```
import numpy as np
import matplotlib.pyplot as plt
import torch
import torch.nn as nn
import torchvision
import torchvision.transforms as transforms
import os
import glob
import cv2
from PIL import Image
from torch.utils.data import Dataset, DataLoader
from albumentations import HorizontalFlip, VerticalFlip, Rotate
import tqdm
import torch.nn.functional as F
import matplotlib.image as mpimg
```

```
torch.manual_seed(42)
np.random.seed(42)
torch.cuda.manual_seed_all(42)
torch.backends.cudnn.deterministic = True
torch.backends.cudnn.benchmark = False
```

```
!nvidia-smi
```

```
Fri Jun  3 02:37:05 2022
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 460.32.03    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 T4            Off  | 00000000:00:04.0 Off |                    0 |
| N/A   47C    P8     9W /  70W |      0MiB / 15109MiB |      0%      Default |
|                               |                      |                  N/A |
+-------------------------------+----------------------+----------------------+

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

```
print(torch.cuda.is_available())
```

```
True
```

```
size = (256, 256)
```

```
class LoadData(Dataset):
    def __init__(self, images_path, masks_path):
        super().__init__()

        self.images_path = images_path
        self.masks_path = masks_path
        self.len = len(images_path)
        self.transform = transforms.Resize(size)

    def __getitem__(self, idx):
        img = Image.open(self.images_path[idx])
        img = self.transform(img)
        img = np.transpose(img, (2, 0, 1))
        img = img/255.0
        img = torch.tensor(img)

        mask = Image.open(self.masks_path[idx]).convert('L')
        mask = self.transform(mask)
        mask = np.expand_dims(mask, axis=0)
        mask = mask/255.0
        mask = torch.tensor(mask)

        return img, mask

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

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

```
     Mounted at /content/drive
```

```
X = sorted(glob.glob('/content/drive/MyDrive/satellite/images/*.jpg'))
y = sorted(glob.glob('/content/drive/MyDrive/satellite/masks/*.jpg'))
```

```
len(X)
```

```
     2841
```

```
len(y)
```

```
     2841
```

```
train_X = X[:2800]
train_y = y[:2800]
```

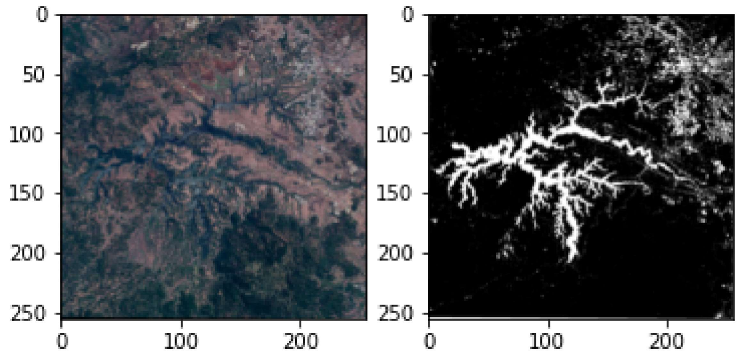
```
valid_X = X[2800:]
valid_y = y[2800:]
```

```
train_dataset = LoadData(train_X, train_y)
valid_dataset = LoadData(valid_X, valid_y)
```

```
img, mask = train_dataset[0]
```

```
f, axarr = plt.subplots(1,2)
axarr[1].imshow(np.squeeze(mask.numpy()), cmap='gray')
axarr[0].imshow(np.transpose(img.numpy(), (1,2,0)))
```

```
<matplotlib.image.AxesImage at 0x7f306ae8ea90>
```



```
img.shape
```

```
torch.Size([3, 256, 256])
```

```
class conv(nn.Module):
    def __init__(self, in_channels, out_channels):
        super().__init__()

        self.conv1 = nn.Conv2d(in_channels, out_channels, kernel_size=3, padding=1)
        self.bn1 = nn.BatchNorm2d(out_channels)

        self.conv2 = nn.Conv2d(out_channels, out_channels, kernel_size=3, padding=1)
        self.bn2 = nn.BatchNorm2d(out_channels)

        self.relu = nn.ReLU()

    def forward(self, images):
        x = self.conv1(images)
        x = self.bn1(x)
        x = self.relu(x)

        x = self.conv2(x)
        x = self.bn2(x)
        x = self.relu(x)

        return x
```

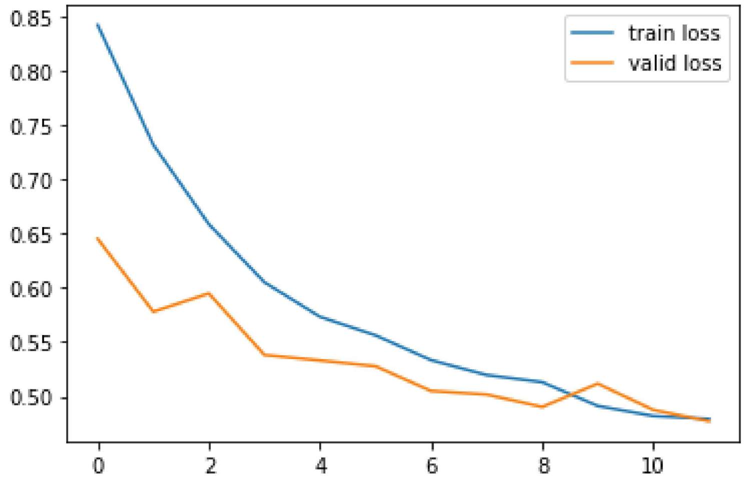
```
class encoder(nn.Module):
    def __init__(self, in_channels, out_channels):
        super().__init__()
        self.conv = conv(in_channels, out_channels)
        self.pool = nn.MaxPool2d((2,2))

    def forward(self, images):
        x = self.conv(images)
        p = self.pool(x)

        return x, p

class decoder(nn.Module):
    def __init__(self, in_channels, out_channels):
        super().__init__()

        self.upconv = nn.ConvTranspose2d(in_channels, out_channels, kernel_size=2, stride=
        self.conv = conv(out_channels * 2, out_channels)

    def forward(self, images, prev):
        x = self.upconv(images)
        x = torch.cat([x, prev], axis=1)
        x = self.conv(x)

        return x


class UNet(nn.Module):
    def __init__(self):
        super().__init__()

        self.e1 = encoder(3, 64)
        self.e2 = encoder(64, 128)
        self.e3 = encoder(128, 256)
        self.e4 = encoder(256, 512)

        self.b = conv(512, 1024)

        self.d1 = decoder(1024, 512)
        self.d2 = decoder(512, 256)
        self.d3 = decoder(256, 128)
        self.d4 = decoder(128, 64)

        self.output = nn.Conv2d(64, 1, kernel_size=1, padding=0)

    def forward(self, images):
        x1, p1 = self.e1(images)
        x2, p2 = self.e2(p1)
        x3, p3 = self.e3(p2)
        x4, p4 = self.e4(p3)

        b = self.b(p4)

        d1 = self.d1(b, x4)
        d2 = self.d2(d1, x3)
        d3 = self.d3(d2, x2)
        d4 = self.d4(d3, x1)
        output_mask = self.output(d4)
        output_mask = torch.sigmoid(output_mask)

        return output_mask


batch_size = 8
num_epochs = 12
lr = 1e-4
checkpoint_path = "./checkpoint.pth"


train_loader = DataLoader(
        dataset=train_dataset,
        batch_size=batch_size,
        shuffle=True,
        num_workers=2,
)

valid_loader = DataLoader(
        dataset=valid_dataset,
        batch_size=batch_size,
        shuffle=False,
        num_workers=2,
)


device = torch.device('cuda')
model = UNet()
model = model.to(device)


class DiceBCELoss(nn.Module):
    def __init__(self, weight=None, size_average=True):
        super(DiceBCELoss, self).__init__()

    def forward(self, inputs, targets, smooth=1):
        inputs = inputs.view(-1)
        targets = targets.view(-1)

        intersection = (inputs * targets).sum()
        dice_score = (2.*intersection + smooth)/(inputs.sum() + targets.sum() + smooth)
        dice_loss = 1 - dice_score
        loss = torch.nn.BCELoss()
        BCE = loss(inputs, targets)
        Dice_BCE = BCE + dice_loss

        return Dice_BCE


optimizer = torch.optim.Adam(model.parameters(), lr=lr)
loss_fn = DiceBCELoss()


def train_model(model, loader, optimizer, loss_fn, device):
    epoch_loss = 0.0

    model.train()
    for x, y in loader:
        x = x.to(device, dtype=torch.float32)
        y = y.to(device, dtype=torch.float32)

        optimizer.zero_grad()
        y_pred = model(x)
        loss = loss_fn(y_pred, y)
        loss.backward()
        optimizer.step()
        epoch_loss += loss.item()

    epoch_loss = epoch_loss/len(loader)
    return epoch_loss


def evaluate(model, loader, loss_fn, device):
    epoch_loss = 0.0

    model.eval()
    with torch.no_grad():
        for x, y in loader:
            x = x.to(device, dtype=torch.float32)
            y = y.to(device, dtype=torch.float32)
#             x,y=x.type(torch.FloatTensor),y.type(torch.FloatTensor)

            y_pred = model(x)
            loss = loss_fn(y_pred, y)
            epoch_loss += loss.item()

        epoch_loss = epoch_loss/len(loader)
    return epoch_loss


train = []
valid = []

best_valid_loss = float("inf")

for epoch in range(num_epochs):
        train_loss = train_model(model, train_loader, optimizer, loss_fn, device)
        valid_loss = evaluate(model, valid_loader, loss_fn, device)

        train.append(train_loss)
        valid.append(valid_loss)

        if valid_loss < best_valid_loss:
            data_str = f"Valid loss improved from {best_valid_loss:2.4f} to {valid_loss:2.
            print(data_str)

            best_valid_loss = valid_loss
            torch.save(model.state_dict(), checkpoint_path)
    data_str = f'Epoch: {epoch+1:02}\n'
    data_str += f'\tTrain Loss: {train_loss:.3f}\n'
    data_str += f'\t Val. Loss: {valid_loss:.3f}\n'
    print(data_str)
```

```
Valid loss improved from inf to 0.6455. Saving checkpoint: ./checkpoint.pth
Epoch: 01
        Train Loss: 0.843
         Val. Loss: 0.645

Valid loss improved from 0.6455 to 0.5781. Saving checkpoint: ./checkpoint.pth
Epoch: 02
        Train Loss: 0.732
         Val. Loss: 0.578

Epoch: 03
        Train Loss: 0.659
         Val. Loss: 0.595

Valid loss improved from 0.5781 to 0.5382. Saving checkpoint: ./checkpoint.pth
Epoch: 04
        Train Loss: 0.605
         Val. Loss: 0.538

Valid loss improved from 0.5382 to 0.5331. Saving checkpoint: ./checkpoint.pth
Epoch: 05
        Train Loss: 0.573
         Val. Loss: 0.533

Valid loss improved from 0.5331 to 0.5278. Saving checkpoint: ./checkpoint.pth
Epoch: 06
        Train Loss: 0.556
         Val. Loss: 0.528

Valid loss improved from 0.5278 to 0.5050. Saving checkpoint: ./checkpoint.pth
Epoch: 07
        Train Loss: 0.533
         Val. Loss: 0.505

Valid loss improved from 0.5050 to 0.5017. Saving checkpoint: ./checkpoint.pth
Epoch: 08
        Train Loss: 0.520
         Val. Loss: 0.502

Valid loss improved from 0.5017 to 0.4902. Saving checkpoint: ./checkpoint.pth
Epoch: 09
        Train Loss: 0.513
         Val. Loss: 0.490

Epoch: 10
        Train Loss: 0.491
         Val. Loss: 0.512

Valid loss improved from 0.4902 to 0.4874. Saving checkpoint: ./checkpoint.pth
Epoch: 11
        Train Loss: 0.482
         Val. Loss: 0.487

Valid loss improved from 0.4874 to 0.4770. Saving checkpoint: ./checkpoint.pth
```

```
Epoch: 12
        Train Loss: 0.479
         Val. Loss: 0.477
```

```
plt.plot(range(0,12), train, label='train loss')
plt.plot(range(0,12), valid, label='valid loss')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7f30685e6750>
```

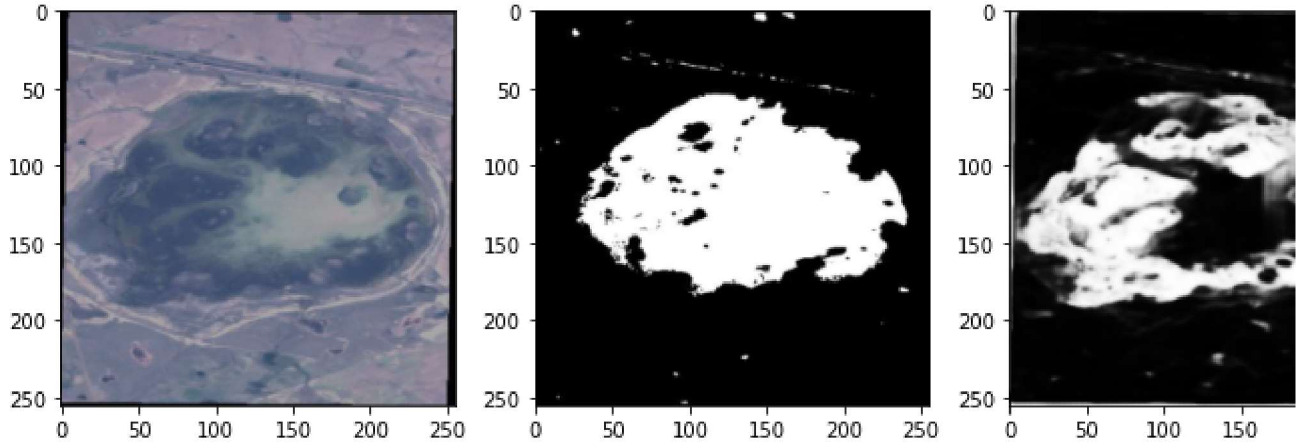


```
m = UNet()
m.load_state_dict(torch.load(checkpoint_path))
m = m.to(device)
```

```
transform = transforms.ToPILImage()
pred = []
for x, y in valid_loader:
    image0 = transform(x[0])
    image1 = transform(x[1])
    image2 = transform(x[2])
    image3 = transform(x[3])
    image4 = transform(x[4])
    image5 = transform(x[5])
    print(x[0].shape)
    x = x.to(device, dtype=torch.float32)
    y = y.to(device, dtype=torch.float32)

    y_pred = m(x)
    img = y_pred.cpu().detach().numpy()
    plt.figure(figsize=(30,8))
    print(img.shape)
    #subplot(r,c) provide the no. of rows and columns
    f, axarr = plt.subplots(6,3)
    f.set_size_inches(12, 30, forward=True)
    axarr[0,0].imshow(image0)
    axarr[0,1].imshow(np.squeeze(y.cpu().detach().numpy())[0], cmap='gray')
    axarr[0,2].imshow(np.squeeze(img)[0], cmap='gray')

    axarr[1,0].imshow(image1)
    axarr[1,1].imshow(np.squeeze(y.cpu().detach().numpy())[1], cmap='gray')
```

```
        axarr[1,2].imshow(np.squeeze(img)[1], cmap='gray')

        axarr[5,0].imshow(image2)
        axarr[5,1].imshow(np.squeeze(y.cpu().detach().numpy())[2], cmap='gray')
        axarr[5,2].imshow(np.squeeze(img)[2], cmap='gray')

        axarr[2,0].imshow(image3)
        axarr[2,1].imshow(np.squeeze(y.cpu().detach().numpy())[3], cmap='gray')
        axarr[2,2].imshow(np.squeeze(img)[3], cmap='gray')

        axarr[3,0].imshow(image4)
        axarr[3,1].imshow(np.squeeze(y.cpu().detach().numpy())[4], cmap='gray')
        axarr[3,2].imshow(np.squeeze(img)[4], cmap='gray')

        axarr[4,0].imshow(image5)
        axarr[4,1].imshow(np.squeeze(y.cpu().detach().numpy())[5], cmap='gray')
        axarr[4,2].imshow(np.squeeze(img)[5], cmap='gray')
        break
```

```
torch.Size([3, 256, 256])
(8, 1, 256, 256)
<Figure size 2160x576 with 0 Axes>
```



```
dice_BCE = evaluate(m, valid_loader, loss_fn, device)
```

```
dice_BCE
```

```
0.4773574968179067
```

```
def dice_score(model, loader, loss_fn, device):
    epoch_loss = 0.0

    model.eval()
    with torch.no_grad():
        for x, y in loader:
            x = x.to(device, dtype=torch.float32)
            y = y.to(device, dtype=torch.float32)
#             x,y=x.type(torch.FloatTensor),y.type(torch.FloatTensor)

            y_pred = model(x)
            inputs = y_pred.view(-1)
            targets = y.view(-1)
            smooth = 1

            intersection = (inputs * targets).sum()
            dice_score = (2.*intersection + smooth)/(inputs.sum() + targets.sum() + smooth
            epoch_loss += dice_score

        epoch_loss = epoch_loss/len(loader)
    return epoch_loss
```

```
diceScore = dice_score(m, valid_loader, loss_fn, device)
```

```
diceScore.item()
```

```
0.8098794221878052
```

```
class LoadPredictionData(Dataset):
    def __init__(self, images_path):
        super().__init__()

        self.images_path = images_path
        # self.masks_path = masks_path
        self.len = len(images_path)
        self.transform = transforms.Resize(size)

    def __getitem__(self, idx):
        img = Image.open(self.images_path[idx])
        img = self.transform(img)
        img = np.transpose(img, (2, 0, 1))
        img = img/255.0
        img = torch.tensor(img)

        # mask = Image.open(self.masks_path[idx]).convert('L')
        # mask = self.transform(mask)
        # mask = np.expand_dims(mask, axis=0)
        # mask = mask/255.0
        # mask = torch.tensor(mask)

        return img

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

```
pred_img = sorted(glob.glob('/content/drive/MyDrive/satellite/download.jpg'))
```

```
pred_dataset = LoadPredictionData(pred_img)
```

```
len(pred_dataset)
```

```
     0
```

```
prediction_loader = DataLoader(
        dataset=pred_dataset,
        batch_size=batch_size,
        shuffle=False,
        num_workers=2,
)
```

```
transform = transforms.ToPILImage()
pred = []
for x in prediction_loader:
    image0 = transform(x[0])

    print(x[0].shape)
    x = x.to(device, dtype=torch.float32)
    # y = y.to(device, dtype=torch.float32)
    y_pred = m(x)
    img = y_pred.cpu().detach().numpy()
    plt.figure(figsize=(30,8))
    print(img.shape)
    #subplot(r,c) provide the no. of rows and columns
    f, axarr = plt.subplots(6,3)
    f.set_size_inches(12, 30, forward=True)
    axarr[0,0].imshow(image0)
    # axarr[0,1].imshow(np.squeeze(y.cpu().detach().numpy())[0], cmap='gray')
    axarr[0,2].imshow(img[0,0,:,:], cmap='gray')

    # axarr[1,0].imshow(image1)
    # axarr[1,1].imshow(np.squeeze(y.cpu().detach().numpy())[1], cmap='gray')
    # axarr[1,2].imshow(np.squeeze(img)[1], cmap='gray')

    # axarr[5,0].imshow(image2)
    # axarr[5,1].imshow(np.squeeze(y.cpu().detach().numpy())[2], cmap='gray')
    # axarr[5,2].imshow(np.squeeze(img)[2], cmap='gray')

    # axarr[2,0].imshow(image3)
    # axarr[2,1].imshow(np.squeeze(y.cpu().detach().numpy())[3], cmap='gray')
    # axarr[2,2].imshow(np.squeeze(img)[3], cmap='gray')

    # axarr[3,0].imshow(image4)
    # axarr[3,1].imshow(np.squeeze(y.cpu().detach().numpy())[4], cmap='gray')
    # axarr[3,2].imshow(np.squeeze(img)[4], cmap='gray')

    # axarr[4,0].imshow(image5)
    # axarr[4,1].imshow(np.squeeze(y.cpu().detach().numpy())[5], cmap='gray')
    # axarr[4,2].imshow(np.squeeze(img)[5], cmap='gray')
    break
```

```
!pip install gradio
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-whee
Collecting gradio
  Downloading gradio-3.0.10-py3-none-any.whl (5.1 MB)
     |████████████████████████████████| 5.1 MB 8.0 MB/s
Requirement already satisfied: requests in /usr/local/lib/python3.7/dist-packages
Collecting ffmpy
  Downloading ffmpy-0.3.0.tar.gz (4.8 kB)
Collecting pycryptodome
  Downloading pycryptodome-3.14.1-cp35-abi3-manylinux2010_x86_64.whl (2.0 MB)
     |████████████████████████████████| 2.0 MB 53.0 MB/s
Collecting uvicorn
  Downloading uvicorn-0.17.6-py3-none-any.whl (53 kB)
     |████████████████████████████████| 53 kB 2.6 MB/s
Requirement already satisfied: matplotlib in /usr/local/lib/python3.7/dist-package
Collecting analytics-python
  Downloading analytics_python-1.4.0-py2.py3-none-any.whl (15 kB)
Collecting python-multipart
  Downloading python-multipart-0.0.5.tar.gz (32 kB)
Collecting aiohttp
  Downloading aiohttp-3.8.1-cp37-cp37m-manylinux_2_5_x86_64.manylinux1_x86_64.many
     |████████████████████████████████| 1.1 MB 44.1 MB/s
Collecting orjson
```

```
  Downloading orjson-3.7.0-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.w
     |████████████████████████████████| 256 kB 68.0 MB/s
Requirement already satisfied: pandas in /usr/local/lib/python3.7/dist-packages (f
Requirement already satisfied: Jinja2 in /usr/local/lib/python3.7/dist-packages (f
Collecting paramiko
  Downloading paramiko-2.11.0-py2.py3-none-any.whl (212 kB)
     |████████████████████████████████| 212 kB 67.8 MB/s
Collecting markdown-it-py[linkify,plugins]
  Downloading markdown_it_py-2.1.0-py3-none-any.whl (84 kB)
     |████████████████████████████████| 84 kB 3.9 MB/s
Requirement already satisfied: pillow in /usr/local/lib/python3.7/dist-packages (f
Collecting pydub
  Downloading pydub-0.25.1-py2.py3-none-any.whl (32 kB)
Collecting fastapi
  Downloading fastapi-0.78.0-py3-none-any.whl (54 kB)
     |████████████████████████████████| 54 kB 3.5 MB/s
Requirement already satisfied: numpy in /usr/local/lib/python3.7/dist-packages (fr
Collecting aiosignal>=1.1.2
  Downloading aiosignal-1.2.0-py3-none-any.whl (8.2 kB)
Requirement already satisfied: charset-normalizer<3.0,>=2.0 in /usr/local/lib/pyth
Collecting yarl<2.0,>=1.0
  Downloading yarl-1.7.2-cp37-cp37m-manylinux_2_5_x86_64.manylinux1_x86_64.manylin
     |████████████████████████████████| 271 kB 56.5 MB/s
Requirement already satisfied: attrs>=17.3.0 in /usr/local/lib/python3.7/dist-pack
Collecting multidict<7.0,>=4.5
  Downloading multidict-6.0.2-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_6
     |████████████████████████████████| 94 kB 4.4 MB/s
Collecting frozenlist>=1.1.1
  Downloading frozenlist-1.3.0-cp37-cp37m-manylinux_2_5_x86_64.manylinux1_x86_64.m
     |████████████████████████████████| 144 kB 59.2 MB/s
Requirement already satisfied: typing-extensions>=3.7.4 in /usr/local/lib/python3
Collecting async-timeout<5.0,>=4.0.0a3
  Downloading async_timeout-4.0.2-py3-none-any.whl (5.8 kB)
Collecting asynctest==0.13.0
  Downloading asynctest-0.13.0-py3-none-any.whl (26 kB)
```

```
def segment(image):
  image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
  cv2.imwrite('/content/drive/MyDrive/satellite/test.jpg',image)
  pred_img = sorted(glob.glob('/content/drive/MyDrive/satellite/test.jpg'))
  print(image.shape)
  pred_dt = LoadPredictionData(pred_img)
  print(len(pred_dt))
  prediction_lr = DataLoader(dataset=pred_dt, batch_size=batch_size, shuffle=False, num_wo
  print(len(prediction_lr))
  for x in prediction_lr:
    print("####################")
    print(x[0].shape)
    image0 = transform(x[0])
    print("####################")
    x = x.to(device, dtype=torch.float32)
    print("####################")
    y_pred = m(x)
    print("####################")
    img = y_pred.cpu().detach().numpy()
    break
  print("**********************************************")
  return img[0,0,:,:]
  # return


# ans=segment(pred_img)
# print(ans.shape)
# plt.figure(figsize=(9,9))
# plt.subplot(1,1,1)
# plt.imshow(ans,cmap='gray')


import numpy as np

import gradio as gr
image = gr.inputs.Image(shape = (256, 256),type="numpy")
demo = gr.Interface(fn=segment, inputs=image, outputs="image")
demo.launch(auth=('user','password'),debug=True)
```

```
/usr/local/lib/python3.7/dist-packages/gradio/deprecation.py:40: UserWarning: `optio
  warnings.warn(value)
Colab notebook detected. This cell will run indefinitely so that you can see errors a
Running on public URL: https://50712.gradio.app

This share link expires in 72 hours. For free permanent hosting, check out Spaces (h
(256, 256, 3)
1
1
####################
torch.Size([3, 256, 256])
####################
####################
####################
**********************************************
(256, 256, 3)
1
1
####################
torch.Size([3, 256, 256])
####################
####################
####################
**********************************************
(256, 256, 3)
1
1
####################
torch.Size([3, 256, 256])
####################
####################
####################
**********************************************
(256, 256, 3)
1
1
####################
torch.Size([3, 256, 256])
####################
####################
####################
```

```
***********************************************
Keyboard interruption in main thread... closing server.
(<gradio.routes.App at 0x7f2ee3ecd410>,
 'http://127.0.0.1:7860/',
 'https://50712.gradio.app')
```