Hidden Layer Deep Network: Sigmoid, Tanh and Relu Activations Functions MNIST Dataset

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In this lab, you will test Sigmoid, Tanh and Relu activation functions on the MNIST dataset with two hidden Layers.

Estimated Time Needed: **25 min**

We'll need the following libraries

In [1]:

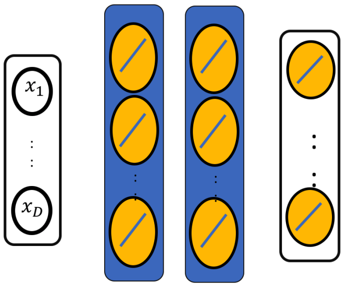
```
# Import the libraries we need for this lab

# Using the following line code to install the torchvision library
# !conda install -y torchvision

import torch
import torch.nn as nn
import torchvision.transforms as transforms
import torchvision.datasets as dsets
import torch.nn.functional as F
import matplotlib.pylab as plt
import numpy as np
torch.manual_seed(2)
```

Out[1]:

```
<torch._C.Generator at 0x7f7f98081130>
```

Neural Network Module and Training Function

Define the neural network module or class, with two hidden Layers



2 Hidden Layers

In [2]:

```
# Create the model class using sigmoid as the activation function

class Net(nn.Module):

    # Constructor
    def __init__(self, D_in, H1, H2, D_out):
        super(Net, self).__init__()
        self.linear1 = nn.Linear(D_in, H1)
        self.linear2 = nn.Linear(H1, H2)
        self.linear3 = nn.Linear(H2, D_out)

    # Prediction
    def forward(self,x):
        x = torch.sigmoid(self.linear1(x))
        x = torch.sigmoid(self.linear2(x))
        x = self.linear3(x)
        return x
```

Define the class with the Tanh activation function

In [3]:

```
# Create the model class using Tanh as a activation function

class NetTanh(nn.Module):

    # Constructor
    def __init__(self, D_in, H1, H2, D_out):
        super(NetTanh, self).__init__()
        self.linear1 = nn.Linear(D_in, H1)
        self.linear2 = nn.Linear(H1, H2)
        self.linear3 = nn.Linear(H2, D_out)

    # Prediction
    def forward(self, x):
        x = torch.tanh(self.linear1(x))
        x = torch.tanh(self.linear2(x))
        x = self.linear3(x)
        return x
```

Define the class for the Relu activation function

In [4]:

```
# Create the model class using Relu as a activation function

class NetRelu(nn.Module):

    # Constructor
    def __init__(self, D_in, H1, H2, D_out):
        super(NetRelu, self).__init__()
        self.linear1 = nn.Linear(D_in, H1)
        self.linear2 = nn.Linear(H1, H2)
        self.linear3 = nn.Linear(H2, D_out)

    # Prediction
    def forward(self, x):
        x = torch.relu(self.linear1(x))
        x = torch.relu(self.linear2(x))
        x = self.linear3(x)
        return x
```

Define a function to train the model, in this case the function returns a Python dictionary to store the training loss and accuracy on the validation data

In [5]:

```
# Train the model

def train(model, criterion, train_loader, validation_loader, optimizer, epochs=100
):
    i = 0
    useful_stuff = {'training_loss': [], 'validation_accuracy': []}

    for epoch in range(epochs):
        for i, (x, y) in enumerate(train_loader):
            optimizer.zero_grad()
            z = model(x.view(-1, 28 * 28))
            loss = criterion(z, y)
            loss.backward()
            optimizer.step()
            useful_stuff['training_loss'].append(loss.data.item())

        correct = 0
        for x, y in validation_loader:
            z = model(x.view(-1, 28 * 28))
            _, label = torch.max(z, 1)
            correct += (label == y).sum().item()

        accuracy = 100 * (correct / len(validation_dataset))
        useful_stuff['validation_accuracy'].append(accuracy)

    return useful_stuff
```

Make Some Data

Load the training dataset by setting the parameters `train` to `True` and convert it to a tensor by placing a transform object int the argument `transform`

In [6]:

```
# Create the training dataset

train_dataset = dsets.MNIST(root='./data', train=True, download=True, transform=transforms.ToTensor())
```

Load the testing dataset by setting the parameters `train` to `False` and convert it to a tensor by placing a transform object int the argument `transform`

In [7]:

```
# Create the validating dataset

validation_dataset = dsets.MNIST(root='./data', train=False, download=True, transform=transforms.ToTensor())
```

Create the criterion function

In [8]:

```
# Create the criterion function

criterion = nn.CrossEntropyLoss()
```

Create the training-data loader and the validation-data loader object

In [9]:

```
# Create the training data loader and validation data loader object

train_loader = torch.utils.data.DataLoader(dataset=train_dataset, batch_size=2000, shuffle=True)
validation_loader = torch.utils.data.DataLoader(dataset=validation_dataset, batch_size=5000, shuffle=False)
```

Define Neural Network, Criterion function, Optimizer and Train the Model

Create the model with 100 hidden layers

In [10]:

```
# Set the parameters for create the model

input_dim = 28 * 28
hidden_dim1 = 50
hidden_dim2 = 50
output_dim = 10
```

The epoch number in the video is 35. You can try 10 for now. If you try 35, it may take a long time.

In [11]:

```
# Set the number of iterations

cust_epochs = 10
```

Test Sigmoid ,Tanh and Relu

Train the network using the Sigmoid activation function

In [ ]:

```
# Train the model with sigmoid function

learning_rate = 0.01
model = Net(input_dim, hidden_dim1, hidden_dim2, output_dim)
optimizer = torch.optim.SGD(model.parameters(), lr=learning_rate)
training_results = train(model, criterion, train_loader, validation_loader, optimiz
er, epochs=cust_epochs)
```

Train the network using the Tanh activation function

In [ ]:

```
# Train the model with tanh function

learning_rate = 0.01
model_Tanh = NetTanh(input_dim, hidden_dim1, hidden_dim2, output_dim)
optimizer = torch.optim.SGD(model_Tanh.parameters(), lr=learning_rate)
training_results_tanch = train(model_Tanh, criterion, train_loader, validation_load
er, optimizer, epochs=cust_epochs)
```

Train the network using the Relu activation function

In [ ]:

```
# Train the model with relu function

learning_rate = 0.01
modelRelu = NetRelu(input_dim, hidden_dim1, hidden_dim2, output_dim)
optimizer = torch.optim.SGD(modelRelu.parameters(), lr=learning_rate)
training_results_relu = train(modelRelu, criterion, train_loader, validation_loader
, optimizer, epochs=cust_epochs)
```

Analyze Results

Compare the training loss for each activation

In [ ]:

```
# Compare the training loss

plt.plot(training_results_tanch['training_loss'], label='tanh')
plt.plot(training_results['training_loss'], label='sigmoid')
plt.plot(training_results_relu['training_loss'], label='relu')
plt.ylabel('loss')
plt.title('training loss iterations')
plt.legend()
```

Compare the validation loss for each model

In [ ]:

```
# Compare the validation loss

plt.plot(training_results_tanch['validation_accuracy'], label = 'tanh')
plt.plot(training_results['validation_accuracy'], label = 'sigmoid')
plt.plot(training_results_relu['validation_accuracy'], label = 'relu')
plt.ylabel('validation accuracy')
plt.xlabel('Iteration')
plt.legend()
```

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