计算机视觉第六次作业

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code:https://github.com/NICHOLASFATHER/dongxu_master_degree/blob/master/W6_MNIST_FC.ipynb

1.问题描述

在W6_MNIST_FC.ipynb基础上，增加卷积层结构/增加 dropout或者BN技术等，训练出尽可能高的MNIST分类效果。

2.超参数设置与数据集构建

```
torch.manual_seed(1)

EPOCH = 8
LR = 0.001
batch_size = 128
DOWNLOAD_MNIST = True
Device = 'cuda' if torch.cuda.is_available() else 'cpu'

train_data = torchvision.datasets.MNIST(root='./mnist/', train=True,
transform=torchvision.transforms.ToTensor(),
                                        download=DOWNLOAD_MNIST)
test_data = torchvision.datasets.MNIST(root='./mnist/', train=False,
transform=torchvision.transforms.ToTensor(),
                                        download=DOWNLOAD_MNIST)

train_dataloader = DataLoader(train_data, batch_size=batch_size, shuffle=True,
pin_memory=True)
test_dataloader = DataLoader(test_data, batch_size=batch_size, shuffle=False,
pin_memory=True)
```

3.模型搭建

```
# baseline
class FC_1(nn.Module):
    def __init__(self):
        super(FC_1, self).__init__()
        self.fc1 = nn.Linear(784, 256)
        self.fc2 = nn.Linear(256, 10)
#         self.fc3 = nn.Linear(10, 10)

    def forward(self, x):
        x = x.view(x.size(0), -1)  # 调整数据维度
        x = self.fc1(x)
        x = F.relu(x)
```

```
        x = self.fc2(x)
#         x = F.relu(x)
#         x = self.fc3(x)

        output = x
        return output

# baseline plus
class FC_2(nn.Module):
    def __init__(self):
        super(FC_2, self).__init__()
        self.fc1 = nn.Linear(784, 256)
        self.fc2 = nn.Linear(256, 10)
        self.fc3 = nn.Linear(10, 10)

    def forward(self, x):
        x = x.view(x.size(0), -1)  # 调整数据维度
        x = self.fc1(x)
        x = F.relu(x)
        x = self.fc2(x)
        x = F.relu(x)
        x = self.fc3(x)

        output = x
        return output


class Conv_net_base(nn.Module):
    def __init__(self):
        super(Conv_net_base, self).__init__()
        self.net = nn.Sequential(
            nn.Conv2d(1, 32, 5, padding=2),  # h,w保持不变
            nn.MaxPool2d(2),
            nn.ReLU(),
            nn.Conv2d(32, 64, 5, padding=2),
            nn.MaxPool2d(2),
            nn.ReLU(),
            nn.Flatten(),
            nn.Linear(64*7*7, 10)
        )

    def forward(self, x):
        x = self.net(x)
        return x


class Conv_net_plus(nn.Module):
    def __init__(self):
        super(Conv_net_plus, self).__init__()
        self.net = nn.Sequential(
            nn.Conv2d(1, 16, 5, padding=2),  # h,w保持不变
            nn.MaxPool2d(2),
            nn.ReLU(),
            nn.Conv2d(16, 32, 5, padding=2),  # h,w保持不变
            nn.MaxPool2d(2),
```

```
            nn.ReLU(),
            nn.Conv2d(32, 64, 5, padding=2),
            nn.Flatten(),
            nn.ReLU(),
            nn.Linear(64*7*7, 512),
            nn.ReLU(),
            nn.Linear(512, 10)
        )

    def forward(self, x):
        x = self.net(x)
        return x


class Conv_net_plus_bn(nn.Module):
    def __init__(self):
        super(Conv_net_plus_bn, self).__init__()
        self.net = nn.Sequential(
            nn.Conv2d(1, 16, 5, padding=2),  # h,w保持不变
            nn.BatchNorm2d(16),
            nn.MaxPool2d(2),
            nn.ReLU(),

            nn.Conv2d(16, 32, 5, padding=2),  # h,w保持不变
            nn.BatchNorm2d(32),
            nn.MaxPool2d(2),
            nn.ReLU(),

            nn.Conv2d(32, 64, 5, padding=2),
            nn.BatchNorm2d(64),
            nn.ReLU(),

            nn.Flatten(),
            nn.Linear(64*7*7, 512),
            nn.BatchNorm1d(512),
            nn.ReLU(),
            nn.Linear(512, 10)
        )

    def forward(self, x):
        x = self.net(x)
        return x



class Conv_net_plus_bn_dropout(nn.Module):
    def __init__(self):
        super(Conv_net_plus_bn_dropout, self).__init__()
        self.net = nn.Sequential(
            nn.Conv2d(1, 16, 5, padding=2),  # h,w保持不变
            nn.BatchNorm2d(16),
            nn.MaxPool2d(2),
            torch.nn.Dropout2d(p=0.1),
            nn.ReLU(),
```

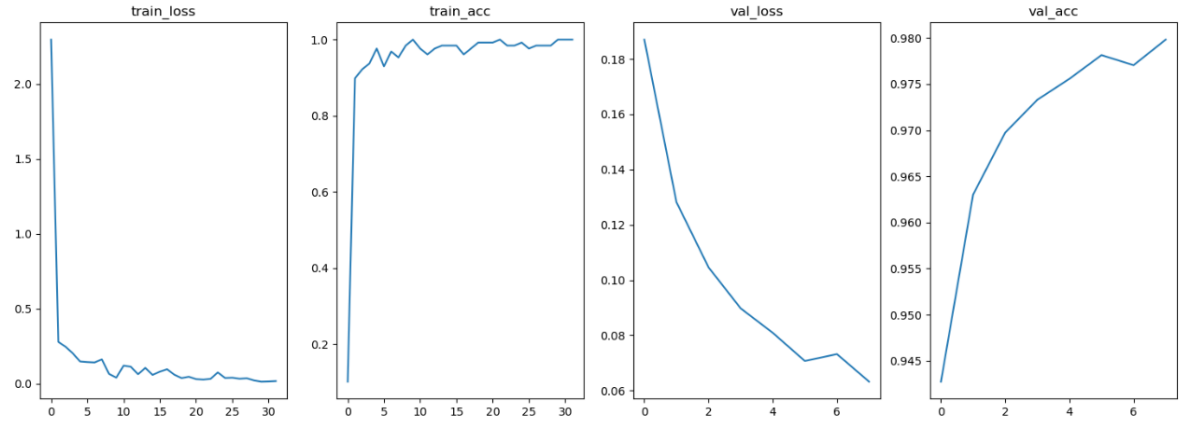
```
            nn.Conv2d(16, 32, 5, padding=2),  # h,w保持不变
            nn.BatchNorm2d(32),
            nn.MaxPool2d(2),
            torch.nn.Dropout2d(p=0.1),
            nn.ReLU(),

            nn.Conv2d(32, 64, 5, padding=2),
            nn.BatchNorm2d(64),
            torch.nn.Dropout2d(p=0.1),
            nn.ReLU(),

            nn.Flatten(),
            nn.Linear(64*7*7, 512),
            nn.BatchNorm1d(512),
            torch.nn.Dropout(0.2),
            nn.ReLU(),
            nn.Linear(512, 10)
        )

    def forward(self, x):
        x = self.net(x)
        return x
```

4.训练与可视化

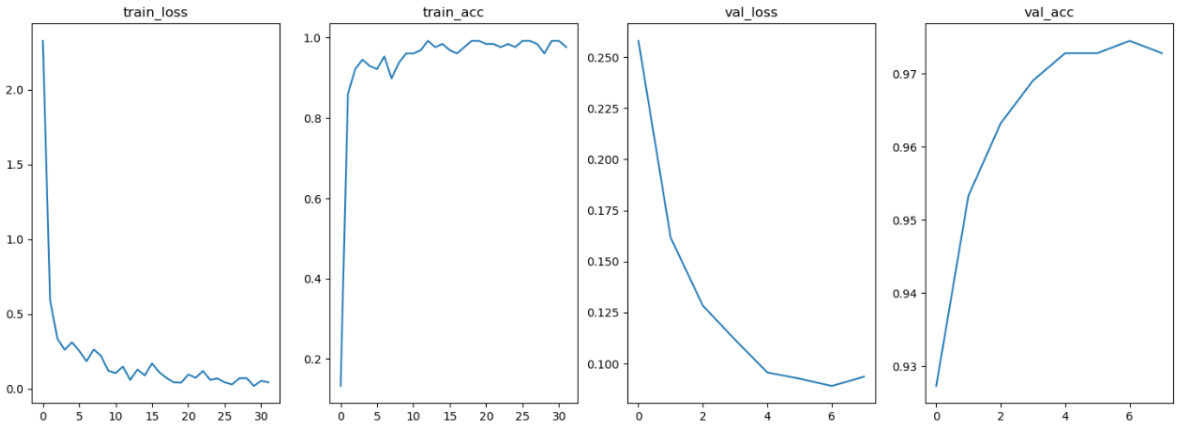
```
def train(network, save_name):

    optimizer = torch.optim.Adam(network.parameters(), lr=LR)
    # loss_func = nn.MSELoss()
    loss_func = nn.CrossEntropyLoss()
    best_val_acc = 0
    train_loss = []
    train_acc = []
    val_loss = []
    val_acc = []

    for epoch in range(EPOCH):
        loss_sum = 0
        acc_sum = 0
        print(f'EPOCH{epoch}\n-----------------')
        size = len(train_dataloader.dataset)

        network.train()
        for batch, item in enumerate(train_dataloader):

            # if batch == 4:  # 删除
            #     break

            pics, labels = item
            pics = pics.to(Device)
            labels = labels.to(Device)

            output = network(pics)
            loss = loss_func(output, labels)
```

```
            loss.backward()
            optimizer.step()
            optimizer.zero_grad()
            if batch % 150 == 0:
                loss_value, current = loss.item(), batch*len(pics)
                train_loss.append(loss_value)
                acc = (output.argmax(dim=1) == labels).sum().item() / len(pics)
                train_acc.append(acc)
                print(f'loss:{loss_value:>7f}  accuracy:{acc:>7f}
[{current:>5d}/{size:>5d}]')


        with torch.no_grad():
            network.eval()
            for item in test_dataloader:
                pics, labels = item
                pics = pics.to(Device)
                labels = labels.to(Device)
                output = network(pics)  # (bs, 10)
                loss = loss_func(output, labels)
                loss_sum += loss.item()
                acc = (output.argmax(dim=1) == labels).sum().item() / len(pics)
                acc_sum += acc
            current_val_acc = acc_sum/len(test_dataloader)
            val_loss.append(loss_sum/len(test_dataloader))
            val_acc.append(current_val_acc)
            if current_val_acc > best_val_acc:
                best_val_acc = current_val_acc
                torch.save(network.state_dict(), f'{save_name}_model.pth')
            print(f'Test\nloss:{loss_sum/len(test_dataloader):>7f}  accuracy:
{current_val_acc:>5f}')

    names = ['train_loss', 'train_acc', 'val_loss', 'val_acc']
    plt.figure(figsize=(18, 6))
    plt.subplot(141)
    plt.plot(train_loss)
    plt.title(names[0])
    plt.subplot(142)
    plt.plot(train_acc)
    plt.title(names[1])
    plt.subplot(143)
    plt.plot(val_loss)
    plt.title(names[2])
    plt.subplot(144)
    plt.plot(val_acc)
    plt.title(names[3])
    plt.figure(figsize=(18, 6))
    plt.plot(val_acc)
    plt.title(names[3])
    return best_val_acc
```

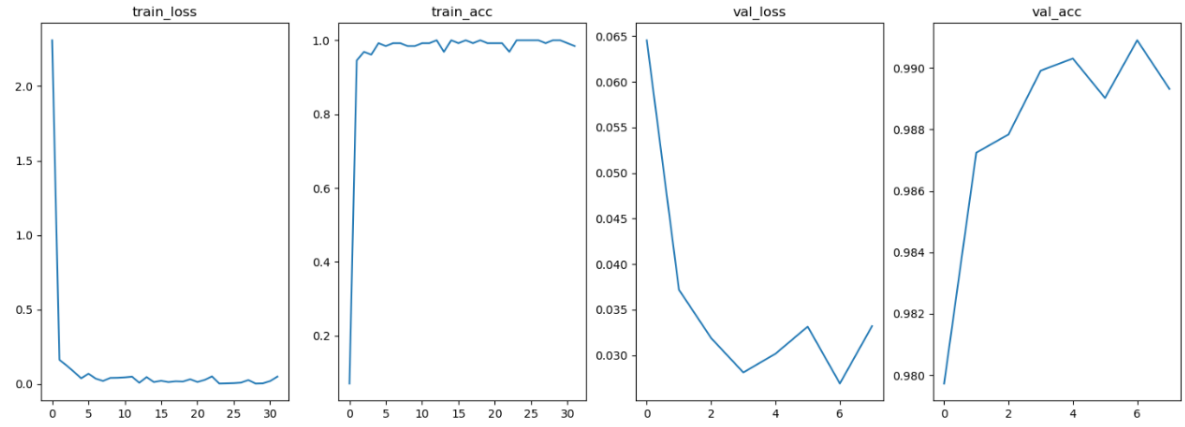
第一组：



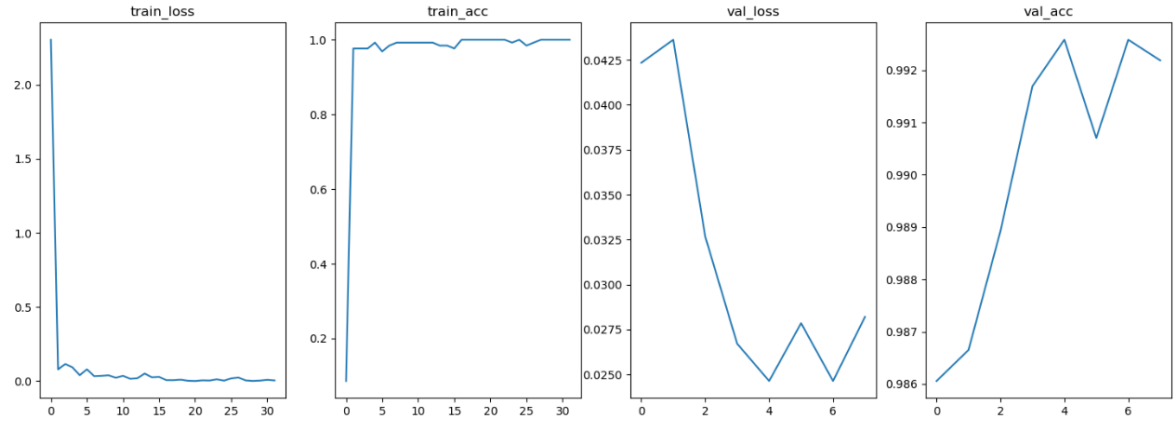
第二组：



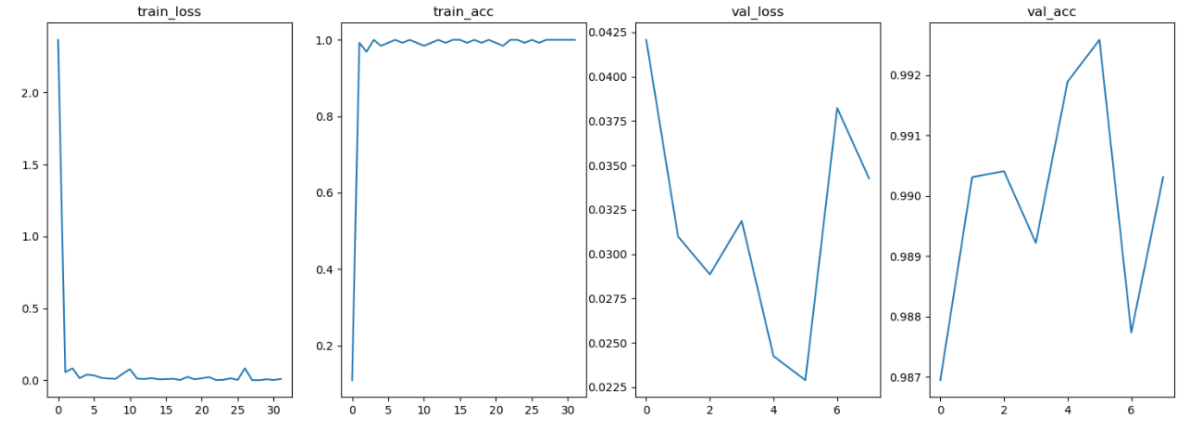
第三组：



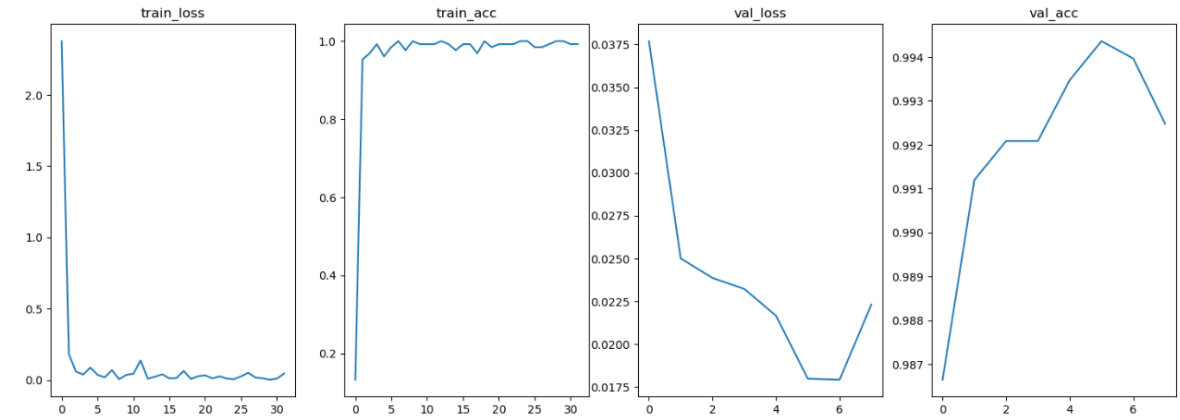
第四组：



第五组：



第六组：



5.实验结果及分析

网络架构	测试准确率
base_fc（两层全连接）	0.9798
plus_fc（三层全连接）	0.9744
conv_base（两层CNN）	0.9909
conv_plus（三层CNN）	0.9925
conv_plus_bn（增加bacth_norm）	0.9925

网络架构	测试准确率
conv_plus_bn_dropout（增加dropout）	**0.9943**

可见，通过加深网络层数、加入batch_norm技术和dropout正则化，可以有效地提高准确率。

6.思考与改进

- 受限于时间和计算资源，本次作业设置epoch为8，而且使用了较大的batch_size（为了节省时间）。这样做可能使得模型没有被充分训练，因此可以从这两个超参入手改进。
- 可以考虑加入动态学习率调节，如余弦衰减，可能会让模型在更短的时间内收敛。