  time: 0.7860  data: 0.0617  max mem: 5550
Test: Total time: 0:00:19 (0.8888 s / it)
Averaged stats: model_time: 0.4814 (0.5234)  evaluator_time: 0.1560 (0.2317)
Accumulating evaluation results…
DONE (t=0.59s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.390
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.626
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.429
```

```
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.091
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.379
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.624
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.356
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.499
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.547
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.295
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.553
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.736
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69722e1f50>}


epoch: 82, training loss: 0.6953576051164418, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:45  model_time: 0.8563 (0.8563)  evaluator_time:
0.2746 (0.2746)  time: 2.0554  data: 0.9117  max mem: 5550
Test:  [21/22]  eta: 0:00:00  model_time: 0.4290 (0.5511)  evaluator_time:
0.1900 (0.2053)  time: 0.8160  data: 0.0783  max mem: 5550
Test: Total time: 0:00:19 (0.8857 s / it)
Averaged stats: model_time: 0.4290 (0.5511)  evaluator_time: 0.1900 (0.2053)
Accumulating evaluation results…
DONE (t=0.60s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.388
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.625
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.427
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.091
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.380
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.622
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.347
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.508
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.557
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.327
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.556
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.739
{'bbox': <pycocotools.cocoeval.COCOeval object at 0x7f69610ada90>}


epoch: 83, training loss: 0.6889228262007236, lr: 0.0001
creating index…
index created!
Test:  [ 0/22]  eta: 0:00:44  model_time: 0.7438 (0.7438)  evaluator_time:
0.4011 (0.4011)  time: 2.0074  data: 0.8449  max mem: 5550
```

# 13 Inference

### 13.0.1 Load Model From Checkpoint

[ ]:
```
SSD_MODEL = torchvision.models.detection.
 ↪ssdlite320_mobilenet_v3_large(pretrained=False)

checkPoint = torch.load("/content/gdrive/MyDrive/facemask_detection/save_model/
 ↪facemaskDetectionSSD_320x320_38MAP.pth",
                         map_location=getDevice())

SSD_MODEL.load_state_dict(checkPoint['model_state_dict'])
SSD_MODEL.eval()
SSD_MODEL.to(getDevice())
```

[ ]:
```
SSD(
  (backbone): SSDLiteFeatureExtractorMobileNet(
    (features): Sequential(
      (0): Sequential(
        (0): ConvBNActivation(
          (0): Conv2d(3, 16, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1),
bias=False)
          (1): BatchNorm2d(16, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): Hardswish()
        )
        (1): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(16, 16, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=16, bias=False)
              (1): BatchNorm2d(16, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): ReLU(inplace=True)
            )
            (1): ConvBNActivation(
              (0): Conv2d(16, 16, kernel_size=(1, 1), stride=(1, 1), bias=False)
              (1): BatchNorm2d(16, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (2): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(16, 64, kernel_size=(1, 1), stride=(1, 1), bias=False)
```

```
              (1): BatchNorm2d(64, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): ReLU(inplace=True)
            )
            (1): ConvBNActivation(
              (0): Conv2d(64, 64, kernel_size=(3, 3), stride=(2, 2), padding=(1,
1), groups=64, bias=False)
              (1): BatchNorm2d(64, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): ReLU(inplace=True)
            )
            (2): ConvBNActivation(
              (0): Conv2d(64, 24, kernel_size=(1, 1), stride=(1, 1), bias=False)
              (1): BatchNorm2d(24, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (3): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(24, 72, kernel_size=(1, 1), stride=(1, 1), bias=False)
              (1): BatchNorm2d(72, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): ReLU(inplace=True)
            )
            (1): ConvBNActivation(
              (0): Conv2d(72, 72, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=72, bias=False)
              (1): BatchNorm2d(72, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): ReLU(inplace=True)
            )
            (2): ConvBNActivation(
              (0): Conv2d(72, 24, kernel_size=(1, 1), stride=(1, 1), bias=False)
              (1): BatchNorm2d(24, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (4): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(24, 72, kernel_size=(1, 1), stride=(1, 1), bias=False)
              (1): BatchNorm2d(72, eps=0.001, momentum=0.03, affine=True,
```

```
track_running_stats=True)
              (2): ReLU(inplace=True)
            )
            (1): ConvBNActivation(
              (0): Conv2d(72, 72, kernel_size=(5, 5), stride=(2, 2), padding=(2,
2), groups=72, bias=False)
              (1): BatchNorm2d(72, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): ReLU(inplace=True)
            )
            (2): SqueezeExcitation(
              (fc1): Conv2d(72, 24, kernel_size=(1, 1), stride=(1, 1))
              (relu): ReLU(inplace=True)
              (fc2): Conv2d(24, 72, kernel_size=(1, 1), stride=(1, 1))
            )
            (3): ConvBNActivation(
              (0): Conv2d(72, 40, kernel_size=(1, 1), stride=(1, 1), bias=False)
              (1): BatchNorm2d(40, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (5): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(40, 120, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(120, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): ReLU(inplace=True)
            )
            (1): ConvBNActivation(
              (0): Conv2d(120, 120, kernel_size=(5, 5), stride=(1, 1),
padding=(2, 2), groups=120, bias=False)
              (1): BatchNorm2d(120, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): ReLU(inplace=True)
            )
            (2): SqueezeExcitation(
              (fc1): Conv2d(120, 32, kernel_size=(1, 1), stride=(1, 1))
              (relu): ReLU(inplace=True)
              (fc2): Conv2d(32, 120, kernel_size=(1, 1), stride=(1, 1))
            )
            (3): ConvBNActivation(
              (0): Conv2d(120, 40, kernel_size=(1, 1), stride=(1, 1),
bias=False)
```

```
              (1): BatchNorm2d(40, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (6): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(40, 120, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(120, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): ReLU(inplace=True)
            )
            (1): ConvBNActivation(
              (0): Conv2d(120, 120, kernel_size=(5, 5), stride=(1, 1),
padding=(2, 2), groups=120, bias=False)
              (1): BatchNorm2d(120, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): ReLU(inplace=True)
            )
            (2): SqueezeExcitation(
              (fc1): Conv2d(120, 32, kernel_size=(1, 1), stride=(1, 1))
              (relu): ReLU(inplace=True)
              (fc2): Conv2d(32, 120, kernel_size=(1, 1), stride=(1, 1))
            )
            (3): ConvBNActivation(
              (0): Conv2d(120, 40, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(40, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (7): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(40, 240, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(240, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (1): ConvBNActivation(
              (0): Conv2d(240, 240, kernel_size=(3, 3), stride=(2, 2),
```

```
padding=(1, 1), groups=240, bias=False)
              (1): BatchNorm2d(240, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (2): ConvBNActivation(
              (0): Conv2d(240, 80, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(80, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (8): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(80, 200, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(200, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (1): ConvBNActivation(
              (0): Conv2d(200, 200, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), groups=200, bias=False)
              (1): BatchNorm2d(200, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (2): ConvBNActivation(
              (0): Conv2d(200, 80, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(80, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (9): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(80, 184, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(184, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
```

```
            )
            (1): ConvBNActivation(
              (0): Conv2d(184, 184, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), groups=184, bias=False)
              (1): BatchNorm2d(184, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (2): ConvBNActivation(
              (0): Conv2d(184, 80, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(80, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (10): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(80, 184, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(184, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (1): ConvBNActivation(
              (0): Conv2d(184, 184, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), groups=184, bias=False)
              (1): BatchNorm2d(184, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (2): ConvBNActivation(
              (0): Conv2d(184, 80, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(80, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (11): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(80, 480, kernel_size=(1, 1), stride=(1, 1),
bias=False)
```

```
              (1): BatchNorm2d(480, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (1): ConvBNActivation(
              (0): Conv2d(480, 480, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), groups=480, bias=False)
              (1): BatchNorm2d(480, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (2): SqueezeExcitation(
              (fc1): Conv2d(480, 120, kernel_size=(1, 1), stride=(1, 1))
              (relu): ReLU(inplace=True)
              (fc2): Conv2d(120, 480, kernel_size=(1, 1), stride=(1, 1))
            )
            (3): ConvBNActivation(
              (0): Conv2d(480, 112, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(112, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (12): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(112, 672, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(672, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (1): ConvBNActivation(
              (0): Conv2d(672, 672, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), groups=672, bias=False)
              (1): BatchNorm2d(672, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (2): SqueezeExcitation(
              (fc1): Conv2d(672, 168, kernel_size=(1, 1), stride=(1, 1))
              (relu): ReLU(inplace=True)
              (fc2): Conv2d(168, 672, kernel_size=(1, 1), stride=(1, 1))
            )
            (3): ConvBNActivation(
```

```
              (0): Conv2d(672, 112, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(112, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (13): ConvBNActivation(
          (0): Conv2d(112, 672, kernel_size=(1, 1), stride=(1, 1), bias=False)
          (1): BatchNorm2d(672, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): Hardswish()
        )
      )
      (1): Sequential(
        (0): Sequential(
          (1): ConvBNActivation(
            (0): Conv2d(672, 672, kernel_size=(5, 5), stride=(2, 2), padding=(2,
2), groups=672, bias=False)
            (1): BatchNorm2d(672, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): Hardswish()
          )
          (2): SqueezeExcitation(
            (fc1): Conv2d(672, 168, kernel_size=(1, 1), stride=(1, 1))
            (relu): ReLU(inplace=True)
            (fc2): Conv2d(168, 672, kernel_size=(1, 1), stride=(1, 1))
          )
          (3): ConvBNActivation(
            (0): Conv2d(672, 80, kernel_size=(1, 1), stride=(1, 1), bias=False)
            (1): BatchNorm2d(80, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): Identity()
          )
        )
        (1): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(80, 480, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(480, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (1): ConvBNActivation(
              (0): Conv2d(480, 480, kernel_size=(5, 5), stride=(1, 1),
```

```
padding=(2, 2), groups=480, bias=False)
              (1): BatchNorm2d(480, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (2): SqueezeExcitation(
              (fc1): Conv2d(480, 120, kernel_size=(1, 1), stride=(1, 1))
              (relu): ReLU(inplace=True)
              (fc2): Conv2d(120, 480, kernel_size=(1, 1), stride=(1, 1))
            )
            (3): ConvBNActivation(
              (0): Conv2d(480, 80, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(80, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
          )
        )
        (2): InvertedResidual(
          (block): Sequential(
            (0): ConvBNActivation(
              (0): Conv2d(80, 480, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(480, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (1): ConvBNActivation(
              (0): Conv2d(480, 480, kernel_size=(5, 5), stride=(1, 1),
padding=(2, 2), groups=480, bias=False)
              (1): BatchNorm2d(480, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Hardswish()
            )
            (2): SqueezeExcitation(
              (fc1): Conv2d(480, 120, kernel_size=(1, 1), stride=(1, 1))
              (relu): ReLU(inplace=True)
              (fc2): Conv2d(120, 480, kernel_size=(1, 1), stride=(1, 1))
            )
            (3): ConvBNActivation(
              (0): Conv2d(480, 80, kernel_size=(1, 1), stride=(1, 1),
bias=False)
              (1): BatchNorm2d(80, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
              (2): Identity()
            )
```

```
          )
        )
        (3): ConvBNActivation(
          (0): Conv2d(80, 480, kernel_size=(1, 1), stride=(1, 1), bias=False)
          (1): BatchNorm2d(480, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): Hardswish()
        )
      )
    )
    (extra): ModuleList(
      (0): Sequential(
        (0): ConvBNActivation(
          (0): Conv2d(480, 256, kernel_size=(1, 1), stride=(1, 1), bias=False)
          (1): BatchNorm2d(256, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): ReLU6(inplace=True)
        )
        (1): ConvBNActivation(
          (0): Conv2d(256, 256, kernel_size=(3, 3), stride=(2, 2), padding=(1,
1), groups=256, bias=False)
          (1): BatchNorm2d(256, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): ReLU6(inplace=True)
        )
        (2): ConvBNActivation(
          (0): Conv2d(256, 512, kernel_size=(1, 1), stride=(1, 1), bias=False)
          (1): BatchNorm2d(512, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): ReLU6(inplace=True)
        )
      )
      (1): Sequential(
        (0): ConvBNActivation(
          (0): Conv2d(512, 128, kernel_size=(1, 1), stride=(1, 1), bias=False)
          (1): BatchNorm2d(128, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): ReLU6(inplace=True)
        )
        (1): ConvBNActivation(
          (0): Conv2d(128, 128, kernel_size=(3, 3), stride=(2, 2), padding=(1,
1), groups=128, bias=False)
          (1): BatchNorm2d(128, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): ReLU6(inplace=True)
        )
        (2): ConvBNActivation(
```

```
          (0): Conv2d(128, 256, kernel_size=(1, 1), stride=(1, 1), bias=False)
          (1): BatchNorm2d(256, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): ReLU6(inplace=True)
        )
      )
      (2): Sequential(
        (0): ConvBNActivation(
          (0): Conv2d(256, 128, kernel_size=(1, 1), stride=(1, 1), bias=False)
          (1): BatchNorm2d(128, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): ReLU6(inplace=True)
        )
        (1): ConvBNActivation(
          (0): Conv2d(128, 128, kernel_size=(3, 3), stride=(2, 2), padding=(1,
1), groups=128, bias=False)
          (1): BatchNorm2d(128, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): ReLU6(inplace=True)
        )
        (2): ConvBNActivation(
          (0): Conv2d(128, 256, kernel_size=(1, 1), stride=(1, 1), bias=False)
          (1): BatchNorm2d(256, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): ReLU6(inplace=True)
        )
      )
      (3): Sequential(
        (0): ConvBNActivation(
          (0): Conv2d(256, 64, kernel_size=(1, 1), stride=(1, 1), bias=False)
          (1): BatchNorm2d(64, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): ReLU6(inplace=True)
        )
        (1): ConvBNActivation(
          (0): Conv2d(64, 64, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1),
groups=64, bias=False)
          (1): BatchNorm2d(64, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): ReLU6(inplace=True)
        )
        (2): ConvBNActivation(
          (0): Conv2d(64, 128, kernel_size=(1, 1), stride=(1, 1), bias=False)
          (1): BatchNorm2d(128, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
          (2): ReLU6(inplace=True)
        )
```

```
      )
    )
  )
  (anchor_generator): DefaultBoxGenerator(aspect_ratios=[[2, 3], [2, 3], [2, 3],
[2, 3], [2, 3], [2, 3]], clip=True, scales=[0.2, 0.35, 0.5, 0.65, 0.8, 0.95,
1.0], steps=None)
  (head): SSDLiteHead(
    (classification_head): SSDLiteClassificationHead(
      (module_list): ModuleList(
        (0): Sequential(
          (0): ConvBNActivation(
            (0): Conv2d(672, 672, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=672, bias=False)
            (1): BatchNorm2d(672, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): ReLU6(inplace=True)
          )
          (1): Conv2d(672, 546, kernel_size=(1, 1), stride=(1, 1))
        )
        (1): Sequential(
          (0): ConvBNActivation(
            (0): Conv2d(480, 480, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=480, bias=False)
            (1): BatchNorm2d(480, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): ReLU6(inplace=True)
          )
          (1): Conv2d(480, 546, kernel_size=(1, 1), stride=(1, 1))
        )
        (2): Sequential(
          (0): ConvBNActivation(
            (0): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=512, bias=False)
            (1): BatchNorm2d(512, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): ReLU6(inplace=True)
          )
          (1): Conv2d(512, 546, kernel_size=(1, 1), stride=(1, 1))
        )
        (3): Sequential(
          (0): ConvBNActivation(
            (0): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=256, bias=False)
            (1): BatchNorm2d(256, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): ReLU6(inplace=True)
          )
```

```
          (1): Conv2d(256, 546, kernel_size=(1, 1), stride=(1, 1))
        )
        (4): Sequential(
          (0): ConvBNActivation(
            (0): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=256, bias=False)
            (1): BatchNorm2d(256, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): ReLU6(inplace=True)
          )
          (1): Conv2d(256, 546, kernel_size=(1, 1), stride=(1, 1))
        )
        (5): Sequential(
          (0): ConvBNActivation(
            (0): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=128, bias=False)
            (1): BatchNorm2d(128, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): ReLU6(inplace=True)
          )
          (1): Conv2d(128, 546, kernel_size=(1, 1), stride=(1, 1))
        )
      )
    )
    (regression_head): SSDLiteRegressionHead(
      (module_list): ModuleList(
        (0): Sequential(
          (0): ConvBNActivation(
            (0): Conv2d(672, 672, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=672, bias=False)
            (1): BatchNorm2d(672, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): ReLU6(inplace=True)
          )
          (1): Conv2d(672, 24, kernel_size=(1, 1), stride=(1, 1))
        )
        (1): Sequential(
          (0): ConvBNActivation(
            (0): Conv2d(480, 480, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=480, bias=False)
            (1): BatchNorm2d(480, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): ReLU6(inplace=True)
          )
          (1): Conv2d(480, 24, kernel_size=(1, 1), stride=(1, 1))
        )
        (2): Sequential(
```

```
          (0): ConvBNActivation(
            (0): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=512, bias=False)
            (1): BatchNorm2d(512, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): ReLU6(inplace=True)
          )
          (1): Conv2d(512, 24, kernel_size=(1, 1), stride=(1, 1))
        )
        (3): Sequential(
          (0): ConvBNActivation(
            (0): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=256, bias=False)
            (1): BatchNorm2d(256, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): ReLU6(inplace=True)
          )
          (1): Conv2d(256, 24, kernel_size=(1, 1), stride=(1, 1))
        )
        (4): Sequential(
          (0): ConvBNActivation(
            (0): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=256, bias=False)
            (1): BatchNorm2d(256, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): ReLU6(inplace=True)
          )
          (1): Conv2d(256, 24, kernel_size=(1, 1), stride=(1, 1))
        )
        (5): Sequential(
          (0): ConvBNActivation(
            (0): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), groups=128, bias=False)
            (1): BatchNorm2d(128, eps=0.001, momentum=0.03, affine=True,
track_running_stats=True)
            (2): ReLU6(inplace=True)
          )
          (1): Conv2d(128, 24, kernel_size=(1, 1), stride=(1, 1))
        )
      )
    )
  )
  (transform): GeneralizedRCNNTransform(
      Normalize(mean=[0.5, 0.5, 0.5], std=[0.5, 0.5, 0.5])
      Resize(min_size=(320,), max_size=320, mode='bilinear')
  )
)
```

### 13.0.2 Show Output

[ ]:
```
device = getDevice()
device
```

[ ]:
```
device(type='cuda')
```

[ ]:
```
from matplotlib import pyplot as plt
import matplotlib.patches as patches


def show_output_with_bbox(img, bboxes, labels, scores):

    print(img.shape)

    img_height = img.shape[0]
    img_width = img.shape[1]

    fig, ax = plt.subplots(figsize=(8,8))

    ax.imshow(img)

    for box, class_name, score in zip(bboxes, labels, scores):

        if score > 0.1:

            class_name = class_dict[class_name]
            xmin, ymin, xmax, ymax = box
            xmin, ymin, width, height = [x for x in [xmin, ymin, (xmax-xmin),␣
↪(ymax-ymin)]]
            rect = patches.Rectangle((xmin, ymin), width, height, linewidth=1,␣
↪edgecolor='r', facecolor='none')
            ax.add_patch(rect)
            ax.text(xmin, ymin, f"{class_name, np.round(score, 2)}", color='r',␣
↪fontsize='large')

            # {'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large',␣
↪'xx-large'}

    plt.show()



################################################################################
```

[ ]:
```
test_images = VALID_DF['filename'].unique().tolist()
train_images = TRAIN_DF['filename'].unique().tolist()

for index, image in enumerate(test_images):

    if index == 10:
        break



    class_dict = {
        0:"background",
        1:"with_mask",
        2:"without_mask",
        3:"mask_weared_incorrect"
    }


    img = cv2.imread(test_images[index])
    img = cv2.resize(img, (320, 320))
    img = cv2.cvtColor(img, cv2.COLOR_BGRA2RGB).astype(np.float32)
    img = img/255.0


    SSD_MODEL.eval()
    img_tensor_float = torch.tensor(img, dtype=torch.float32).permute(2,0,1).
↪unsqueeze(dim=0).to(device)
    out = SSD_MODEL(img_tensor_float)

    keepIndex = torchvision.ops.nms(out[0]['boxes'], out[0]['scores'],␣
↪iou_threshold=0.2)

    bboxTensors = out[0]['boxes'][keepIndex]
    labelsTensors = out[0]['labels'][keepIndex]
    scoresTensors = out[0]['scores'][keepIndex]


    boxes = bboxTensors.detach().cpu().numpy().astype(np.int)
    labels = labelsTensors.detach().cpu().numpy()
    scores = scoresTensors.detach().cpu().numpy()

    show_output_with_bbox(img, boxes, labels, scores)
```

### 13.0.3 From Single Image

[ ]:
```
from matplotlib import pyplot as plt
import matplotlib.patches as patches


def show_output_with_bbox(img, bboxes, labels, scores):

    print(img.shape)

    img_height = img.shape[0]
    img_width = img.shape[1]

    fig, ax = plt.subplots(figsize=(8,8))

    ax.imshow(img)

    for box, class_name, score in zip(bboxes, labels, scores):

        if score > 0.2:

            class_name = class_dict[class_name]
            xmin, ymin, xmax, ymax = box
            xmin, ymin, width, height = [x for x in [xmin, ymin, (xmax-xmin),␣
↪(ymax-ymin)]]
            rect = patches.Rectangle((xmin, ymin), width, height, linewidth=1,␣
↪edgecolor='r', facecolor='none')
            ax.add_patch(rect)
            ax.text(xmin, ymin, f"{class_name, np.round(score, 2)}", color='r',␣
↪fontsize='large')

            # {'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large',␣
↪'xx-large'}

    plt.show()




################################################################################
```

[ ]:
```
imagePath = "/content/Screenshot from 2021-10-14 21-25-39.png"

img = cv2.imread(imagePath)
img = cv2.resize(img, (320, 320))
img = cv2.cvtColor(img, cv2.COLOR_BGRA2RGB).astype(np.float32)
img = img/255.0
```

```
SSD_MODEL.eval()
img_tensor_float = torch.tensor(img, dtype=torch.float32).permute(2,0,1).
 ↪unsqueeze(dim=0).to(device)
out = SSD_MODEL(img_tensor_float)

keepIndex = torchvision.ops.nms(out[0]['boxes'], out[0]['scores'],␣
 ↪iou_threshold=0.1)

bboxTensors = out[0]['boxes'][keepIndex]
labelsTensors = out[0]['labels'][keepIndex]
scoresTensors = out[0]['scores'][keepIndex]


boxes = bboxTensors.detach().cpu().numpy().astype(np.int)
labels = labelsTensors.detach().cpu().numpy()
scores = scoresTensors.detach().cpu().numpy()

show_output_with_bbox(img, boxes, labels, scores)
```

```
(320, 320, 3)
```


## 14 Deployed Heroku API

[ ]:
```
import requests

file = "/content/IMG_20211011_022805_1.jpg"
resp = requests.post("https://facemask-detection-api.herokuapp.com/predict",␣
↪files={'filename': open(file, 'rb')})
```

[ ]:
```
resp.content
```

[ ]:
```
b'{"result":{"boxes":[[100,151,234,306],[116,195,219,304],[68,86,255,291],[133,1
58,226,273],[114,183,157,231],[203,141,227,166],[218,142,238,164],[113,160,163,2
```

21],[127,182,189,219],[129,157,185,217],[135,162,204,201],[205,130,226,151],[111
,290,205,320],[131,188,163,214],[149,159,198,214],[139,196,193,235],[192,170,234
,259],[89,286,117,320],[137,177,224,225],[239,123,258,146],[110,149,203,246],[15
5,207,183,242],[75,108,153,248],[239,140,257,158],[135,197,173,230],[198,159,232
,221],[196,125,213,147],[221,120,239,141],[112,250,211,301],[139,208,166,237],[2
38,112,263,140],[197,139,216,164],[237,130,260,153],[168,165,227,248],[78,153,17
1,279],[200,142,221,162],[215,129,238,152],[144,177,198,237],[189,197,233,231],[
105,6,241,146],[141,293,227,320],[210,140,245,166],[146,152,207,185],[157,255,23
8,302],[239,152,256,172],[218,99,243,131],[21,122,130,235],[201,147,223,166],[16
3,165,221,204],[84,296,104,320],[121,206,213,261],[45,70,169,213],[45,284,101,32
0],[192,184,235,214],[205,113,226,137],[196,142,224,163],[62,292,82,320],[138,19
0,222,240],[213,135,242,155],[116,196,152,227],[204,141,235,165],[131,168,175,19
7],[221,128,258,151],[212,146,240,169],[10,140,132,284],[126,149,196,196],[170,1
98,200,233],[220,152,238,172],[177,295,242,320],[36,178,283,314],[155,187,185,21
8],[23,132,193,309],[237,89,264,130],[194,112,213,137],[146,213,194,261],[194,13
9,228,163],[72,36,204,174],[209,147,243,190],[256,120,281,156],[169,106,193,140]
,[188,133,219,153],[102,174,144,233],[157,283,233,309],[35,0,284,181],[238,102,2
59,133],[84,18,192,140],[191,286,242,309],[143,7,279,150],[117,279,210,311],[202
,170,231,199],[23,85,132,202],[179,191,229,240],[256,134,281,172],[114,188,174,2
42],[93,292,160,320],[175,140,205,168],[77,77,202,224],[229,119,276,163],[103,21
0,154,250],[0,50,22,107],[254,103,281,143],[212,83,256,133],[99,183,143,275],[24
0,168,256,193],[0,161,21,215],[3,82,155,320],[211,164,237,207],[26,284,83,320],[
121,223,213,279],[168,120,238,265],[0,49,105,171],[161,113,180,140],[57,298,103,
320],[161,162,210,222],[59,273,84,320],[160,98,180,128],[194,137,224,156],[193,1
02,211,127],[44,290,66,320],[0,129,21,183],[0,145,21,199],[178,209,242,252],[125
,153,177,184],[219,19,249,66],[0,191,22,248],[118,114,320,320],[217,297,271,320]
,[198,147,229,180],[0,112,21,167],[234,18,266,66],[0,179,21,230],[45,8,174,153],
[84,294,132,320],[0,96,21,152],[124,185,189,251],[209,10,258,73],[172,95,193,126
],[240,156,260,185],[227,99,277,149],[14,35,147,182],[137,209,169,253],[240,1,26
2,32],[118,50,232,167],[207,102,224,125],[0,0,168,252],[219,156,238,181],[107,20
,136,66],[29,298,92,320],[123,20,153,66],[54,48,161,169],[0,33,22,91],[72,296,11
6,320],[0,10,29,76],[257,148,280,186],[214,162,247,212],[0,215,24,284],[139,20,1
68,66],[203,20,232,65],[0,0,34,55],[255,0,278,33],[155,20,184,66],[224,228,270,3
13],[222,92,242,122],[224,1,245,32],[187,20,216,65],[0,70,28,141],[200,144,229,1
89],[171,20,200,66],[221,64,244,104],[183,87,224,132],[119,185,149,222],[219,111
,250,133],[193,10,242,72],[217,220,308,316],[97,10,145,73],[199,246,235,305],[8,
7,90,150],[113,10,161,73],[27,289,53,320],[129,10,177,72],[249,54,320,168],[95,1
94,156,295],[11,285,36,320],[145,10,193,72],[208,1,229,32],[151,0,320,256],[177,
10,225,72],[161,10,209,72],[176,1,197,32],[160,1,181,32],[144,1,165,32],[192,1,2
13,32],[197,86,239,131],[128,1,149,32],[205,67,228,104],[112,1,133,32],[238,0,32
0,91],[210,19,317,137],[227,78,276,136],[203,285,231,320],[208,149,235,171],[236
,297,297,320],[208,91,236,116],[102,278,170,311],[223,8,275,74],[157,63,181,106]
,[235,59,261,104],[44,34,286,312],[189,67,212,105],[76,0,213,89],[8,156,40,220],
[164,82,206,132],[0,0,29,34],[172,65,196,105],[90,19,121,66],[297,36,320,116],[6
,183,41,255],[0,6,20,43],[124,60,149,105],[140,60,165,105],[0,0,84,91],[137,291,
169,320],[149,290,182,320],[12,3,35,39],[228,131,273,178],[61,62,85,105],[217,16
7,234,196],[108,61,133,104],[224,91,253,116],[298,157,320,239],[247,12,283,70],[

269,0,295,35],[217,0,256,35],[218,73,247,118],[77,279,114,320],[80,10,130,73],[1
70,124,193,151],[3,208,44,294],[189,81,215,119],[232,0,272,35],[208,279,259,320]
,[95,1,117,32],[7,45,41,113],[240,179,258,209],[172,0,309,89],[257,161,280,198],
[251,81,281,132],[144,102,164,136],[210,109,255,149],[142,86,165,124],[0,265,22,
320],[48,1,70,33],[203,80,229,117],[201,0,240,35],[170,292,195,320],[169,0,208,3
5],[153,0,192,35],[137,0,176,35],[185,0,224,35],[121,0,160,35],[297,0,320,67],[1
05,0,144,35],[8,124,40,188],[41,271,68,320],[77,0,103,33],[155,76,184,121],[241,
108,292,167],[92,61,117,105],[4,0,45,37],[1,299,65,320]],"labels":[2,2,2,2,2,1,1
,2,2,2,2,1,1,2,2,2,2,1,2,1,2,2,2,1,2,2,1,1,2,2,1,1,1,2,2,2,1,2,2,2,1,1,2,2,1,1,2
,3,2,1,2,2,1,2,1,3,1,2,1,2,3,2,1,3,2,2,2,1,2,2,2,2,1,1,2,2,2,3,1,1,1,2,2,2,1,2,2
,2,2,2,2,2,1,2,1,2,2,1,2,1,1,1,2,1,1,2,3,1,2,2,2,1,1,2,1,1,1,1,1,1,1,2,2,1,1,2,1
,3,1,1,1,2,1,1,2,1,1,1,1,2,2,1,2,1,1,1,1,1,1,2,1,1,1,1,3,1,1,1,1,1,1,1,1,1,1,1,2
,1,1,1,2,1,1,1,1,2,2,1,1,1,2,2,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,2,1,1,1,1,1,2,1,1,1
,3,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,3,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
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