```
import torch
import torch.nn as nn
import torch.nn.functional as F
import torchvision.transforms as transforms
import torch.optim as optim
import torchvision
from torch.utils.data import DataLoader, Dataset
from skimage import io, color
import pandas as pd
import os
from tqdm.notebook import tqdm
```

```
# Takes inputs with dims = (N, C, *)
# Gives outputs with dimes = (N, C, *)
class LocalResponseNormalization(nn.Module):
    def __init__(self, neighbourhood_length, normalisation_const_alpha, contrast_const_beta, noise_k):
        super(LocalResponseNormalization, self).__init__()
        self.nbd_len = neighbourhood_length
        self.alpha = normalisation_const_alpha
        self.beta = contrast_const_beta
        self.k = noise_k

    # The following is exactly what pytorch does under the hood as well. I only replicated it for my understanding :)
    def forward(self, x):
        # Lets validate if x is atleast 3 dimensional
        dim = x.dim()
        if dim < 3:
            raise ValueError("Expected tensor of atleast 3 dimensions, found only {}".format(dim))
        denom = x.pow(2).unsqueeze(1)
        if dim == 3:
            denom = F.pad(denom, (0, 0, self.nbd_len // 2, (self.nbd_len - 1) // 2))
            denom = F.avg_pool2d(denom, (self.nbd_len, 1), stride=1)
            denom = denom.squeeze(1)
        else:
            sizes = x.size()
            # The last two dimensions make up a single channel. The third dimension decides the number of channels
            # across which we will apply local response normalization.
            denom = denom.view(sizes[0], 1, sizes[1], sizes[2], -1)
            # The point is to pad in front and back of the channels across which we'll apply normalization
            denom = F.pad(denom, (0, 0, 0, 0, self.nbd_len // 2, (self.nbd_len - 1) // 2))
            denom = F.avg_pool3d(denom, (self.nbd_len, 1, 1), stride=1)
            denom = denom.squeeze(1).view(sizes)
        denom = denom.mul(self.alpha).add(self.k).pow(self.beta)
        return x.div(denom)
```

```
# Expects input tensor to be of dimensions (batch_size, 3, 224, 224)
class Alexnet(nn.Module):
    def __init__(self):
        super(Alexnet, self).__init__()
        self.conv1 = nn.Conv2d(in_channels=3, out_channels=96, kernel_size=11, stride=4, padding=2)
        self.conv2 = nn.Conv2d(in_channels=96, out_channels=256, kernel_size=5, stride=1, padding=2)
        self.conv3 = nn.Conv2d(in_channels=256, out_channels=384, kernel_size=3, stride=1, padding=1)
        self.conv4 = nn.Conv2d(in_channels=384, out_channels=384, kernel_size=3, stride=1, padding=1)
        self.conv5 = nn.Conv2d(in_channels=384, out_channels=256, kernel_size=3, stride=1, padding=1)
        self.fc1 = nn.Linear(in_features=256 * 6 * 6, out_features=4096)
        self.fc2 = nn.Linear(in_features=4096, out_features=4096)
        self.fc3 = nn.Linear(in_features=4096, out_features=10)
        self.max_pool = nn.MaxPool2d(kernel_size=3, stride=2)
        # This layer helps us avoid calculating output map size when feeding into a linear layer in PyTorch.
        self.adaptive_pool = nn.AdaptiveAvgPool2d(output_size=(6, 6))
        self.norm = LocalResponseNormalization(neighbourhood_length=5, normalisation_const_alpha=1e-4, contrast_const_beta=0.75, noise_k=
        self.dropout = nn.Dropout()

    def forward(self, x):
        x = self.max_pool(self.norm(F.relu(self.conv1(x))))
        x = self.max_pool(self.norm(F.relu(self.conv2(x))))
        x = F.relu(self.conv3(x))
        x = F.relu(self.conv4(x))
        x = self.adaptive_pool(self.norm(F.relu(self.conv5(x))))
        x = torch.flatten(x, 1)
        x = F.relu(self.fc1(x))
        x = F.relu(self.fc2(x))
        x = self.dropout(x)
        x = self.fc3(x)
        return x
```

```
class SceneDataset(Dataset):
    def __init__(self, annotations_csv, root_dir, transform=None):
        self.annotations = pd.read_csv(annotations_csv)
```

```
        self.root_dir = root_dir
        self.transform = transform

    def __len__(self):
        return len(self.annotations)

    def __getitem__(self, index):
        img_path = os.path.join(self.root_dir, self.annotations.iloc[index, 0])
        image = io.imread(img_path)
        label = torch.tensor(int(self.annotations.iloc[index, 1]))
        if self.transform:
            image = self.transform(image)
        return [image, label]
```

```
def check_accuracy(loader, model):
    num_correct = 0
    num_samples = 0
    # Don't forget to toggle to eval mode!
    model.eval()

    with torch.no_grad():
        for data, targets in tqdm(loader):
            data = data.to(device)
            targets = targets.to(device)
            scores = model(data)
            _, predictions = scores.max(1)
            num_correct += (predictions == targets).sum()
            num_samples += predictions.size(0)
        print("Correct: {}, Total: {}, Accuracy: {}".format(num_correct, num_samples, int(num_correct) / int(num_samples)))
    # Don't forget to toggle back to model.train() since you're done with evaluation
    model.train()
```

```
from google.colab import drive
drive.mount('/content/drive')
```

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

```
%cd /content/drive/My Drive/KIST Hackathon 2023/Phase II workshop/Day 1/files and datasets/files
```

```
/content/drive/My Drive/KIST Hackathon 2023/Phase II workshop/Day 1/files and datasets/files
```

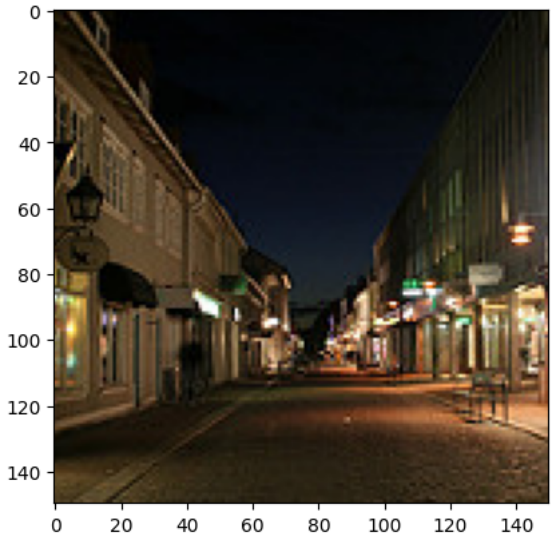
```
if __name__ == '__main__':

    LEARNING_RATE = 0.0001
    # You could try playing around with the batch size(say 16) and learning rate(say 0.001) for faster convergence.
    BATCH_SIZE = 8
    EPOCHS = 10
    device = "cuda" if torch.cuda.is_available() else "cpu"

    transform_img = transforms.Compose([
        transforms.ToPILImage(),
        transforms.Resize((224, 224)),
        transforms.ToTensor()
    ])

    data = SceneDataset(annotations_csv="train-scene classification/train.csv",
                        root_dir="train-scene classification/train",
                        transform = transform_img)
    print(len(data))
    train_data, test_data = torch.utils.data.random_split(data, [65, 9])
    train_loader = DataLoader(dataset=train_data, batch_size=BATCH_SIZE, shuffle=True)
    test_loader = DataLoader(dataset=test_data, batch_size=BATCH_SIZE, shuffle=True)

    alexnet = Alexnet()
    alexnet.to(device)
    criterion = nn.CrossEntropyLoss()
    optimizer = optim.Adam(alexnet.parameters(), lr=LEARNING_RATE)

    data, targets = next(iter(train_loader))
    for epoch in tqdm(range(EPOCHS)):
        losses = []
        with tqdm(total=len(train_loader)) as pbar:
            for batch_idx, (data, targets) in enumerate(train_loader):
                data = data.to(device=device)
                targets = targets.to(device=device)

                scores = alexnet(data)
                loss = criterion(scores, targets)
                losses.append(loss)
```

```
                # backprop
                optimizer.zero_grad()
                loss.backward()
                optimizer.step()
#                 print(loss.item())
                pbar.update(1)
        print("Cost at epoch {} is {}".format(epoch, sum(losses) / len(losses)))
        check_accuracy(train_loader, alexnet)
        check_accuracy(test_loader, alexnet)
```

```
100%                                                 2/2 [00:00<00:00, 2.54it/s]
Correct: 2, Total: 9, Accuracy: 0.2222222222222222
100%                                                 9/9 [00:13<00:00, 1.20s/it]
Cost at epoch 2 is 1.7962262630462646
100%                                                 9/9 [00:03<00:00, 2.34it/s]
Correct: 20, Total: 65, Accuracy: 0.3076923076923077
100%                                                 2/2 [00:00<00:00, 2.57it/s]
```

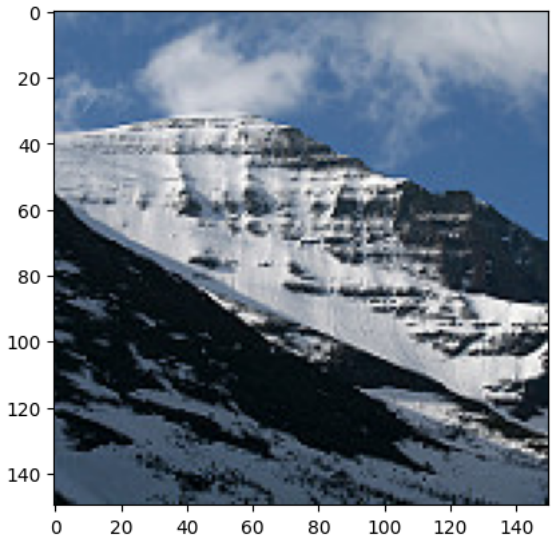
```
import matplotlib.pyplot as plt

def show_image_and_prediction(img_path):
    idx2label = {0: "Buildings", 1: "Forests", 2: "Mountains", 3: "Glacier", 4: "Sea", 5: "Street"}
    img = io.imread(img_path)
    transformed_img = transform_img(img)
    out = alexnet(transformed_img.unsqueeze(0).to(device=device))
    _, pred = out.max(1)
    plt.imshow(img)
    plt.show()
    print("Alexnet thinks this scence contains: {}".format(idx2label[pred.item()]))
```

```
show_image_and_prediction("train-scene classification/train/50.jpg")
```




```
Alexnet thinks this scence contains: Street
```

```
show_image_and_prediction("train-scene classification/train/30.jpg")
```




```
Alexnet thinks this scence contains: Street
```

Yolo Model:

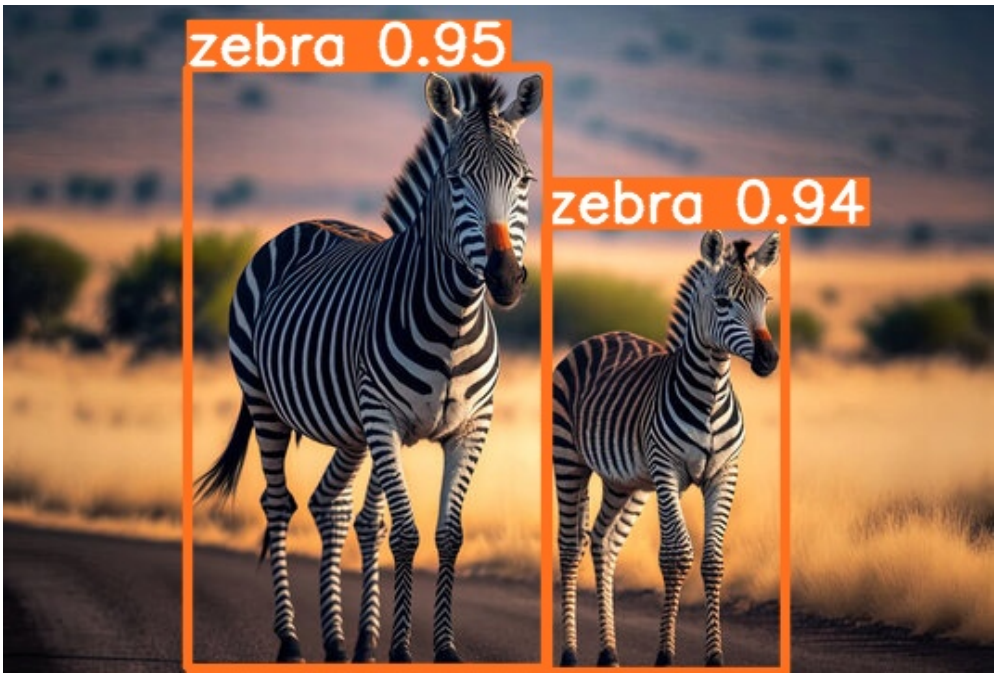
```
!pip install ultralytics==8.0.20
```

```
from IPython import display
display.clear_output()

from ultralytics import YOLO
from IPython.display import display, Image
```

```
!yolo task=detect mode=predict model=yolov8n.pt conf=0.25 source='images2.jpg' save=true
```

```
2023-09-12 14:09:03.585009: I tensorflow/core/platform/cpu_feature_guard.cc:182] This TensorFlow binary is optimized to use availab
To enable the following instructions: AVX2 FMA, in other operations, rebuild TensorFlow with the appropriate compiler flags.
2023-09-12 14:09:04.751814: W tensorflow/compiler/tf2tensorrt/utils/py_utils.cc:38] TF-TRT Warning: Could not find TensorRT
Ultralytics YOLOv8.0.20 🚀 Python-3.10.12 torch-2.0.1+cu118 CPU
YOLOv8n summary (fused): 168 layers, 3151904 parameters, 0 gradients, 8.7 GFLOPs
image 1/1 /content/drive/MyDrive/KIST Hackathon 2023/Phase II workshop/Day 1/files and datasets/files/images2.jpg: 448x640 2 zebras
Speed: 1.3ms pre-process, 115.1ms inference, 2.9ms postprocess per image at shape (1, 3, 640, 640)
Results saved to runs/detect/predict3
```

```
Image(filename='runs/detect/predict3/images2.jpg', height=500)
```



Yolo live detection

```
from IPython.display import display, Javascript, Image
from google.colab.output import eval_js
from google.colab.patches import cv2_imshow
from base64 import b64decode, b64encode
import cv2
import numpy as np
import PIL
import io
import html
import time
import matplotlib.pyplot as plt
%matplotlib inline
```

```
# clone darknet repo
!git clone https://github.com/AlexeyAB/darknet
```

```
Cloning into 'darknet'...
remote: Enumerating objects: 15750, done.
remote: Counting objects: 100% (213/213), done.
remote: Compressing objects: 100% (125/125), done.
remote: Total 15750 (delta 103), reused 155 (delta 86), pack-reused 15537
Receiving objects: 100% (15750/15750), 14.62 MiB | 11.82 MiB/s, done.
Resolving deltas: 100% (10536/10536), done.
Updating files: 100% (2063/2063), done.
```

```
# change makefile to have GPU, OPENCV and LIBSO enabled
%cd darknet
!sed -i 's/OPENCV=0/OPENCV=1/' Makefile
!sed -i 's/GPU=0/GPU=1/' Makefile
!sed -i 's/CUDNN=0/CUDNN=1/' Makefile
```

```
!sed -i 's/CUDNN_HALF=0/CUDNN_HALF=1/' Makefile
!sed -i 's/LIBSO=0/LIBSO=1/' Makefile
```

```
/content/drive/MyDrive/KIST Hackathon 2023/Phase II workshop/Day 1/files and datasets/files/darknet
```

```
!make
```

```
mkdir -p ./obj/
mkdir -p backup
chmod +x *.sh
g++ -std=c++11 -std=c++11 -Iinclude/ -I3rdparty/stb/include -DOPENCV `pkg-config --cflags opencv4 2> /dev/null || pkg-config --c
./src/image_opencv.cpp: In function ‘void draw_detections_cv_v3(void**, detection*, int, float, char**, image**, int, int)’:
./src/image_opencv.cpp:946:23: warning: variable ‘rgb’ set but not used [-Wunused-but-set-variable]
  946 |                 float rgb[3];
      |                       ^~~
./src/image_opencv.cpp: In function ‘void cv_draw_object(image, float*, int, int, int*, float*, int*, int, char**)’:
./src/image_opencv.cpp:1444:14: warning: unused variable ‘buff’ [-Wunused-variable]
 1444 |         char buff[100];
      |              ^~~~
./src/image_opencv.cpp:1420:9: warning: unused variable ‘it_tb_res’ [-Wunused-variable]
 1420 |     int it_tb_res = cv::createTrackbar(it_trackbar_name, window_name, &it_trackbar_value, 1000);
      |         ^~~~~~~~~
./src/image_opencv.cpp:1424:9: warning: unused variable ‘lr_tb_res’ [-Wunused-variable]
 1424 |     int lr_tb_res = cv::createTrackbar(lr_trackbar_name, window_name, &lr_trackbar_value, 20);
      |         ^~~~~~~~~
./src/image_opencv.cpp:1428:9: warning: unused variable ‘cl_tb_res’ [-Wunused-variable]
 1428 |     int cl_tb_res = cv::createTrackbar(cl_trackbar_name, window_name, &cl_trackbar_value, classes-1);
      |         ^~~~~~~~~
./src/image_opencv.cpp:1431:9: warning: unused variable ‘bo_tb_res’ [-Wunused-variable]
 1431 |     int bo_tb_res = cv::createTrackbar(bo_trackbar_name, window_name, boxonly, 1);
      |         ^~~~~~~~~
g++ -std=c++11 -std=c++11 -Iinclude/ -I3rdparty/stb/include -DOPENCV `pkg-config --cflags opencv4 2> /dev/null || pkg-config --c
./src/http_stream.cpp: In member function ‘bool JSON_sender::write(const char*)’:
./src/http_stream.cpp:253:21: warning: unused variable ‘n’ [-Wunused-variable]
  253 |                 int n = _write(client, outputbuf, outlen);
      |                     ^
./src/http_stream.cpp: In function ‘void set_track_id(detection*, int, float, float, float, int, int, int)’:
./src/http_stream.cpp:867:27: warning: comparison of integer expressions of different signedness: ‘int’ and ‘std::vector<detecti
  867 |         for (int i = 0; i < v.size(); ++i) {
      |                         ~~^~~~~~~~~~
./src/http_stream.cpp:875:33: warning: comparison of integer expressions of different signedness: ‘int’ and ‘std::vector<detecti
  875 |     for (int old_id = 0; old_id < old_dets.size(); ++old_id) {
      |                          ~~~~~~~^~~~~~~~~~~~~~~~~
./src/http_stream.cpp:894:31: warning: comparison of integer expressions of different signedness: ‘int’ and ‘std::vector<detecti
  894 |     for (int index = 0; index < new_dets_num*old_dets.size(); ++index) {
      |                         ~~~~~~~^~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
./src/http_stream.cpp:930:28: warning: comparison of integer expressions of different signedness: ‘std::deque<std::vector<detect
  930 |     if (old_dets_dq.size() > deque_size) old_dets_dq.pop_front();
      |         ~~~~~~~~~~~~~~~~~~~^~~~~~~~~~~~
gcc -Iinclude/ -I3rdparty/stb/include -DOPENCV `pkg-config --cflags opencv4 2> /dev/null || pkg-config --cflags opencv` -DGPU -I
./src/gemm.c: In function ‘convolution_2d’:
./src/gemm.c:2044:15: warning: unused variable ‘out_w’ [-Wunused-variable]
 2044 |     const int out_w = (w + 2 * pad - ksize) / stride + 1;    // output_width=input_width for stride=1 and pad=1
      |               ^~~~~
./src/gemm.c:2043:15: warning: unused variable ‘out_h’ [-Wunused-variable]
 2043 |     const int out_h = (h + 2 * pad - ksize) / stride + 1;    // output_height=input_height for stride=1 and pad=1
      |               ^~~~~
gcc -Iinclude/ -I3rdparty/stb/include -DOPENCV `pkg-config --cflags opencv4 2> /dev/null || pkg-config --cflags opencv` -DGPU -I
./src/utils.c: In function ‘custom_hash’:
./src/utils.c:1093:12: warning: suggest parentheses around assignment used as truth value [-Wparentheses]
 1093 |     while (c = *str++)
      |            ^
In file included from /usr/include/string.h:535,
                 from include/darknet.h:14,
```

```
# get bthe scaled yolov4 weights file that is pre-trained to detect 80 classes (objects) from shared google drive
!wget --load-cookies /tmp/cookies.txt "https://docs.google.com/uc?export=download&confirm=$(wget --quiet --save-cookies /tmp/cookies.txt
```

```
--2023-09-12 14:22:03--  https://docs.google.com/uc?export=download&confirm=t&id=1V3vsIaxAlGWvK4Aar9bAiK5U0QFttKwq
Resolving docs.google.com (docs.google.com)... 74.125.142.102, 74.125.142.101, 74.125.142.139, ...
Connecting to docs.google.com (docs.google.com)|74.125.142.102|:443... connected.
HTTP request sent, awaiting response... 303 See Other
Location: https://doc-14-84-docs.googleusercontent.com/docs/securesc/ha0ro937gcuc7l7deffksulhg5h7mbp1/1ilu0v3i7v7on09ejrqa2ch7seoun
Warning: wildcards not supported in HTTP.
--2023-09-12 14:22:04--  https://doc-14-84-docs.googleusercontent.com/docs/securesc/ha0ro937gcuc7l7deffksulhg5h7mbp1/1ilu0v3i7v7on0
Resolving doc-14-84-docs.googleusercontent.com (doc-14-84-docs.googleusercontent.com)... 74.125.197.132, 2607:f8b0:400e:c03::84
Connecting to doc-14-84-docs.googleusercontent.com (doc-14-84-docs.googleusercontent.com)|74.125.197.132|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 211944840 (202M) [application/octet-stream]
Saving to: ‘yolov4-csp.weights’

yolov4-csp.weights  100%[===================>] 202.13M  44.9MB/s    in 4.5s

2023-09-12 14:22:08 (44.6 MB/s) - ‘yolov4-csp.weights’ saved [211944840/211944840]
```

```
# import darknet functions to perform object detections
from darknet import *
# load in our YOLOv4 architecture network
network, class_names, class_colors = load_network("cfg/yolov4-csp.cfg", "cfg/coco.data", "yolov4-csp.weights")
width = network_width(network)
height = network_height(network)

# darknet helper function to run detection on image
def darknet_helper(img, width, height):
  darknet_image = make_image(width, height, 3)
  img_rgb = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
  img_resized = cv2.resize(img_rgb, (width, height),
                           interpolation=cv2.INTER_LINEAR)

  # get image ratios to convert bounding boxes to proper size
  img_height, img_width, _ = img.shape
  width_ratio = img_width/width
  height_ratio = img_height/height

  # run model on darknet style image to get detections
  copy_image_from_bytes(darknet_image, img_resized.tobytes())
  detections = detect_image(network, class_names, darknet_image)
  free_image(darknet_image)
  return detections, width_ratio, height_ratio
```

```
---------------------------------------------------------------------------
OSError                                   Traceback (most recent call last)
<ipython-input-63-5a31be365992> in <cell line: 2>()
      1 # import darknet functions to perform object detections
----> 2 from darknet import *
      3 # load in our YOLOv4 architecture network
      4 network, class_names, class_colors = load_network("cfg/yolov4-csp.cfg", "cfg/coco.data",
"yolov4-csp.weights")
      5 width = network_width(network)

                                 1 frames
/usr/lib/python3.10/ctypes/__init__.py in __init__(self, name, mode, handle, use_errno,
use_last_error, winmode)
    372
    373         if handle is None:
--> 374             self._handle = _dlopen(self._name, mode)
    375         else:
    376             self._handle = handle

OSError: libcuda.so.1: cannot open shared object file: No such file or directory
```

```
# run test on person.jpg image that comes with repository
image = cv2.imread("images1.jpeg")
detections, width_ratio, height_ratio = darknet_helper(image, width, height)

for label, confidence, bbox in detections:
  left, top, right, bottom = bbox2points(bbox)
  left, top, right, bottom = int(left * width_ratio), int(top * height_ratio), int(right * width_ratio), int(bottom * height_ratio)
  cv2.rectangle(image, (left, top), (right, bottom), class_colors[label], 2)
  cv2.putText(image, "{} [{:.2f}]".format(label, float(confidence)),
                    (left, top - 5), cv2.FONT_HERSHEY_SIMPLEX, 0.5,
                    class_colors[label], 2)
cv2_imshow(image)
```

```
# function to convert the JavaScript object into an OpenCV image
def js_to_image(js_reply):
  """
  Params:
          js_reply: JavaScript object containing image from webcam
  Returns:
          img: OpenCV BGR image
  """
  # decode base64 image
  image_bytes = b64decode(js_reply.split(',')[1])
  # convert bytes to numpy array
  jpg_as_np = np.frombuffer(image_bytes, dtype=np.uint8)
  # decode numpy array into OpenCV BGR image
  img = cv2.imdecode(jpg_as_np, flags=1)

  return img

# function to convert OpenCV Rectangle bounding box image into base64 byte string to be overlayed on video stream
def bbox_to_bytes(bbox_array):
  """
  Params:
          bbox_array: Numpy array (pixels) containing rectangle to overlay on video stream.
```

```
  Returns:
        bytes: Base64 image byte string
  """
  # convert array into PIL image
  bbox_PIL = PIL.Image.fromarray(bbox_array, 'RGBA')
  iobuf = io.BytesIO()
  # format bbox into png for return
  bbox_PIL.save(iobuf, format='png')
  # format return string
  bbox_bytes = '{}'.format((str(b64encode(iobuf.getvalue()), 'utf-8')))

  return bbox_bytes
```

```
# JavaScript to properly create our live video stream using our webcam as input
def video_stream():
  js = Javascript('''
    var video;
    var div = null;
    var stream;
    var captureCanvas;
    var imgElement;
    var labelElement;

    var pendingResolve = null;
    var shutdown = false;

    function removeDom() {
       stream.getVideoTracks()[0].stop();
       video.remove();
       div.remove();
       video = null;
       div = null;
       stream = null;
       imgElement = null;
       captureCanvas = null;
       labelElement = null;
    }

    function onAnimationFrame() {
      if (!shutdown) {
        window.requestAnimationFrame(onAnimationFrame);
      }
      if (pendingResolve) {
        var result = "";
        if (!shutdown) {
          captureCanvas.getContext('2d').drawImage(video, 0, 0, 640, 480);
          result = captureCanvas.toDataURL('image/jpeg', 0.8)
        }
        var lp = pendingResolve;
        pendingResolve = null;
        lp(result);
      }
    }

    async function createDom() {
      if (div !== null) {
        return stream;
      }

      div = document.createElement('div');
      div.style.border = '2px solid black';
      div.style.padding = '3px';
      div.style.width = '100%';
      div.style.maxWidth = '600px';
      document.body.appendChild(div);

      const modelOut = document.createElement('div');
      modelOut.innerHTML = "<span>Status:</span>";
      labelElement = document.createElement('span');
      labelElement.innerText = 'No data';
      labelElement.style.fontWeight = 'bold';
      modelOut.appendChild(labelElement);
      div.appendChild(modelOut);

      video = document.createElement('video');
      video.style.display = 'block';
      video.width = div.clientWidth - 6;
      video.setAttribute('playsinline', '');
      video.onclick = () => { shutdown = true; };
      stream = await navigator.mediaDevices.getUserMedia(
          {video: { facingMode: "environment"}});
      div.appendChild(video);
```

```
      imgElement = document.createElement('img');
      imgElement.style.position = 'absolute';
      imgElement.style.zIndex = 1;
      imgElement.onclick = () => { shutdown = true; };
      div.appendChild(imgElement);

      const instruction = document.createElement('div');
      instruction.innerHTML =
          '<span style="color: red; font-weight: bold;">' +
          'When finished, click here or on the video to stop this demo</span>';
      div.appendChild(instruction);
      instruction.onclick = () => { shutdown = true; };

      video.srcObject = stream;
      await video.play();

      captureCanvas = document.createElement('canvas');
      captureCanvas.width = 640; //video.videoWidth;
      captureCanvas.height = 480; //video.videoHeight;
      window.requestAnimationFrame(onAnimationFrame);

      return stream;
    }
    async function stream_frame(label, imgData) {
      if (shutdown) {
        removeDom();
        shutdown = false;
        return '';
      }

      var preCreate = Date.now();
      stream = await createDom();

      var preShow = Date.now();
      if (label != "") {
        labelElement.innerHTML = label;
      }

      if (imgData != "") {
        var videoRect = video.getClientRects()[0];
        imgElement.style.top = videoRect.top + "px";
        imgElement.style.left = videoRect.left + "px";
        imgElement.style.width = videoRect.width + "px";
        imgElement.style.height = videoRect.height + "px";
        imgElement.src = imgData;
      }

      var preCapture = Date.now();
      var result = await new Promise(function(resolve, reject) {
        pendingResolve = resolve;
      });
      shutdown = false;

      return {'create': preShow - preCreate,
              'show': preCapture - preShow,
              'capture': Date.now() - preCapture,
              'img': result};
    }
    ''')

  display(js)

def video_frame(label, bbox):
  data = eval_js('stream_frame("{}", "{}")'.format(label, bbox))
  return data
```

```
# start streaming video from webcam
video_stream()
# label for video
label_html = 'Capturing...'
# initialze bounding box to empty
bbox = ''
count = 0
while True:
    js_reply = video_frame(label_html, bbox)
    if not js_reply:
        break

    # convert JS response to OpenCV Image
    frame = js_to_image(js_reply["img"])
```

```
# create transparent overlay for bounding box
bbox_array = np.zeros([480,640,4], dtype=np.uint8)

# call our darknet helper on video frame
detections, width_ratio, height_ratio = darknet_helper(frame, width, height)

# loop through detections and draw them on transparent overlay image
for label, confidence, bbox in detections:
  left, top, right, bottom = bbox2points(bbox)
  left, top, right, bottom = int(left * width_ratio), int(top * height_ratio), int(right * width_ratio), int(bottom * height_ratio)
  bbox_array = cv2.rectangle(bbox_array, (left, top), (right, bottom), class_colors[label], 2)
  bbox_array = cv2.putText(bbox_array, "{} [{:.2f}]".format(label, float(confidence)),
                   (left, top - 5), cv2.FONT_HERSHEY_SIMPLEX, 0.5,
                   class_colors[label], 2)

bbox_array[:,:,3] = (bbox_array.max(axis = 2) > 0 ).astype(int) * 255
# convert overlay of bbox into bytes
bbox_bytes = bbox_to_bytes(bbox_array)
# update bbox so next frame gets new overlay
bbox = bbox_bytes
```