Machine Learning Project - Assignmnet 09

Classification for Multiple Categories using Pytorch

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Computing Area

0. Preset

```
## Import required libraries
import torch
from torch import nn, optim
from torch.utils.data import DataLoader
from torchvision import datasets
from torchvision import transforms
import matplotlib.pyplot as plt
import numpy as np
import random
import pandas as pd
%matplotlib inline
```

1. Data

```
transform = transforms.Compose([
    transforms.ToTensor(),
    transforms.Normalize((0.1307,),(0.3081,)),  # mean value = 0.1307, standard deviation va
])
```

```
data_path = './MNIST'

training_set = datasets.MNIST(root = data_path, train= True, download=True, transform= trans
testing_set = datasets.MNIST(root = data_path, train= False, download=True, transform= trans
```

2. Model

```
class classification(nn.Module):
    def __init__(self):
        super(classification, self).__init__()

        # construct layers for a neural network
        self.classifier1 = nn.Sequential(
            nn.Linear(in_features=28*28, out_features=20*20),
            nn.Sigmoid(),
        )
        self.classifier2 = nn.Sequential(
            nn.Linear(in_features=20*20, out_features=10*10),
            nn.Sigmoid(),
        )
        self.classifier3 = nn.Sequential(
```

```
            nn.Linear(in_features=10*10, out_features=10),
            nn.LogSoftmax(dim=1),
        )


    def forward(self, inputs):                  # [batchSize, 1, 28, 28]
        x = inputs.view(inputs.size(0), -1)     # [batchSize, 28*28]
        x = self.classifier1(x)                 # [batchSize, 20*20]
        x = self.classifier2(x)                 # [batchSize, 10*10]
        out = self.classifier3(x)               # [batchSize, 10]

        return out
```

```
# Definition of hyper parameters
learning_rate_value = 0.03
batch_size = 128
epochs = 30

USE_CUDA = torch.cuda.is_available()
device = torch.device("cuda" if USE_CUDA else "cpu")

random.seed(777)
torch.manual_seed(777)
if device == 'cuda':
    torch.cuda.manual_seed_all(777)
```

3. Loss function

```
criterion = nn.NLLLoss()
```

4. Optimization

```
# Dataloader & Optimizer
training_loader = DataLoader(training_set, batch_size=batch_size, shuffle=True)
testing_loader = DataLoader(testing_set, batch_size=batch_size, shuffle=False)

classifier = classification()
optimizer = optim.SGD(classifier.parameters(), lr=learning_rate_value)
```

```
# Training - Gradient Descent
train_loss = []
train_acc = []
test_loss = []
test_acc = []

for epoch in range(epochs):
    train_loss_tmp = 0
    train_acc_tmp = 0

    for data, target in training_loader:
        # Zero the parameter gradients
        optimizer.zero_grad()
        # Forward
        output = classifier(data)
        loss = criterion(output, target)
        # Backword
        loss.backward()
```

```
        loss.backward()
        # Loss
        train_loss_tmp += loss
        # Update
        optimizer.step()
        # Accuracy
        result = output.data.max(1)[1]
        accuracy = result.eq(target.data).sum() / 10*batch_size
        train_acc_tmp += accuracy

    train_loss.append(train_loss_tmp / batch_size)
    train_acc.append(train_acc_tmp / batch_size)

    test_loss_tmp = 0
    test_acc_tmp = 0

    with torch.no_grad():
        for data, target in testing_loader:
            # Forward
            output = classifier(data)
            loss = criterion(output, target)
            # Loss
            test_loss_tmp += loss
            # Accuracy
            result = output.data.max(1)[1]
            accuracy = result.eq(target.data).sum() / 10*batch_size
            test_acc_tmp += accuracy

    test_loss.append(test_loss_tmp / batch_size)
    test_acc.append(test_acc_tmp / batch_size)
```

```
#train_loss_32 = train_loss_tmp / batch_size
#test_loss_32 = test_loss_tmp / batch_size
#train_acc_32 = train_acc_tmp / batch_size
#test_acc_32 = test_acc_tmp / batch_size
#train_loss_64 = train_loss_tmp / batch_size
#test_loss_64 = test_loss_tmp / batch_size
#train_acc_64 = train_acc_tmp / batch_size
#test_acc_64 = test_acc_tmp / batch_size
train_loss_128 = train_loss_tmp / batch_size
test_loss_128 = test_loss_tmp / batch_size
train_acc_128 = train_acc_tmp / batch_size
test_acc_128 = test_acc_tmp / batch_size
```

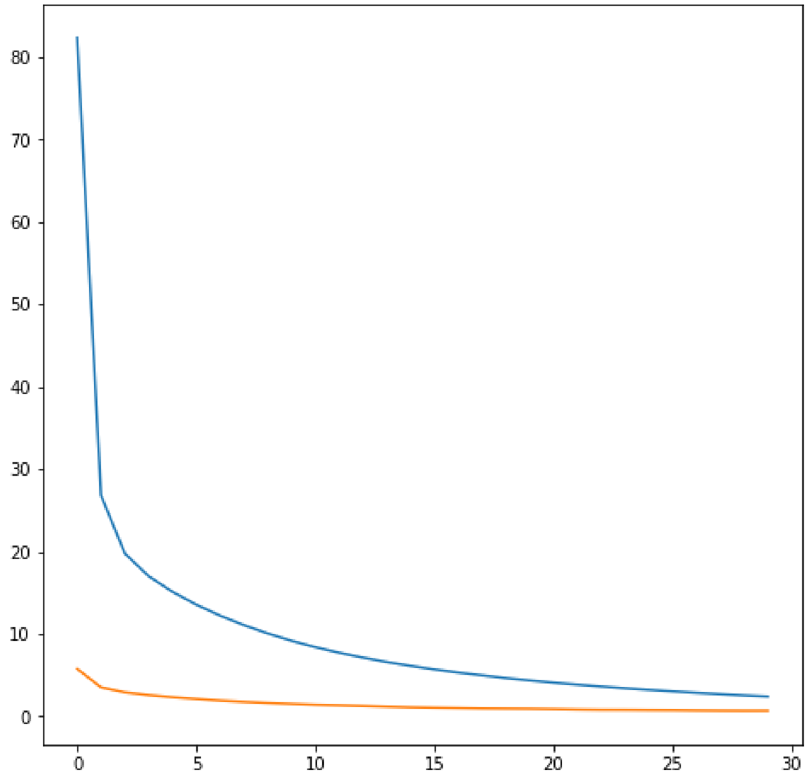
```
ind_loss = ['training loss', 'testing loss']
ind_acc = ['traininng accuracy', 'testing accuracy']
col = ['32', '64', '128']
con_loss = [[train_loss_32.item(),train_loss_64.item(),train_loss_128.item()], [test_loss_3
con_acc = [[(train_acc_32/100).item(),(train_acc_64/100).item(),(train_acc_128/100).item()]
```

Result Area

1. Plot the training and testing losses with a batch size of 32 [4pt]

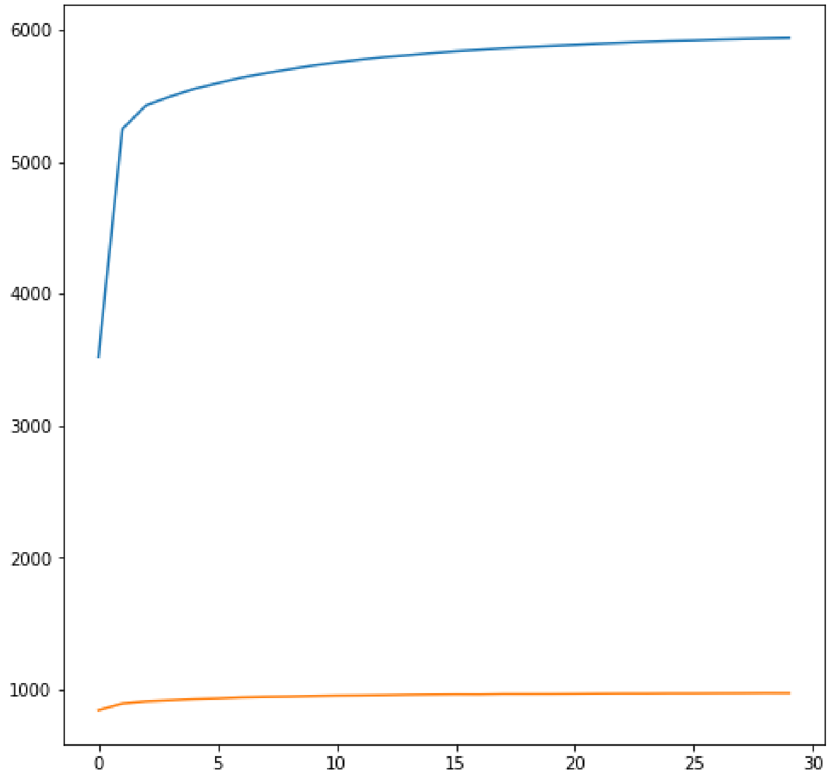
```
plt.figure(figsize=(8,8))
plt.plot(train_loss)
plt.plot(test_loss)
```

```
3 plt.plot(test_loss)
4 plt.show()
```



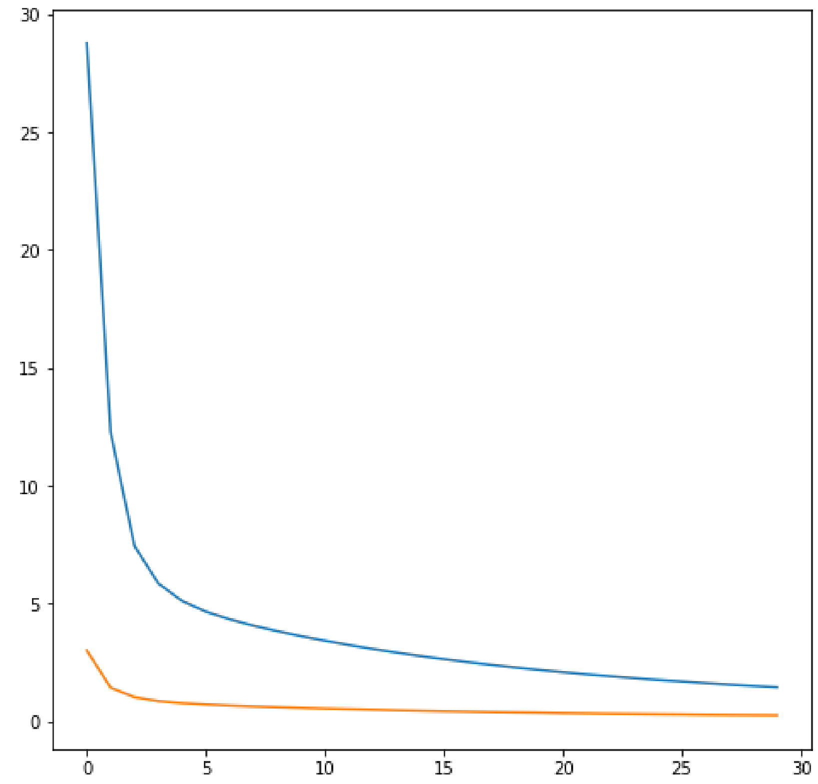
2. Plot the training and testing accuracies with a batch size of 32 [4pt]

```
1 plt.figure(figsize=(8,8))
2 plt.plot(train_acc)
3 plt.plot(test_acc)
4 plt.show()
```



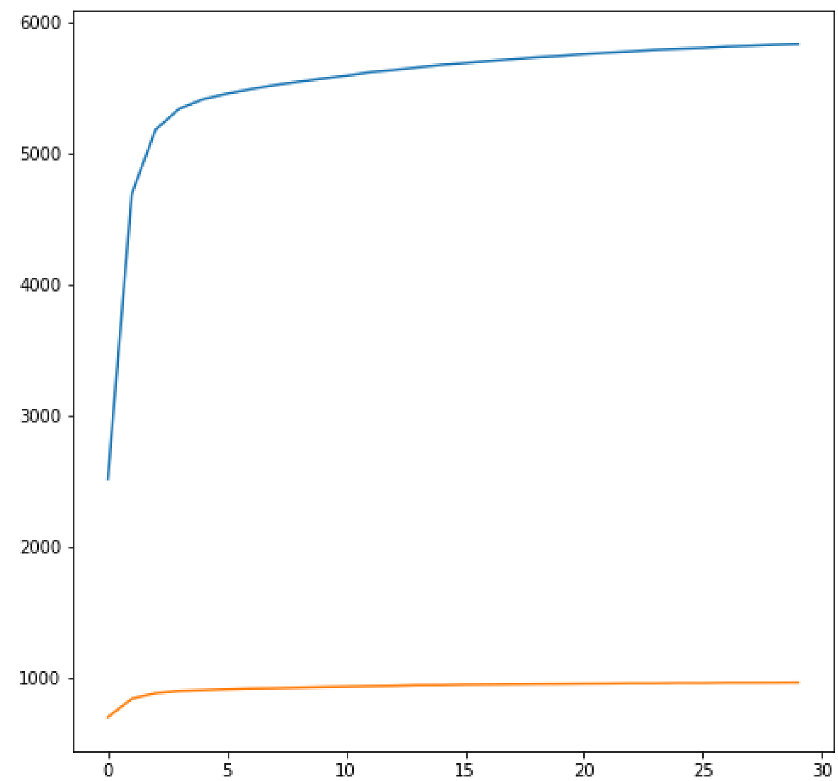
3. Plot the training and testing losses with a batch size of 64 [4pt]

```python
plt.figure(figsize=(8,8))
plt.plot(train_loss)
plt.plot(test_loss)
plt.show()
```



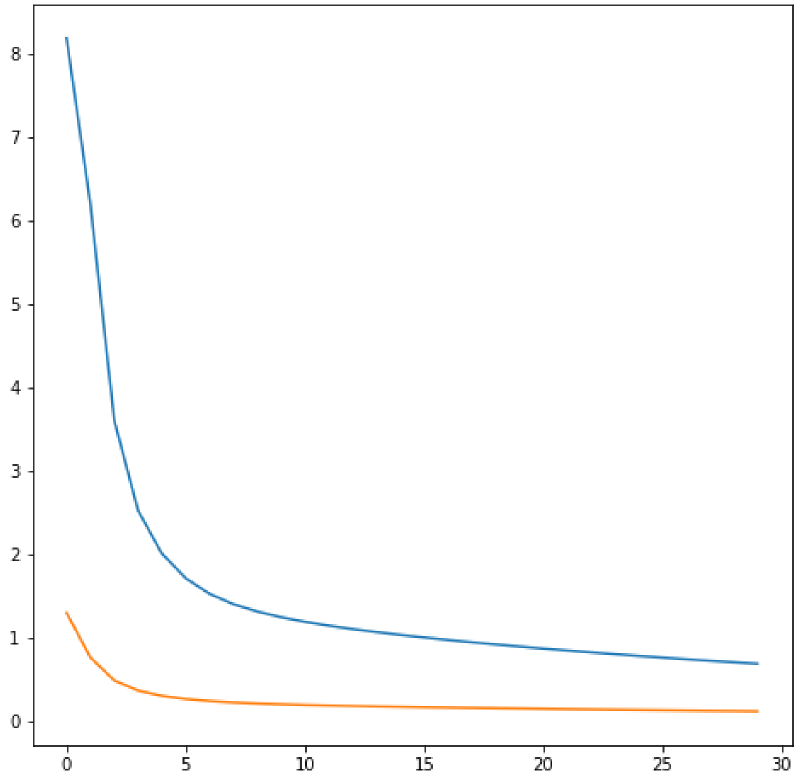
4. Plot the training and testing accuracies with a batch size of 64 [4pt]

```python
plt.figure(figsize=(8,8))
plt.plot(train_acc)
plt.plot(test_acc)
plt.show()
```



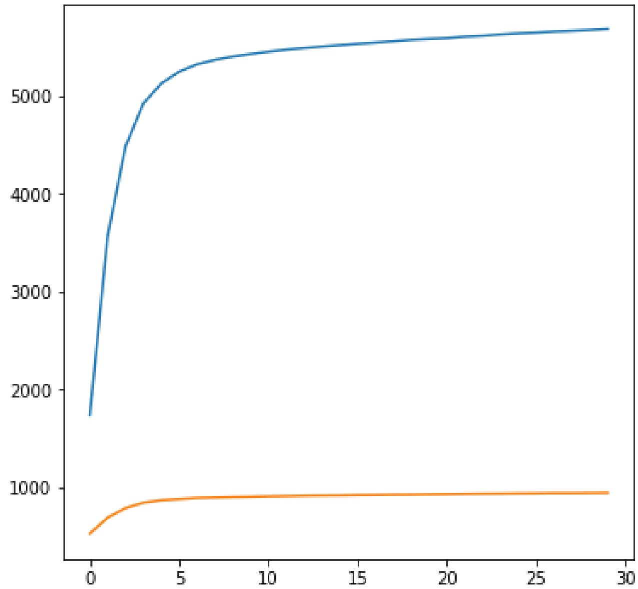
5. Plot the training and testing losses with a batch size of 128 [4pt]

```
plt.figure(figsize=(8,8))
plt.plot(train_loss)
plt.plot(test_loss)
plt.show()
```



6. Plot the training and testing accuracies with a batch size of 128 [4pt]

```
plt.figure(figsize=(6,6))
plt.plot(train_acc)
plt.plot(test_acc)
plt.show()
```



7. Print the loss at convergence with different mini-batch sizes [3pt]

```
pd.DataFrame(con_loss, columns=col, index=ind_loss)
```

	32	64	128
training loss	2.419568	1.459722	0.682588
testing loss	0.707441	0.274281	0.114711

8. Print the accuracy at convergence with different mini-batch sizes [3pt]

```
pd.DataFrame(con_acc, columns=col, index=ind_acc)
```

	32	64	128
traininng accuracy	59.384743	58.322002	56.79097
testing accuracy	9.770015	9.650004	9.46200