Clone the Repostory

```
!git clone https://github.com/pijush2022/Lane_detection.git
```

Install the Requirements

- Install all the python dependencies
- After Installing dependencies, Restart the runtime. If you do not restart the runtime, the python will throw "module not found error"

```
!pip install -r road-detection/TwinLiteNet/requirements.txt

Requirement already satisfied: certifi==2023.7.22 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 1)) (2023.7.22)
Requirement already satisfied: charset-normalizer==3.3.2 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 2)) (3.3.2)
Requirement already satisfied: colorama==0.4.6 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 3)) (0.4.6)
Requirement already satisfied: contourpy==1.2.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 4)) (1.2.0)
Requirement already satisfied: cycler==0.12.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 5)) (0.12.1)
Requirement already satisfied: dnspython==2.4.2 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 6)) (2.4.2)
Requirement already satisfied: elephant==0.12.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 7)) (0.12.0)
Requirement already satisfied: filelock==3.13.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 8)) (3.13.1)
Requirement already satisfied: fonttools==4.44.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 9)) (4.44.0)
Requirement already satisfied: fsspec==2023.10.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 10)) (2023.10.0)
Requirement already satisfied: idna==3.4 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 11)) (3.4)
Requirement already satisfied: Jinja2==3.1.2 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 12)) (3.1.2)
Requirement already satisfied: joblib==1.2.0 in
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/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 13)) (1.2.0)
Requirement already satisfied: kiwisolver==1.4.5 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 14)) (1.4.5)
Requirement already satisfied: MarkupSafe==2.1.3 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 15)) (2.1.3)
Requirement already satisfied: matplotlib==3.7.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 16)) (3.7.1)
Requirement already satisfied: mpmath==1.3.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 17)) (1.3.0)
Requirement already satisfied: neo==0.12.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 18)) (0.12.0)
Requirement already satisfied: networkx==3.2.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 19)) (3.2.1)
Requirement already satisfied: numpy==1.24.3 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 20)) (1.24.3)
Requirement already satisfied: opencv-python==4.7.0.72 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 21)) (4.7.0.72)
Requirement already satisfied: packaging==23.2 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 22)) (23.2)
Requirement already satisfied: Pillow==9.5.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 23)) (9.5.0)
Requirement already satisfied: pyparsing==3.1.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 24)) (3.1.1)
Requirement already satisfied: python-dateutil==2.8.2 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 25)) (2.8.2)
Requirement already satisfied: python-etcd==0.4.5 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 26)) (0.4.5)
Requirement already satisfied: PyYAML==6.0.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 27)) (6.0.1)
Requirement already satisfied: quantities==0.14.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 28)) (0.14.1)
Requirement already satisfied: requests==2.31.0 in
/usr/local/lib/python3.10/dist-packages (from -r
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road-detection/TwinLiteNet/requirements.txt (line 29)) (2.31.0)
Requirement already satisfied: scikit-learn==1.3.2 in
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Requirement already satisfied: scipy==1.10.1 in
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road-detection/TwinLiteNet/requirements.txt (line 31)) (1.10.1)
Requirement already satisfied: six==1.16.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 32)) (1.16.0)
Requirement already satisfied: sympy==1.12 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 33)) (1.12)
Requirement already satisfied: threadpoolctl==3.2.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 34)) (3.2.0)
Requirement already satisfied: torch==2.1.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 35)) (2.1.0)
Requirement already satisfied: torchdata==0.7.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 36)) (0.7.0)
Requirement already satisfied: torchelastic==0.2.2 in
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road-detection/TwinLiteNet/requirements.txt (line 37)) (0.2.2)
Requirement already satisfied: torchtext==0.16.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 38)) (0.16.0)
Requirement already satisfied: torchvision==0.16.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 39)) (0.16.0)
Requirement already satisfied: tqdm==4.66.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 40)) (4.66.1)
Requirement already satisfied: typing_extensions==4.8.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 41)) (4.8.0)
Requirement already satisfied: urllib3==2.0.7 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 42)) (2.0.7)
Requirement already satisfied: webcolors==1.13 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 43)) (1.13)
Requirement already satisfied: yacs==0.1.8 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 44)) (0.1.8)
Requirement already satisfied: zipp==3.15.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 45)) (3.15.0)
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Requirement already satisfied: nvidia-cuda-nvrtc-cu12==12.1.105 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (12.1.105)
Requirement already satisfied: nvidia-cuda-runtime-cu12==12.1.105
in /usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r
road-detection/TwinLiteNet/requirements.txt (line 35)) (12.1.105)
Requirement already satisfied: nvidia-cuda-cupti-cu12==12.1.105 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (12.1.105)
Requirement already satisfied: nvidia-cudnn-cu12==8.9.2.26 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (8.9.2.26)
Requirement already satisfied: nvidia-cublas-cu12==12.1.3.1 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (12.1.3.1)
Requirement already satisfied: nvidia-cufft-cu12==11.0.2.54 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (11.0.2.54)
Requirement already satisfied: nvidia-curand-cu12==10.3.2.106 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (10.3.2.106)
Requirement already satisfied: nvidia-cusolver-cu12==11.4.5.107 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (11.4.5.107)
Requirement already satisfied: nvidia-cusparse-cu12==12.1.0.106 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (12.1.0.106)
Requirement already satisfied: nvidia-nccl-cu12==2.18.1 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (2.18.1)
Requirement already satisfied: nvidia-nvtx-cu12==12.1.105 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (12.1.105)
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/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (2.1.0)
Requirement already satisfied: nvidia-nvjitlink-cu12 in
/usr/local/lib/python3.10/dist-packages (from nvidia-cusolver-
cu12==11.4.5.107->torch==2.1.0->-r
road-detection/TwinLiteNet/requirements.txt (line 35)) (12.4.99)
```

Copy Dataset from Repository

- Our repository contains dataset.zip in datasets folder in the repository. copy that zip file to root

```
!cp road-detection/datasets/dataset.zip ./
```

Unzip the file

```
!unzip dataset.zip
```

```
Archive:  dataset.zip
replace dataset/test/images/road_image_160.png? [y]es, [n]o, [A]ll,
[N]one, [r]ename: a
error:  invalid response [a]
replace dataset/test/images/road_image_160.png? [y]es, [n]o, [A]ll,
[N]one, [r]ename: A
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Import the all the required libraries

```
import torch
import cv2
import torch.utils.data
import torchvision.transforms as transforms
import numpy as np
import os
import random
import math
from matplotlib import pyplot as plt
import torch.nn as nn
```

Image transformation functions

- By paper author

```
def augment_hsv(img, hgain=0.015, sgain=0.7, vgain=0.4):
    """change color hue, saturation, value"""
    r = np.random.uniform(-1, 1, 3) * [hgain, sgain, vgain] + 1  # 
random gains
    hue, sat, val = cv2.split(cv2.cvtColor(img, cv2.COLOR_BGR2HSV))
    dtype = img.dtype  # uint8

    x = np.arange(0, 256, dtype=np.int16)
    lut_hue = ((x * r[0]) % 180).astype(dtype)
    lut_sat = np.clip(x * r[1], 0, 255).astype(dtype)
```

```
    lut_val = np.clip(x * r[2], 0, 255).astype(dtype)

    img_hsv = cv2.merge((cv2.LUT(hue, lut_hue), cv2.LUT(sat, lut_sat),
cv2.LUT(val, lut_val))).astype(dtype)
    cv2.cvtColor(img_hsv, cv2.COLOR_HSV2BGR, dst=img)  # no return
needed

def random_perspective(combination,  degrees=10, translate=.1,
scale=.1, shear=10, perspective=0.0, border=(0, 0)):
    """combination of img transform"""
    # torchvision.transforms.RandomAffine(degrees=(-10, 10),
translate=(.1, .1), scale=(.9, 1.1), shear=(-10, 10))
    # targets = [cls, xyxy]
    img, gray, line = combination
    height = img.shape[0] + border[0] * 2  # shape(h,w,c)
    width = img.shape[1] + border[1] * 2

    # Center
    C = np.eye(3)
    C[0, 2] = -img.shape[1] / 2  # x translation (pixels)
    C[1, 2] = -img.shape[0] / 2  # y translation (pixels)

    # Perspective
    P = np.eye(3)
    P[2, 0] = random.uniform(-perspective, perspective)  # x
perspective (about y)
    P[2, 1] = random.uniform(-perspective, perspective)  # y
perspective (about x)

    # Rotation and Scale
    R = np.eye(3)
    a = random.uniform(-degrees, degrees)
    # a += random.choice([-180, -90, 0, 90])  # add 90deg rotations to
small rotations
    s = random.uniform(1 - scale, 1 + scale)
    # s = 2 ** random.uniform(-scale, scale)
    R[:2] = cv2.getRotationMatrix2D(angle=a, center=(0, 0), scale=s)

    # Shear
    S = np.eye(3)
    S[0, 1] = math.tan(random.uniform(-shear, shear) * math.pi / 180)
# x shear (deg)
    S[1, 0] = math.tan(random.uniform(-shear, shear) * math.pi / 180)
# y shear (deg)

    # Translation
    T = np.eye(3)
    T[0, 2] = random.uniform(0.5 - translate, 0.5 + translate) * width
# x translation (pixels)
    T[1, 2] = random.uniform(0.5 - translate, 0.5 + translate) *
```

```
height  # y translation (pixels)

    # Combined rotation matrix
    M = T @ S @ R @ P @ C  # order of operations (right to left) is
IMPORTANT
    if (border[0] != 0) or (border[1] != 0) or (M != np.eye(3)).any():
# image changed
        if perspective:
            img = cv2.warpPerspective(img, M, dsize=(width, height),
borderValue=(114, 114, 114))
            gray = cv2.warpPerspective(gray, M, dsize=(width, height),
borderValue=0)
            line = cv2.warpPerspective(line, M, dsize=(width, height),
borderValue=0)
        else:  # affine
            img = cv2.warpAffine(img, M[:2], dsize=(width, height),
borderValue=(114, 114, 114))
            gray = cv2.warpAffine(gray, M[:2], dsize=(width, height),
borderValue=0)
            line = cv2.warpAffine(line, M[:2], dsize=(width, height),
borderValue=0)



    combination = (img, gray, line)
    return combination
```

Custom Dataset Class

- This custom dataset class is based on the dataset class written by the author but with slight modifications like path. we have adjusted the path according to the google colab.

```
class MyDataset(torch.utils.data.Dataset):
    '''
    Class to load the dataset
    '''
    def __init__(self, transform=None,valid=False):
        '''
        :param imList: image list (Note that these lists have been
processed and pickled using the loadData.py)
        :param labelList: label list (Note that these lists have been
processed and pickled using the loadData.py)
        :param transform: Type of transformation. SEe Transforms.py
for supported transformations
        '''

        self.transform = transform
        self.Tensor = transforms.ToTensor()
        self.valid=valid
        if valid:
```

```
            self.root='dataset/validation/images'
            self.names=os.listdir(self.root)
        else:
            self.root='dataset/train/images/'
            self.names=os.listdir(self.root)

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

    def __getitem__(self, idx):
        '''

        :param idx: Index of the image file
        :return: returns the image and corresponding label file.
        '''
        W_=640
        H_=360
        image_name=os.path.join(self.root,self.names[idx])

        image = cv2.imread(image_name)
        original_image = cv2.imread(image_name)
        label1 =
cv2.imread(image_name.replace("images","segments").replace("jpg","png"
), 0)
        label2 =
cv2.imread(image_name.replace("images","lane").replace("jpg","png"),
0)
        if not self.valid:
            if random.random()<0.5:
                combination = (image, label1, label2)
                (image, label1, label2)= random_perspective(
                    combination=combination,
                    degrees=10,
                    translate=0.1,
                    scale=0.25,
                    shear=0.0
                )
            if random.random()<0.5:
                augment_hsv(image)
            if random.random() < 0.5:
                image = np.fliplr(image)
                label1 = np.fliplr(label1)
                label2 = np.fliplr(label2)

        label1 = cv2.resize(label1, (W_, H_))
        label2 = cv2.resize(label2, (W_, H_))
        image = cv2.resize(image, (W_, H_))

        _,seg_b1 = cv2.threshold(label1,1,255,cv2.THRESH_BINARY_INV)
        _,seg_b2 = cv2.threshold(label2,1,255,cv2.THRESH_BINARY_INV)
```

```
        _,seg1 = cv2.threshold(label1,1,255,cv2.THRESH_BINARY)
        _,seg2 = cv2.threshold(label2,1,255,cv2.THRESH_BINARY)

        seg1 = self.Tensor(seg1)
        seg2 = self.Tensor(seg2)
        seg_b1 = self.Tensor(seg_b1)
        seg_b2 = self.Tensor(seg_b2)
        seg_da = torch.stack((seg_b1[0], seg1[0]),0)
        seg_ll = torch.stack((seg_b2[0], seg2[0]),0)
        image = image[:, :, ::-1].transpose(2, 0, 1)
        image = np.ascontiguousarray(image)

        return original_image, image_name,torch.from_numpy(image),
(seg_da,seg_ll)
```

Intialize a dataloader

- Intialize a dataloader with batch size 8

```
from torch.utils.data import DataLoader

train_dataloader = DataLoader(MyDataset(), batch_size = 8, shuffle =
True)
```

Display images

- Show first sample of each mini-batch with size 8

```
# Printing the first sample of the each minibatch of size 8

plt.figure(figsize = (100, 100))

f, axarr = plt.subplots(5, 4)
i = 0
j = 0

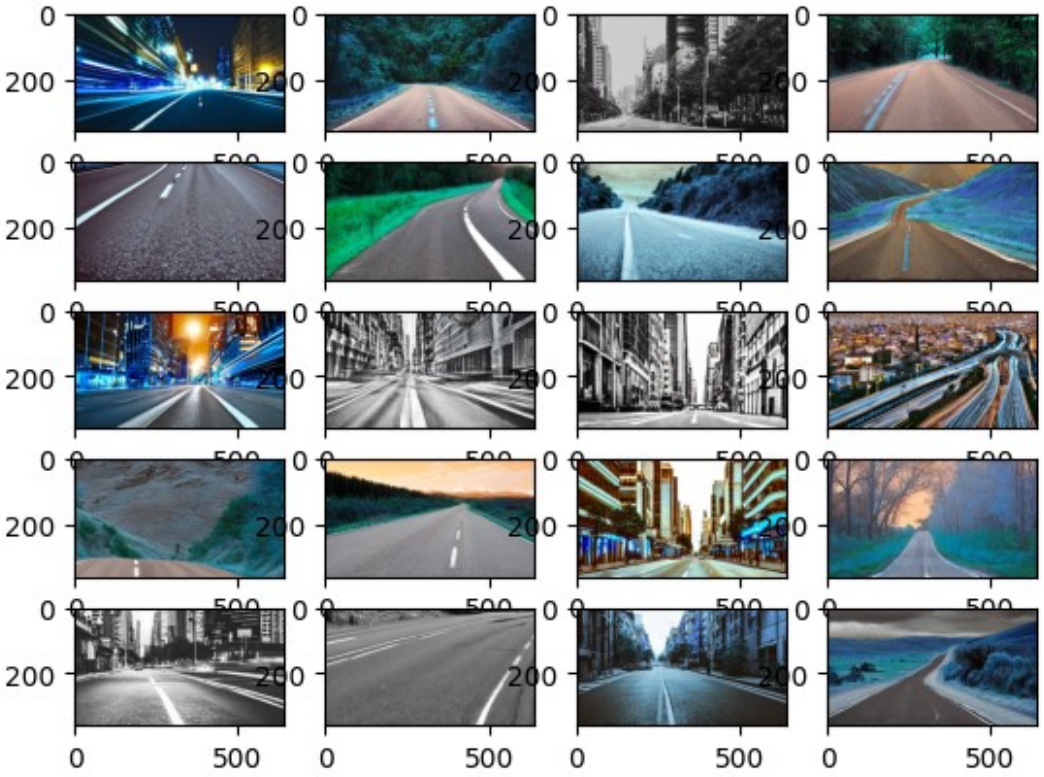
for batch in train_dataloader:
  original_image, image_name, input, target = batch
  print(image_name[0])
  axarr[i, j].imshow(original_image[0])
  j += 1
  if j%4 == 0:
    i += 1
    j = 0

plt.show()
```

```
dataset/train/images/road_image_138.png
dataset/train/images/road_image_69.png
dataset/train/images/road_image_122.png
dataset/train/images/road_image_49.png
```

```
dataset/train/images/road_image_71.png
dataset/train/images/road_image_61.png
dataset/train/images/road_image_75.png
dataset/train/images/road_image_98.png
dataset/train/images/road_image_137.png
dataset/train/images/road_image_143.png
dataset/train/images/road_image_117.png
dataset/train/images/road_image_144.png
dataset/train/images/road_image_35.png
dataset/train/images/road_image_51.png
dataset/train/images/road_image_114.png
dataset/train/images/road_image_26.png
dataset/train/images/road_image_125.png
dataset/train/images/road_image_85.png
dataset/train/images/road_image_116.png
dataset/train/images/road_image_52.png

<Figure size 10000x10000 with 0 Axes>
```



Load the pretrained model

```
import TwinLite as net


model = net.TwinLiteNet()
```

```
model = torch.nn.DataParallel(model)
model = model.cuda()
model.load_state_dict(torch.load('best.pth'))
```

```
<All keys matched successfully>
```

Intialize loss and optimizer.

- This is based on the original code from paper author

```
from tqdm import tqdm
from loss import TotalLoss

lr = 5e-4
optimizer = torch.optim.Adam(model.parameters(), lr, (0.9, 0.999),
eps=1e-08, weight_decay=5e-4)

criteria = TotalLoss()

args = dict()

args["lr"] = lr
args["max_epochs"] = 3
args["onGPU"] = True

args
```

```
{'lr': 0.0005, 'max_epochs': 3, 'onGPU': True}
```

Intialize Polynomial Learning Rate Scheduler

- By Paper Author

```
def poly_lr_scheduler(args, optimizer, epoch, power=2):
    lr = round(args["lr"] * (1 - epoch / args["max_epochs"]) ** power,
8)
    for param_group in optimizer.param_groups:
        param_group['lr'] = lr

    return lr
```

Write a trainer function for each epoch

- By Paper Author

```
def train(args, train_loader, model, criterion, optimizer, epoch):
    model.train()

    total_batches = len(train_loader)
    pbar = enumerate(train_loader)
    pbar = tqdm(pbar, total=total_batches, bar_format='{l_bar}{bar:10}
{r_bar}')
```

```
    for i, (_, _, input, target) in pbar:
        if args["onGPU"] == True:
            input = input.cuda().float() / 255.0
        output = model(input)

        # target=target.cuda()
        optimizer.zero_grad()

        focal_loss,tversky_loss,loss = criterion(output,target)


        optimizer.zero_grad()
        loss.backward()
        optimizer.step()
        pbar.set_description(('%13s' * 1 + '%13.4g' * 3) %
                                        (f'{epoch}/{args["max_epochs"] -
1}', tversky_loss, focal_loss, loss.item()))
```

Train the model with custom data and also print the loss

- This loss is based on the paper

```
for epoch in range(0, args["max_epochs"]):
    poly_lr_scheduler(args, optimizer, epoch)
    for param_group in optimizer.param_groups:
        lr = param_group['lr']
    print("Learning rate: " +  str(lr))

    # train for one epoch
    model.train()
    train( args, train_dataloader, model, criteria, optimizer, epoch)
    model.eval()
```

```
Learning rate: 0.0005

          0/2       0.5133       0.3487        0.862: 100%|██████████|
20/20 [00:10<00:00,  1.99it/s]

Learning rate: 0.00022222

          1/2      0.08693      0.05467       0.1416: 100%|██████████|
20/20 [00:09<00:00,  2.09it/s]

Learning rate: 5.556e-05

          2/2      0.08697      0.05309       0.1401: 100%|██████████|
20/20 [00:08<00:00,  2.24it/s]
```

Loss

- Loss in epoch 1: 0.862
- Loss in epoch 2: 0.1416

- Loss in epoch 3: 0.1401