SL Project - Scratch

December 14, 2022

[1]:
```python
import torchvision
import torch
import torch.nn as nn
from torchsummary import summary
```

[2]:
```python
from torchvision import transforms, datasets
import matplotlib.pyplot as plt
from tqdm import tqdm
```

[3]:
```python
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

[4]:
```python
sns.set_style("darkgrid")
```

[5]:
```python
transform = transforms.Compose([
    transforms.ToTensor()
])
```

[6]:
```python
PATH = "../../data/asl_alphabet_train/"
```

[7]:
```python
dataset = datasets.ImageFolder(PATH, transform=transform)
```

[8]:
```python
n = len(dataset)
```

[9]:
```python
torch.manual_seed(1)
indices = torch.randperm(n)
```

[10]:
```python
test_proportion = 0.2 # 20 percent of data used for testing
test_size = int(n * test_proportion)
```

[11]:
```python
train_dataset = torch.utils.data.Subset(dataset, indices[test_size:])
test_dataset = torch.utils.data.Subset(dataset, indices[:test_size])
```

[12]:
```python
len(train_dataset)
```

[12]: 69600

[13]:
```
len(test_dataset)
```

[13]: 17400

[14]:
```
DEVICE = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
```

[15]:
```
train_dataloader = torch.utils.data.DataLoader(dataset=train_dataset,
                                               batch_size=32,
                                               shuffle=True,
                                               num_workers=4)

test_dataloader = torch.utils.data.DataLoader(dataset=test_dataset,
                                              batch_size=32,
                                              shuffle=False,
                                              num_workers=4)
```

[16]:
```
classes = dataset.classes
```

[17]:
```
class ASLNeuralNet(nn.Module):

    def __init__(self, num_classes=1000):
        super(ASLNeuralNet, self).__init__()
        # declare all the layers for feature extraction
        self.features = nn.Sequential(
            nn.Conv2d(in_channels=3, out_channels=64, kernel_size=11, stride=4,␣
 ↪padding=2),
            nn.ReLU(inplace=True),
            nn.MaxPool2d(kernel_size=2, stride=2),
            nn.Conv2d(in_channels=64, out_channels=192, kernel_size=3,␣
 ↪padding=2),
            nn.ReLU(inplace=True),
            nn.MaxPool2d(kernel_size=2, stride=2),
            nn.Conv2d(in_channels=192, out_channels=256, kernel_size=3,␣
 ↪padding=1),
            nn.ReLU(inplace=True),
            nn.MaxPool2d(kernel_size=2, stride=2),)
        # declare all the layers for classification
        self.classifier = nn.Sequential(
            nn.Linear(6 * 6 * 256, 200),
            nn.ReLU(inplace=True),
            nn.Dropout(p=0.5),
            nn.Linear(200, 500),
            nn.ReLU(inplace=True),
            nn.Linear(500, num_classes),)

    def forward(self, x):
        # apply the feature extractor in the input
```

```
        x = self.features(x)
        # squeeze the spatial dimensions in one
        x = x.view(-1, 6 * 6 * 256)
        # classify the images
        x = self.classifier(x)
        return x
```

[18]:
```
model = ASLNeuralNet(num_classes=29).to(DEVICE)
```

[19]:
```
# sanity check
print(model)
```

```
ASLNeuralNet(
  (features): Sequential(
    (0): Conv2d(3, 64, kernel_size=(11, 11), stride=(4, 4), padding=(2, 2))
    (1): ReLU(inplace=True)
    (2): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1,
ceil_mode=False)
    (3): Conv2d(64, 192, kernel_size=(3, 3), stride=(1, 1), padding=(2, 2))
    (4): ReLU(inplace=True)
    (5): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1,
ceil_mode=False)
    (6): Conv2d(192, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (7): ReLU(inplace=True)
    (8): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1,
ceil_mode=False)
  )
  (classifier): Sequential(
    (0): Linear(in_features=9216, out_features=200, bias=True)
    (1): ReLU(inplace=True)
    (2): Dropout(p=0.5, inplace=False)
    (3): Linear(in_features=200, out_features=500, bias=True)
    (4): ReLU(inplace=True)
    (5): Linear(in_features=500, out_features=29, bias=True)
  )
)
```

[20]:
```
from torchsummary import summary
summary(model, (3, 200, 200))
```

```
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
            Conv2d-1           [-1, 64, 49, 49]          23,296
              ReLU-2           [-1, 64, 49, 49]               0
         MaxPool2d-3           [-1, 64, 24, 24]               0
            Conv2d-4          [-1, 192, 26, 26]         110,784
              ReLU-5          [-1, 192, 26, 26]               0
```

```
       MaxPool2d-6          [-1, 192, 13, 13]               0
          Conv2d-7          [-1, 256, 13, 13]         442,624
            ReLU-8          [-1, 256, 13, 13]               0
       MaxPool2d-9            [-1, 256, 6, 6]               0
         Linear-10                  [-1, 200]       1,843,400
           ReLU-11                  [-1, 200]               0
        Dropout-12                  [-1, 200]               0
         Linear-13                  [-1, 500]         100,500
           ReLU-14                  [-1, 500]               0
         Linear-15                   [-1, 29]          14,529
================================================================
Total params: 2,535,133
Trainable params: 2,535,133
Non-trainable params: 0
----------------------------------------------------------------
Input size (MB): 0.46
Forward/backward pass size (MB): 5.60
Params size (MB): 9.67
Estimated Total Size (MB): 15.73
----------------------------------------------------------------
```

[21]:

```python
batch_size = 64
```

[22]:

```python
def train_one_epoch(train_loader, model, device, optimizer, log_interval,␣
 ↪epoch):
    model.train()
    losses = []
    counter = []

    for i, (img, label) in enumerate(train_loader):
        img, label = img.to(device), label.to(device)
        optimizer.zero_grad()
        output = model(img)
        loss = criterion(output, label)
        loss.backward()
        optimizer.step()
        if (i+1) % log_interval == 0:
            losses.append(loss.item())
            counter.append(
                (i * batch_size) + img.size(0) + epoch * len(train_loader.
 ↪dataset))

    return losses, counter
```

[23]:

```python
def test_one_epoch(test_loader, model, device):
    model.eval()
    test_loss = 0
```

```python
    num_correct = 0

    with torch.no_grad():
        for i, (img, label) in enumerate(test_loader):
            img, label = img.to(device), label.to(device)
            output = model(img)
            pred = torch.argmax(output, dim=1)
            num_correct += (pred == label).sum().item()
            test_loss += criterion(output, label).item()

    test_loss /= len(test_loader.dataset)
    return test_loss, num_correct
```

[24]:

```python
criterion = nn.CrossEntropyLoss()
```

[25]:

```python
no_of_epochs = 10
```

[26]:

```python
lr = 0.01

log_interval = 100

optimizer = torch.optim.SGD(model.parameters(), lr=lr)

train_losses = []
train_counter = []
test_losses = []
test_correct = []
train_correct = []
for epoch in tqdm(range(no_of_epochs)):
    train_loss, counter = train_one_epoch(train_dataloader, model, DEVICE,␣
 ↪optimizer, log_interval, epoch)
    test_loss, num_correct = test_one_epoch(test_dataloader, model, DEVICE)
    _, num_correct_train = test_one_epoch(train_dataloader, model, DEVICE)

    # record results
    train_losses.extend(train_loss)
    train_counter.extend(counter)
    test_losses.append(test_loss)
    test_correct.append(num_correct)
    train_correct.append(num_correct_train)
```

```
100%|      | 10/10 [40:23<00:00, 242.39s/it]
```

[27]:

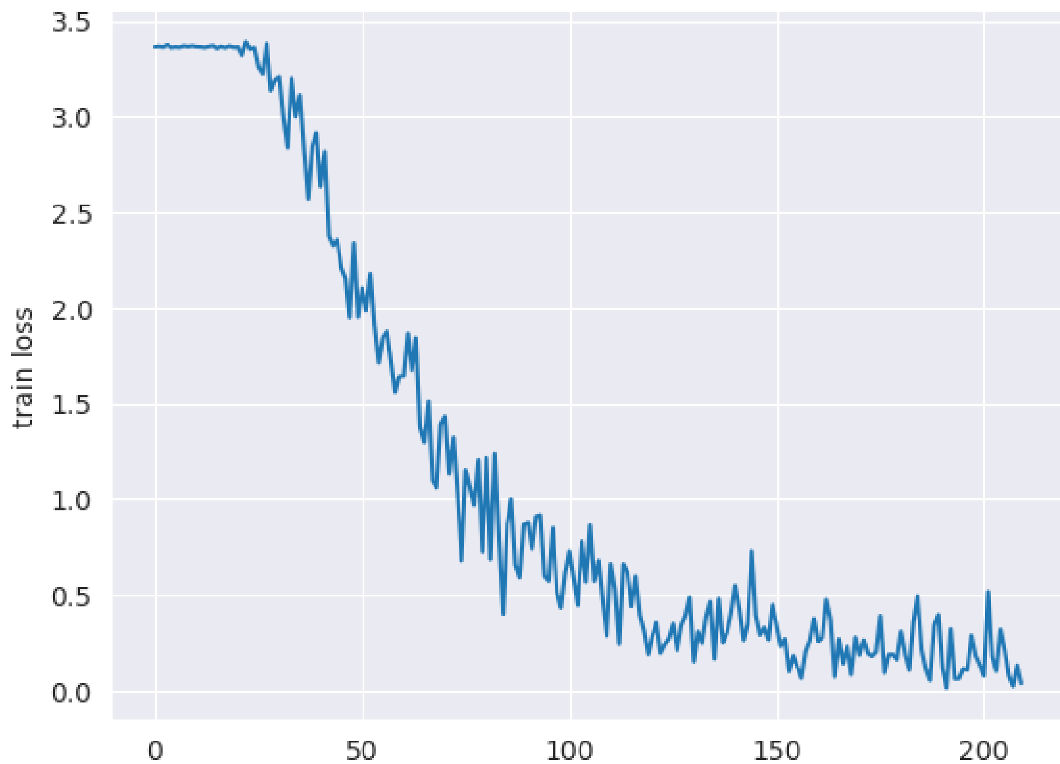
```python
print(f"test accuracy: {test_correct[-1]/len(test_dataloader.dataset)}")
print(f"train accuracy: {train_correct[-1]/len(train_dataloader.dataset)}")
```

```
test accuracy: 0.985
train accuracy: 0.9872557471264368
```

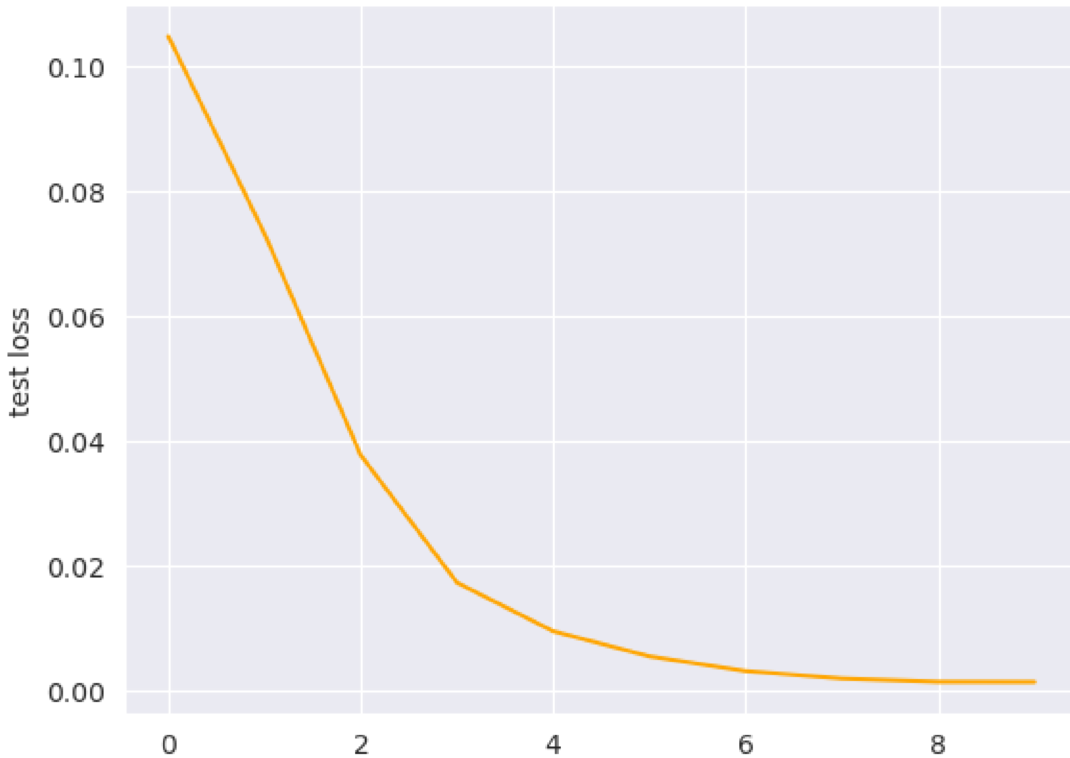
[28]:
```python
SAVE_PATH = "../../data/googlenet_asl_v0.pth"
```

[29]:
```python
torch.save(model, SAVE_PATH)
```

[30]:
```python
sns.lineplot(train_losses)
plt.ylabel("train loss");
```



[31]:
```python
sns.lineplot(test_losses, color="orange")
plt.ylabel("test loss");
```


0.10
0.08
0.06
0.04
0.02
0.00
test loss
0
2
4
6
8