computervision-final-prep / lab / Lab 10 (Segmentation)-20251128 / lab9.2_Segmentation_Deep_learning_based.ipynb

limhpone lab 10 9e381c9 · 2 hours ago

663 lines (663 loc) · 34.7 KB

Preview Code Blame Raw

In [2]:

```
import os
import torch
!pip install torch_snippets
from torch_snippets import *
from torchvision import transforms
from sklearn.model_selection import train_test_split
from torchvision.models import vgg16_bn
import cv2 as cv
from tqdm import tqdm
```

```
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```

In [ ]:

```
## DOWNLOAD YOUR OWN DATASET AND TRY TO FIT

# if not os.path.exists('dataset1'):
#     !wget -q https://www.dropbox.com/s/0pigmmmynbf9xwq/dataset1.zip 'need
#     !unzip -q dataset1.zip
#     !rm dataset1.zip
#     !pip install -q pytorch_model_summary
```

In [3]:

```
# Create Params dictionary
class Params(object):
    def __init__(self, batch_size, test_batch_size, epochs, lr, seed, cuda,
        self.batch_size = batch_size
        self.test_batch_size = test_batch_size
        self.epochs = epochs
        self.lr = lr
        self.seed = seed
        self.cuda = 'cuda' if cuda and torch.cuda.is_available() else 'cpu'
        self.log_interval = log_interval

# Configure args
args = Params(8, 2, 5, 1e-3, 1, True, 10)
```

In [4]:

```
def get_transforms():
  return transforms.Compose([
                             transforms.ToTensor(),
                             transforms.Normalize(
                                 [0.485, 0.456, 0.406],
                                 [0.229, 0.224, 0.225]
                                 )
                             ])
```

In [5]:

```
from torch.utils.data import Dataset, DataLoader

class SegmentationData(Dataset):
    def __init__(self, split):
        self.items = stems(f'dataset1/images_prepped_{split}')
        self.split = split                                          # Store the s

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

    def __getitem__(self, idx):
        # Retrieve an image and its corresponding mask based on the index 'i
        image = read(f'dataset1/images_prepped_{self.split}/{self.items[idx]
        image = cv.resize(image, (224,224))

        mask = read(f'dataset1/annotations_prepped_{self.split}/{self.items[
```

```
        mask = cv.resize(mask, (224,224))

        return image, mask

    def choose(self): return self[randint(len(self))]  # Randomly select and

    def collate_fn(self, batch):
        # Custom collate function to combine a batch of images and masks
        # Unzip the batch into images and masks
        ims, masks = list(zip(*batch))

        # Transform the images: Normalize and convert to tensor, then stack

        ims = torch.cat([get_transforms()(im.copy()/255.)[None] for im in im

        # Convert masks to tensors, stack them into a single tensor and cast

        ce_masks = torch.cat([torch.Tensor(mask[None]) for mask in masks]).l

        return ims, ce_masks
```

In [ ]:

```
def get_dataloaders():
    trn_ds = SegmentationData('train')
    val_ds = SegmentationData('test')

    trn_dl = DataLoader(trn_ds, batch_size=args.batch_size, shuffle=True, co
    val_dl = DataLoader(val_ds, batch_size=args.test_batch_size, shuffle=Tru

    return trn_dl, val_dl
```

In [ ]:

```
trn_dl, val_dl = get_dataloaders()
```

U Net Architecture

- U-Net is a convolutional neural network architecture primarily used for image segmentation tasks. It consists of a contracting path (encoder) that captures context and a symmetric expanding path (decoder) that enables precise localization.

In [6]:

```
def conv(in_channels, out_channels):
    return nn.Sequential(
        nn.Conv2d(in_channels, out_channels, kernel_size=3, stride=1, paddin
        nn.BatchNorm2d(out_channels),
        nn.ReLU(inplace=True)
    )
```

In [7]:

```
def up_conv(in_channels, out_channels):
    return nn.Sequential(
        nn.ConvTranspose2d(in_channels, out_channels, kernel_size=2, stride=
        nn.ReLU(inplace=True)
    )
```

In [8]:

```
import torch.nn as nn
class UNet(nn.Module):
    def __init__(self, pretrained=True, out_channels=12):
        super().__init__()

        self.encoder = vgg16_bn(pretrained=pretrained).features
        self.block1 = nn.Sequential(*self.encoder[:6])
        self.block2 = nn.Sequential(*self.encoder[6:13])
        self.block3 = nn.Sequential(*self.encoder[13:20])
        self.block4 = nn.Sequential(*self.encoder[20:27])
        self.block5 = nn.Sequential(*self.encoder[27:34])

        self.bottleneck = nn.Sequential(*self.encoder[34:])
        self.conv_bottleneck = conv(512, 1024)

        self.up_conv6 = up_conv(1024, 512)
        self.conv6 = conv(512 + 512, 512)
        self.up_conv7 = up_conv(512, 256)
        self.conv7 = conv(256 + 512, 256)
        self.up_conv8 = up_conv(256, 128)
        self.conv8 = conv(128 + 256, 128)
        self.up_conv9 = up_conv(128, 64)
        self.conv9 = conv(64 + 128, 64)
        self.up_conv10 = up_conv(64, 32)
        self.conv10 = conv(32 + 64, 32)
        self.conv11 = nn.Conv2d(32, out_channels, kernel_size=1)

    def forward(self, x):
        # Contractive Path
        block1 = self.block1(x)
        block2 = self.block2(block1)
        block3 = self.block3(block2)
        block4 = self.block4(block3)
        block5 = self.block5(block4)

        bottleneck = self.bottleneck(block5)
        x = self.conv_bottleneck(bottleneck)
        # Expansive Path
        x = self.up_conv6(x)
        x = torch.cat([x, block5], dim=1)
        x = self.conv6(x)

        x = self.up_conv7(x)
        x = torch.cat([x, block4], dim=1)
        x = self.conv7(x)

        x = self.up_conv8(x)
        x = torch.cat([x, block3], dim=1)
        x = self.conv8(x)

        x = self.up_conv9(x)
```

```
        x = torch.cat([x, block2], dim=1)
        x = self.conv9(x)

        x = self.up_conv10(x)
        x = torch.cat([x, block1], dim=1)
        x = self.conv10(x)

        x = self.conv11(x)

        return x
```

Steps

Initializes the U-Net model.

Takes two parameters:

```
- pretrained: A boolean indicating whether to use a
pretrained VGG16 model.
- out_channels: The number of output channels for the final
segmentation map (e.g., 12 classes for segmentation).
```

Encoder (Contractive Path)

```
- The encoder part uses the features from a VGG16 model with
batch normalization (vgg16_bn).
- The encoder is divided into five blocks, each consisting of
several convolutional layers that progressively reduce the
spatial dimensions while increasing the number of feature
channels.
```

Bottleneck

```
- The bottleneck section takes the deepest layers of the
encoder.
- A convolution layer `conv_bottleneck` is applied to
increase the number of feature channels from 512 to 1024,
allowing the network to learn more complex features.
```

Decoder (Expansive Path)

The decoder consists of up-convolution (or transposed convolution) layers followed by concatenation with corresponding encoder features to retain spatial information:

```
- Each up_conv layer increases the spatial dimensions
(upsampling).
- The output of each up-convolution is concatenated with the
corresponding feature map from the encoder (skip
connections).
- This helps the model learn both high-level features from
```

- This helps the model learn both high-level features from deeper layers and low-level features from shallower layers.
- Finally, conv11 reduces the number of channels to out_channels (e.g., for multi-class segmentation).

In [9]:
```
vgg16_bn
```

Out[9]:
```
<function torchvision.models.vgg.vgg16_bn(*, weights: Optional[torchvision.m
odels.vgg.VGG16_BN_Weights] = None, progress: bool = True, **kwargs: Any) ->
torchvision.models.vgg.VGG>
```

In [10]:
```
ce = nn.CrossEntropyLoss()   # Applies softmax to output logits --> converts

def UnetLoss(preds, targets):
    ce_loss = ce(preds, targets)
    acc = (torch.max(preds, 1)[1] == targets).float().mean()
    #  (torch.max(preds, 1)[1] returns the indices of the maximum values alo
    #  The 1 indicates that we're looking along the columns (the class dimen
    #  if preds class == targets return 1 --> change to float --> take mean
    return ce_loss, acc
```

In [11]:
```
class TrainEngine():
    def train_batch(model, data, optimizer, criterion):
        model.train()

        ims, ce_masks = data
        _masks = model(ims)
        optimizer.zero_grad()

        loss, acc = criterion(_masks, ce_masks)
        loss.backward()
        optimizer.step()

        return loss.item(), acc.item()

    @torch.no_grad()
    def validate_batch(model, data, criterion):
        model.eval()

        ims, masks = data
        _masks = model(ims)

        loss, acc = criterion(_masks, masks)

        return loss.item(), acc.item()
```

In [12]:
```
from torch import optim
def make_model():
    model = UNet().to(args.cuda)
    criterion = UnetLoss
    optimizer = optim.Adam(model.parameters(), lr=args.lr)
    return model, criterion, optimizer
```

In [13]:
```
model, criterion, optimizer = make_model()
# Total num. of parametes
num_params = sum(p.numel() for p in model.parameters())
# Total num. of "trainable" parameters
num_trainable_params = sum(p.numel() for p in model.parameters() if p.requir
print(f'Total num. of parametes: {num_params}')
print(f'Total num. of Trainable parametes: {num_trainable_params}')
```

```
/home/jupyter-dsai-st123439/.local/lib/python3.12/site-packages/torchvision/mo
dels/_utils.py:208: UserWarning: The parameter 'pretrained' is deprecated sinc
e 0.13 and may be removed in the future, please use 'weights' instead.
  warnings.warn(
/home/jupyter-dsai-st123439/.local/lib/python3.12/site-packages/torchvision/mo
dels/_utils.py:223: UserWarning: Arguments other than a weight enum or `None`
for 'weights' are deprecated since 0.13 and may be removed in the future. The
current behavior is equivalent to passing `weights=VGG16_BN_Weights.IMAGENET1K
_V1`. You can also use `weights=VGG16_BN_Weights.DEFAULT` to get the most up-t
o-date weights.
  warnings.warn(msg)
Downloading: "https://download.pytorch.org/models/vgg16_bn-6c64b313.pth" to /h
ome/jupyter-dsai-st123439/.cache/torch/hub/checkpoints/vgg16_bn-6c64b313.pth
100%|██████████| 528M/528M [00:47<00:00, 11.6MB/s]
Total num. of parametes: 29311308
Total num. of Trainable parametes: 29311308
```