Vgg

笔记本:	深度学习-图像分类篇		
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URL:	about:blank		

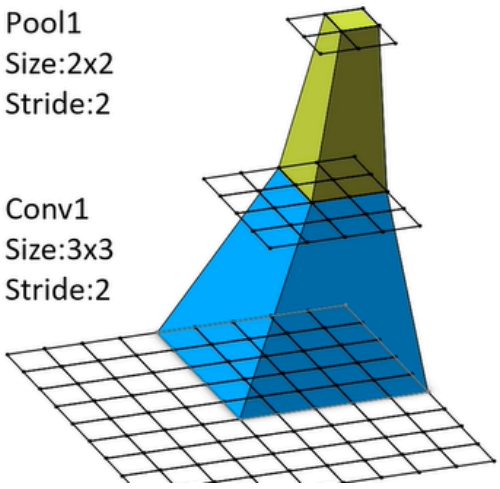
1、创新之处:
使用多个3*3的卷积核来代替5*5或者7*7卷积，可以减少参数。

使用7x7卷积核所需参数，与堆叠三个3x3卷积核所需参数(假设输入输出channel为C)

$$7\times7\times C\times C=49C^2$$

$$3\times3\times C\times C+3\times3\times C\times C+3\times3\times C\times C=27C^2$$

2、感受野的概念:
如本图中输出特征中的一个单元，就对应输入特征中的一个5*5的区域的大小。



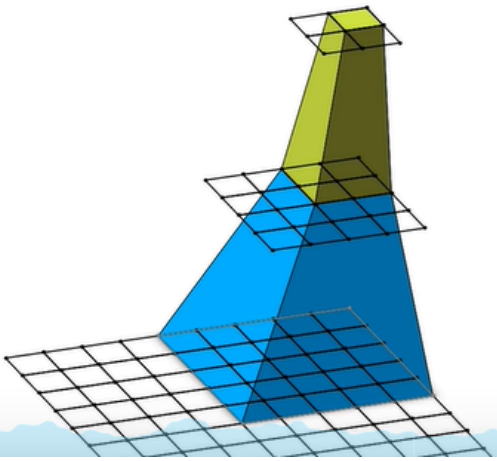
感受野计算公式:

$$F(i)=(F(i+1)-1)\times Stride+Ksize$$

F(i)为第i层感受野，
Stride为第i层的步距，
Ksize为卷积核或池化核尺寸

Feature map: F = 1
Pool1: F = (1 - 1) x 2 + 2 = 2
Conv1: F = (2 - 1) x 2 + 3 = 5

三个3*3的卷积核与1个7*7的卷积核拥有相同的感受野。（vgg论文中s=2，k=3）



感受野计算公式:

$$F(i)=(F(i+1)-1)\times Stride+Ksize$$

F(i)为第i层感受野，
Stride为第i层的步距，
Ksize为卷积核或采样核尺寸

Feature map: F = 1
Conv3x3(3): F = (1 - 1) x 1 + 3 = 3
Conv3x3(2): F = (3 - 1) x 1 + 3 = 5
Conv3x3(1): F = (5 - 1) x 1 + 3 = 7

感受野就是输出特征中的一个元素对应输入层上的区域的大小。

3、代码:

①模型代码：

```
import torch.nn as nn
import torch


# official pretrain weights
model_urls = {
    'vgg11': 'https://download.pytorch.org/models/vgg11-bbd30ac9.pth',
    'vgg13': 'https://download.pytorch.org/models/vgg13-c768596a.pth',
    'vgg16': 'https://download.pytorch.org/models/vgg16-397923af.pth',
    'vgg19': 'https://download.pytorch.org/models/vgg19-dcbb9e9d.pth'
}




class VGG(nn.Module):
    def __init__(self, features, num_classes=1000, init_weights=False):
        super(VGG, self).__init__()
        self.features = features
        self.classifier = nn.Sequential(
            nn.Linear(512*7*7, 4096),
            nn.ReLU(True),
            nn.Dropout(p=0.5),
            nn.Linear(4096, 4096),
            nn.ReLU(True),
            nn.Dropout(p=0.5),
            nn.Linear(4096, num_classes)
        )
        if init_weights:
            self._initialize_weights()


    def forward(self, x):
        # N x 3 x 224 x 224
        x = self.features(x)
        # N x 512 x 7 x 7
        x = torch.flatten(x, start_dim=1)
        # N x 512*7*7
        x = self.classifier(x)
        return x


    def _initialize_weights(self):
        for m in self.modules():
            if isinstance(m, nn.Conv2d):
                # nn.init.kaiming_normal_(m.weight, mode='fan_out',
nonlinearity='relu')
                nn.init.xavier_uniform_(m.weight)
                if m.bias is not None:
                    nn.init.constant_(m.bias, 0)
            elif isinstance(m, nn.Linear):
                nn.init.xavier_uniform_(m.weight)
                # nn.init.normal_(m.weight, 0, 0.01)
                nn.init.constant_(m.bias, 0)

#cfg 是一个列表类型
def make_features(cfg: list):
```

```
    layers = []
    in_channels = 3
    for v in cfg:
        if v == "M":
            layers += [nn.MaxPool2d(kernel_size=2, stride=2)]
        else:
            conv2d = nn.Conv2d(in_channels, v, kernel_size=3, padding=1)
            layers += [conv2d, nn.ReLU(True)]
            in_channels = v
    return nn.Sequential(*layers) #*可理解为解包操作，把layers列表中的元素拆分成一个个元素
#nn.Sequential 可以接受两种类型
①比如model = nn.Sequential(
          nn.Conv2d(1,20,5),
          nn.ReLU(),
          nn.Conv2d(20,64,5),
          nn.ReLU()
        )

②model = nn.Sequential(OrderedDict([
          ('conv1', nn.Conv2d(1,20,5)),
          ('relu1', nn.ReLU()),
          ('conv2', nn.Conv2d(20,64,5)),
          ('relu2', nn.ReLU())
        ]))

cfgs = {
    'vgg11': [64, 'M', 128, 'M', 256, 256, 'M', 512, 512, 'M', 512, 512, 'M'],
    'vgg13': [64, 64, 'M', 128, 128, 'M', 256, 256, 'M', 512, 512, 'M', 512, 512, 'M'],
    'vgg16': [64, 64, 'M', 128, 128, 'M', 256, 256, 256, 'M', 512, 512, 512, 'M', 512, 512, 512, 'M'],
    'vgg19': [64, 64, 'M', 128, 128, 'M', 256, 256, 256, 256, 'M', 512, 512, 512, 512, 'M', 512, 512, 512, 512, 'M'],
}



def vgg(model_name="vgg16", **kwargs):
    assert model_name in cfgs, "Warning: model number {} not in cfgs dict!".format(model_name)
    cfg = cfgs[model_name]
    model = VGG(make_features(cfg), **kwargs)
    return model
```

②训练：

```
import os
import sys
import json
import torch, gc


import torch
import torch.nn as nn
from torchvision import transforms, datasets
```

```
import torch.optim as optim
from tqdm import tqdm


from model import vgg




def main():
    device = torch.device("cuda:0" if torch.cuda.is_available() else
"cpu")
    print("using {} device.".format(device))


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


    data_transform = {
        "train": transforms.Compose([transforms.RandomResizedCrop(224),
                                     transforms.RandomHorizontalFlip(),
                                     transforms.ToTensor(),
                                     transforms.Normalize((0.5, 0.5,
0.5), (0.5, 0.5, 0.5))]),
        "val": transforms.Compose([transforms.Resize((224, 224)),
                                   transforms.ToTensor(),
                                   transforms.Normalize((0.5, 0.5, 0.5),
(0.5, 0.5, 0.5))])}


    data_root = os.path.abspath(os.path.join(os.getcwd(), "../.."))  #
get data root path
    image_path = os.path.join(data_root, "data_set", "flower_data")  #
flower data set path
    assert os.path.exists(image_path), "{} path does not
exist.".format(image_path)
    train_dataset = datasets.ImageFolder(root=os.path.join(image_path,
"train"),
                                         transform=data_transform["train"])
    train_num = len(train_dataset)


    # {'daisy':0, 'dandelion':1, 'roses':2, 'sunflower':3, 'tulips':4}
    flower_list = train_dataset.class_to_idx
    cla_dict = dict((val, key) for key, val in flower_list.items())
    # write dict into json file
    json_str = json.dumps(cla_dict, indent=4)
    with open('class_indices.json', 'w') as json_file:
        json_file.write(json_str)


    batch_size = 4
    nw = 0  # number of workers
    print('Using {} dataloader workers every process'.format(nw))


    train_loader = torch.utils.data.DataLoader(train_dataset,
```

```
                                               batch_size=batch_size,
shuffle=True,
                                               num_workers=nw)


    validate_dataset =
datasets.ImageFolder(root=os.path.join(image_path, "val"),
                                            transform=data_transform["val"])
    val_num = len(validate_dataset)
    validate_loader = torch.utils.data.DataLoader(validate_dataset,
                                                  batch_size=batch_size,
shuffle=False,
                                                  num_workers=nw)
    print("using {} images for training, {} images for
validation.".format(train_num,
                                                                        val_num))


    # test_data_iter = iter(validate_loader)
    # test_image, test_label = test_data_iter.next()


    model_name = "vgg11"
    net = vgg(model_name=model_name, num_classes=5, init_weights=True)
    net.to(device)
    loss_function = nn.CrossEntropyLoss()
    optimizer = optim.Adam(net.parameters(), lr=0.0001)


    epochs = 10
    best_acc = 0.0
    save_path = './{}Net.pth'.format(model_name)
    train_steps = len(train_loader)
    for epoch in range(epochs):
        # train
        net.train()
        running_loss = 0.0
        train_bar = tqdm(train_loader, file=sys.stdout)
        for step, data in enumerate(train_bar):
            images, labels = data
            optimizer.zero_grad()
            outputs = net(images.to(device))
            loss = loss_function(outputs, labels.to(device))
            loss.backward()
            optimizer.step()


            # print statistics
            running_loss += loss.item()


            train_bar.desc = "train epoch[{}/{}] loss:
{:.3f}".format(epoch + 1,
                                                                    epochs,
                                                                    loss)


        # validate
```

```
        net.eval()
        acc = 0.0  # accumulate accurate number / epoch
        with torch.no_grad():
            val_bar = tqdm(validate_loader, file=sys.stdout)
            for val_data in val_bar:
                val_images, val_labels = val_data
                outputs = net(val_images.to(device))
                predict_y = torch.max(outputs, dim=1)[1]
                acc += torch.eq(predict_y,
val_labels.to(device)).sum().item()


        val_accurate = acc / val_num
        print('[epoch %d] train_loss: %.3f  val_accuracy: %.3f' %
              (epoch + 1, running_loss / train_steps, val_accurate))


        if val_accurate > best_acc:
            best_acc = val_accurate
            torch.save(net.state_dict(), save_path)


    print('Finished Training')




if __name__ == '__main__':
    main()
```

③预测：

```
# 时间：2023/4/5 17:38
# cky
import os
import json
import torch
from PIL import Image
from torchvision import transforms
import matplotlib.pyplot as plt


from model import vgg




def main():
    device = torch.device("cuda:0" if torch.cuda.is_available() else
"cpu")


    data_transform = transforms.Compose(
        [transforms.Resize((224, 224)),
         transforms.ToTensor(),
         transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))])
```

```
    # load image
    img_path = "../tulip.jpg"
    assert os.path.exists(img_path), "file: '{}' dose not
exist.".format(img_path)
    img = Image.open(img_path)
    plt.imshow(img)
    # [N, C, H, W]
    img = data_transform(img)
    # expand batch dimension
    img = torch.unsqueeze(img, dim=0)


    # read class_indict
    json_path = './class_indices.json'
    assert os.path.exists(json_path), "file: '{}' dose not
exist.".format(json_path)


    with open(json_path, "r") as f:
        class_indict = json.load(f)


    # create model
    model = vgg(model_name="vgg16", num_classes=5).to(device)
    # load model weights
    weights_path = "./vgg16Net.pth"
    assert os.path.exists(weights_path), "file: '{}' dose not
exist.".format(weights_path)
    model.load_state_dict(torch.load(weights_path, map_location=device))


    model.eval()
    with torch.no_grad():
        # predict class
        output = torch.squeeze(model(img.to(device))).cpu()
        predict = torch.softmax(output, dim=0)
        predict_cla = torch.argmax(predict).numpy()


    print_res = "class: {}   prob:
{:.3}".format(class_indict[str(predict_cla)],
                                                 predict[predict_cla].numpy())
    plt.title(print_res)
    for i in range(len(predict)):
        print("class: {:10}   prob: {:.3}".format(class_indict[str(i)],
                                                  predict[i].numpy()))
    plt.show()




if __name__ == '__main__':
    main()
```