In 1
```
from google.colab import drive
drive.mount('/content/drive')
%cd /content/drive/MyDrive/DepthSense
```
```
Mounted at /content/drive
/content/drive/MyDrive/DepthSense
```

In 2
```
!ls
```
```
data           notes.md                                  resnet_with_feature_fusion.pth
globalsave.pkl  nyu-v2-depth-resnext50_32x4d-unetplusplus.pt  scratchpad.ipynb
LICENSE        online_sampling                           scripts
loss           README.md                                 shelve.out.db
models         ReDWeb_V1                                 utils
notes          ReDWeb_V1.tar.gz
```

In 3
```
!ls ReDWeb_V1/Imgs/ | wc -l
```
```
3600
```

In 4
```
!ls ReDWeb_V1/RDs/ | wc -l
```
```
3600
```

In 5
```
!pip install -Uq segmentation-models-pytorch
```
```
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 106.7/106.7 kB 1.2 MB/s eta 0:00:00
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 58.8/58.8 kB 4.3 MB/s eta 0:00:00
  Preparing metadata (setup.py) ... done
  Preparing metadata (setup.py) ... done
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 2.2/2.2 MB 13.4 MB/s eta 0:00:00
  Building wheel for efficientnet-pytorch (setup.py) ... done
  Building wheel for pretrainedmodels (setup.py) ... done
```

In 6
```
!pip install torchmetrics
```
```
Requirement already satisfied: fsspec in /usr/local/lib/python3.10/dist-packages (from torch>=1.8.1->torchmetrics) (2023.6.0)
Requirement already satisfied: triton==2.1.0 in /usr/local/lib/python3.10/dist-packages (from torch>=1.8.1->torchmetrics) (2.1.0)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.10/dist-packages (from jinja2->torch>=1.8.1->torchmetrics)
(2.1.3)
Requirement already satisfied: mpmath>=0.19 in /usr/local/lib/python3.10/dist-packages (from sympy->torch>=1.8.1->torchmetrics)
(1.3.0)
Installing collected packages: lightning-utilities, torchmetrics
Successfully installed lightning-utilities-0.10.0 torchmetrics-1.2.1
```

In 7
```
import os
import numpy as np
import pandas as pd
import torch
import torch.nn as nn
from torch.cuda.amp import GradScaler, autocast
from tqdm.auto import tqdm
import cv2 as cv
from PIL import Image
import segmentation_models_pytorch as smp
from sklearn.model_selection import train_test_split
import albumentations as A
from albumentations.pytorch import ToTensorV2
from torchmetrics.image import StructuralSimilarityIndexMeasure as SSIM
from torchmetrics.regression import MeanSquaredError as MSE
from torchmetrics.collections import MetricCollection
import gc
from torchvision.transforms import Normalize

import matplotlib.pyplot as plt
import torch
from torchvision import transforms
import torch.nn as nn


from torch.utils.data import DataLoader
from loss.StructureGuide import EdgeguidedRankingLoss

from data.loaders.DataLoader import RedWebDataset , Rescale , RandomCrop
normal_dataset = RedWebDataset(root_dir="../data/ReDWeb_V1",transform=transforms.Compose([
    Rescale((256,256)),
]))
batcher = DataLoader(normal_dataset,batch_size=1,shuffle=True)
```

In _
```
rgb_dir = "ReDWeb_V1/Imgs/"
depth_dir = "ReDWeb_V1/RDs/"
dataset_df = normal_dataset
```

In 9
```
train_df = dataset_df[:3200]
test_df = dataset_df[3200:]
print(train_df.shape , test_df.shape)
```
```
(3200, 2) (400, 2)
```

In 10
```
train_df, val_df = train_test_split(train_df,test_size=0.1,shuffle=True)
val_df, test_df = train_test_split(test_df, test_size=0.1,shuffle=True)
train_df.reset_index(drop=True,inplace=True)
val_df.reset_index(drop=True,inplace=True)
test_df.reset_index(drop=True,inplace=True)
len(train_df),len(val_df), len(test_df)
```
Out 10
```
(2880, 360, 40)
```

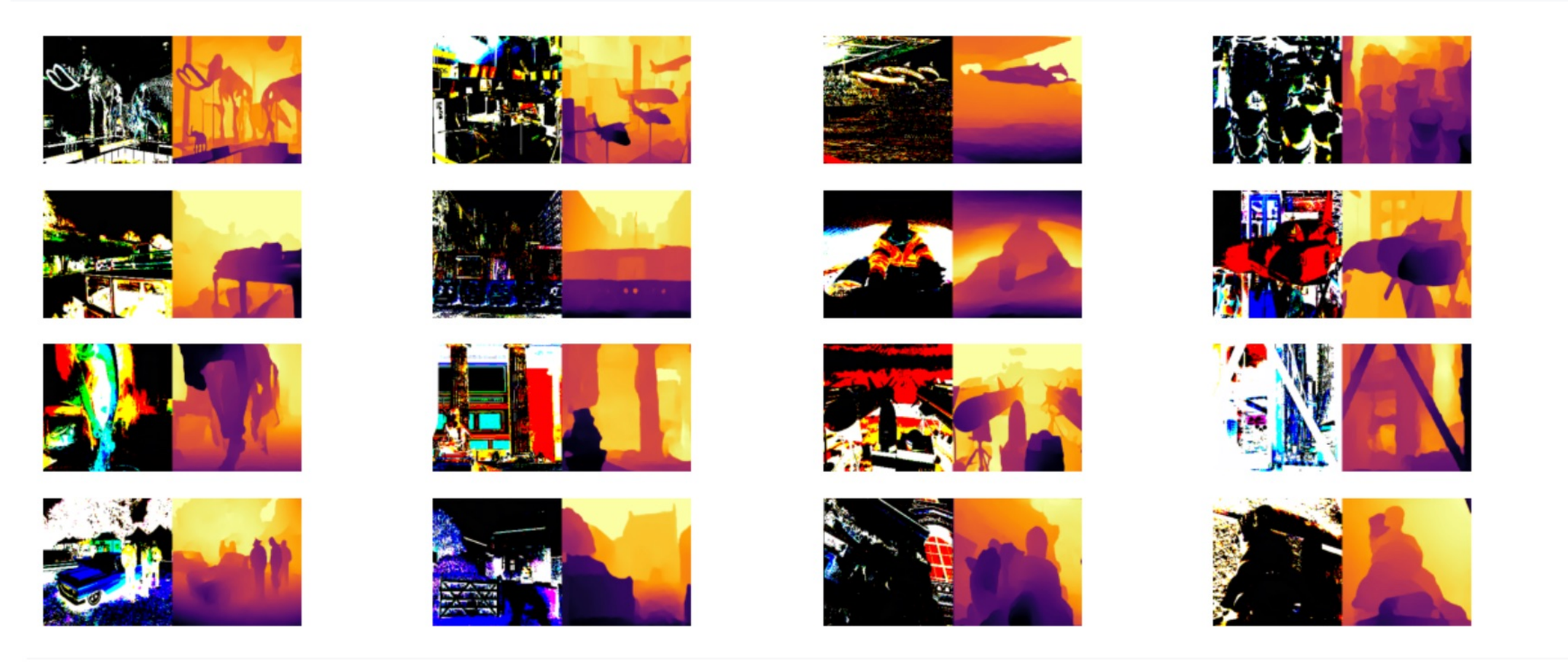
In 12
```
sample_tfms = [
    A.HorizontalFlip(),
    A.GaussNoise(p=0.2),
    A.OneOf([
        A.MotionBlur(p=.3),
        A.MedianBlur(blur_limit=3, p=0.3),
        A.Blur(blur_limit=3, p=0.5),
    ], p=0.3),
    A.RGBShift(),
    A.RandomBrightnessContrast(),
    A.RandomResizedCrop(384,384),
    A.ColorJitter(),
    A.ShiftScaleRotate(shift_limit=0.1, scale_limit=0.3, rotate_limit=45, p=0.5),
    A.HueSaturationValue(p=0.3),
]
train_tfms = A.Compose([...],is_check_shapes=False)
valid_tfms = A.Compose([...],is_check_shapes=False)
```

In 13
```
class Dataset:...
```

In 14
```
train_ds = Dataset(train_df,train_tfms)
val_ds = Dataset(val_df,valid_tfms)
test_ds = Dataset(test_df, valid_tfms)
len(train_ds), len(val_ds), len(test_ds)

```
Out 14
```
(2880, 360, 40)
```

In 11
```
def colored_depthmap(depth, d_min=None, d_max=None,cmap=plt.cm.inferno):
    if d_min is None:
        d_min = np.min(depth)
    if d_max is None:
        d_max = np.max(depth)
    depth_relative = (depth - d_min) / (d_max - d_min)
    return 255 * cmap(depth_relative)[:,:,:3] # H, W, C

def merge_into_row(input, depth_target):
    input = np.array(input)
    depth_target = np.squeeze(np.array(depth_target))

    d_min = np.min(depth_target)
    d_max = np.max(depth_target)
    depth_target_col = colored_depthmap(depth_target, d_min, d_max)
    img_merge = np.hstack([input, depth_target_col])

    return img_merge

plt.figure(figsize=(15, 6))
for i, idx in enumerate(np.random.randint(0,len(dataset_df),(16,))):
    ax = plt.subplot(4, 4, i + 1)
    image = Image.open(dataset_df.iloc[idx,0]).convert('RGB')
    mask = Image.open(dataset_df.iloc[idx,1]).convert('L')
    image_viz = merge_into_row(
        image,mask
    )
    plt.imshow(image_viz.astype("uint8"))
    plt.axis("off")
```

In 15
```
randoms = [test_ds[idx] for idx in range(16)]
plt.figure(figsize=(15, 6))
for i, (img,mask) in enumerate(randoms):
    ax = plt.subplot(4, 4, i + 1)
    img, mask = img.permute(1,2,0).numpy(), mask.permute(1,2,0).numpy()
    mask = colored_depthmap(np.squeeze(mask))
    image_viz = np.hstack([img,mask])
    plt.imshow(image_viz.astype("uint8"))
    plt.axis("off")
```



In 16
```
train_dl = torch.utils.data.DataLoader(train_ds,shuffle=True,batch_size=64)
val_dl = torch.utils.data.DataLoader(val_ds,shuffle=False,batch_size=64)
test_dl = torch.utils.data.DataLoader(test_ds, shuffle=True, batch_size=4)
len(train_dl), len(val_dl), len(test_dl)
```
Out 16
```
(45, 6, 10)
```

In 17
```

class ResnetFF(nn.Module):
    def __init__(self, encoder_name='resnext50_32x4d', in_channels=3, classes=1):
        super().__init__()
        self.encoder = smp.encoders.get_encoder(encoder_name, in_channels=in_channels)
        self.decoder = smp.unet.decoder.UnetDecoder(
            encoder_channels=self.encoder.out_channels,
            decoder_channels=(256, 128, 64, 32),
            n_blocks=(3, 2, 1, 0),
            use_batchnorm=True,
            center=False,
            attention_type=None,  # You can change this to 'scse' or 'cbam' for attention mechanisms
        )
        self.segmentation_head = smp.unet.model.UnetHead(
            in_channels=self.decoder.out_channels[-1], out_channels=classes, activation=None
        )

    def trainable_encoder(self, trainable=True):
        for p in self.encoder.parameters():
            p.requires_grad = trainable

    def forward(self, x):
        features = self.encoder(x)
        decoder_output = self.decoder(*features)
        logits = self.segmentation_head(decoder_output[-1])
        return logits

    def _num_params(self):
        return sum([p.numel() for p in self.parameters() if p.requires_grad])

model = ResnetFF(encoder_name='resnext50_32x4d', in_channels=3, classes=1)
```

In 18
```
class UnNormalize(Normalize):
    def __init__(self,*args,**kwargs):
        mean=(0.485, 0.456, 0.406)
        std=(0.229, 0.224, 0.225)
        new_mean = [-m/s for m,s in zip(mean,std)]
        new_std = [1/s for s in std]
        super().__init__(new_mean, new_std, *args, **kwargs)

@torch.no_grad()
def plot_vals(imgs, preds, targets,n=4,figsize=(6,2),title=''):
    plt.figure(figsize=figsize,dpi=150)
    r = 2 if n == 4 else 8
    c = 2
    for i,idx in enumerate(np.random.randint(0,imgs.size(0),(n,))):
        ax = plt.subplot(r,c,i + 1)
        img,pred,gt = imgs[idx], preds[idx], targets[idx]
        img = UnNormalize()(img)*255.
        img,pred,gt = img.permute(1,2,0).numpy(), pred.permute(1,2,0).numpy(), gt.permute(1,2,0).numpy()
        pred = colored_depthmap(np.squeeze(pred))
        gt = colored_depthmap(np.squeeze(gt))
        image_viz = np.hstack([img,pred,gt])
        plt.imshow(image_viz.astype("uint8"))
        plt.axis("off")
    title = f'{title}\input - output - redweb_out' if len(title)!=0 else 'input - output - redweb_out'
    plt.suptitle(title)
    plt.show()
```

In 19
```
epochs = 5
freeze_epochs = 2
lr = 1e-3

device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
print(device)

metrics = MetricCollection([
    SSIM(data_range=(0,1)),
    MSE()
]).to(device)
train_metrics = metrics.clone()
val_metrics = metrics.clone()

logs = pd.DataFrame()
logs[['loss_train','loss_val','ssim_train','ssim_val','mse_train','mse_val']]=None

model = model.to(device)
model.trainable_encoder(trainable=False)

loss_fn = EdgeguidedRankingLoss()
optim = torch.optim.AdamW(model.parameters(),lr=lr / 25.,weight_decay=0.02)
sched = torch.optim.lr_scheduler.OneCycleLR(optim,max_lr=lr,epochs=epochs,steps_per_epoch=(len(train_dl)))

scaler = GradScaler()
```
```
cuda
Downloading: "https://download.pytorch.org/models/resnext50_32x4d-7cdf4587.pth" to /root/
.cache/torch/hub/checkpoints/resnext50_32x4d-7cdf4587.pth
100%|██████████| 95.8M/95.8M [00:00<00:00, 238MB/s]
```

In 20
```
best_ssim = -1e9
best_epoch = -1

print('training decoder only')

for epoch in tqdm(range(epochs)):

    model.train()

    if epoch == freeze_epochs:
        model.trainable_encoder(trainable=True)
        print('training encoder and decoder both')

    running_loss = 0.
    train_prog = tqdm(train_dl,total=len(train_dl))

    for img, mask in train_prog:

        with autocast():
            img, mask = img.to(device), mask.to(device)
            preds = model(img)

            loss = loss_fn(preds,mask)
            scaler.scale(loss).backward()
            scaler.unscale_(optim)
            nn.utils.clip_grad_norm_(model.parameters(), max_norm=2.0, norm_type=2)
            scaler.step(optim)
```

```
            scaler.step(optim)
            scaler.update()
            sched.step()
            optim.zero_grad()

            running_loss += loss.item()

            train_prog.set_description(f'loss: {loss.item():.3f}')
            train_metrics(preds,mask)

        del img, mask, preds, loss

    m = train_metrics.compute()
    _ssim,_mse = m['StructuralSimilarityIndexMeasure'].cpu().item(), m['MeanSquaredError'].cpu().item()
    logs.loc[epoch,['loss_train','ssim_train','mse_train']] = (running_loss/len(train_dl),_ssim,_mse)
    train_metrics.reset()
    model.eval()

    with torch.no_grad():

        running_loss = 0.

        val_prog = tqdm(val_dl,total=len(val_dl))
        for img, mask in val_prog:

            with autocast():
                img, mask = img.to(device), mask.to(device)
                preds = model(img)
                loss = loss_fn(preds,mask)
                running_loss += loss.item()
                val_prog.set_description(f'loss: {loss.item():.3f}')

                val_metrics(preds, mask)

            del img, mask, preds, loss

        m = val_metrics.compute()
        _ssim,_mse = m['StructuralSimilarityIndexMeasure'].cpu().item(), m['MeanSquaredError'].cpu().item()
        logs.loc[epoch,['loss_val','ssim_val','mse_val']] = (running_loss/len(val_dl),_ssim,_mse)
        val_metrics.reset()

    if _ssim > best_ssim:
        best_ssim = _ssim
        best_epoch = epoch
        sd = model.state_dict()
        torch.save(sd,'ResnetFF.pt')

    print(f"\n\n{logs.tail(1)}\n\n")

    with torch.no_grad():
        with autocast():
            img, mask = next(iter(test_dl))
            img, mask = img.to(device), mask.to(device)
            preds = model(img)
            plot_vals(
                img.cpu(),
                preds.cpu(),
                mask.cpu()
            )

    gc.collect()
    torch.cuda.empty_cache()
```

```
training decoder only
```

0%| | 0/45 [00:00<?, ?it/s]

0%| | 0/45 [00:00<?, ?it/s]

```
/usr/local/lib/python3.10/dist-packages/torch/optim/lr_scheduler.py:136: UserWarning: Detected call of `lr_scheduler.step()` before `optimizer.step()`. In PyTorch 1.1.0 and later, you should call them in the opposite order: `optimizer.step()` before `lr_scheduler.step()`.  Failure to do this will result in PyTorch skipping the first value of the learning rate schedule. See more details at https://pytorch.org/docs/stable/optim.html#how-to-adjust-learning-rate
  warnings.warn("Detected call of `lr_scheduler.step()` before `optimizer.step()`. "
```

0%| | 0/6 [00:00<?, ?it/s]

```
  loss_train  loss_val ssim_train  ssim_val mse_train   mse_val
0   0.648853  0.226287   0.136301  0.185084  0.648853  0.225426
```

0%| | 0/45 [00:00<?, ?it/s]

0%| | 0/6 [00:00<?, ?it/s]

```
  loss_train loss_val ssim_train  ssim_val mse_train   mse_val
1   0.051893  0.04105   0.566209  0.571114  0.051893  0.041102
```


```
training encoder and decoder both
```

0%| | 0/45 [00:00<?, ?it/s]

0%| | 0/6 [00:00<?, ?it/s]

```
  loss_train  loss_val ssim_train  ssim_val mse_train   mse_val
2    0.05496  0.052545   0.641519  0.611616   0.05496  0.053802
```

0%| | 0/45 [00:00<?, ?it/s]

0%| | 0/6 [00:00<?, ?it/s]

```
  loss_train  loss_val ssim_train  ssim_val mse_train   mse_val
3    0.04948  0.039877   0.670676  0.630191   0.04948  0.039895
```

0%| | 0/45 [00:00<?, ?it/s]

0%| | 0/6 [00:00<?, ?it/s]

```
  loss_train  loss_val ssim_train  ssim_val mse_train   mse_val
4   0.044071  0.037185   0.678429  0.635818  0.044071  0.03726
```