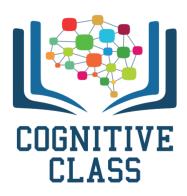


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Test Uniform, Default and He Initialization on MNIST Dataset with Relu Activation

Table of Contents

In this lab, you will test the Uniform Initialization, Default Initialization and He Initialization on the MNIST dataset with Relu Activation

- Neural Network Module and Training Function
- Make Some Data
- Define Several Neural Network, Criterion function, Optimizer
- Test Uniform, Default and He Initialization
- Analyze Results

Estimated Time Needed: 25 min

Preparation

We'll need the following libraries:

```
In [1]:
```

```
# Import the libraries we need to use in 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(0)
```

Out[1]:

<torch._C.Generator at 0x7f8c4fc113d0>

Neural Network Module and Training Function

Define the neural network module or class with He Initialization

In [2]:

```
# Define the class for neural network model with He Initialization
class Net_He(nn.Module):
    # Constructor
   def init (self, Layers):
        super(Net He, self). init ()
        self.hidden = nn.ModuleList()
        for input size, output size in zip(Layers, Layers[1:]):
            linear = nn.Linear(input size, output size)
            torch.nn.init.kaiming uniform (linear.weight, nonlinearity='relu')
            self.hidden.append(linear)
    # Prediction
   def forward(self, x):
        L = len(self.hidden)
        for (1, linear_transform) in zip(range(L), self.hidden):
            if 1 < L - 1:
                x = F.relu(linear transform(x))
            else:
                x = linear transform(x)
        return x
```

Define the class or neural network with Uniform Initialization

```
# Define the class for neural network model with Uniform Initialization
class Net_Uniform(nn.Module):
    # Constructor
    def __init__(self, Layers):
        super(Net_Uniform, self).__init__()
        self.hidden = nn.ModuleList()
        for input_size, output_size in zip(Layers, Layers[1:]):
            linear = nn.Linear(input size,output size)
            linear.weight.data.uniform_(0, 1)
            self.hidden.append(linear)
    # Prediction
    def forward(self, x):
        L = len(self.hidden)
        for (1, linear_transform) in zip(range(L), self.hidden):
            if 1 < L - 1:
                x = F.relu(linear_transform(x))
            else:
                x = linear_transform(x)
        return x
```

Class or Neural Network with PyTorch Default Initialization

In [4]:

```
# Define the class for neural network model with PyTorch Default Initialization
class Net(nn.Module):
    # Constructor
    def init (self, Layers):
        super(Net, self).__init__()
        self.hidden = nn.ModuleList()
        for input_size, output_size in zip(Layers, Layers[1:]):
            linear = nn.Linear(input size, output size)
            self.hidden.append(linear)
    def forward(self, x):
        L=len(self.hidden)
        for (1, linear_transform) in zip(range(L), self.hidden):
            if 1 < L - 1:
                x = F.relu(linear transform(x))
            else:
                x = linear transform(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]:

```
# Define function to train model
def train(model, criterion, train loader, validation loader, optimizer, epochs = 10
0):
    i = 0
    loss_accuracy = {'training_loss': [], 'validation_accuracy': []}
    #n epochs
    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()
            loss_accuracy['training_loss'].append(loss.data.item())
        correct = 0
        for x, y in validation_loader:
            yhat = model(x.view(-1, 28 * 28))
            _, label = torch.max(yhat, 1)
            correct += (label == y).sum().item()
        accuracy = 100 * (correct / len(validation_dataset))
        loss accuracy['validation accuracy'].append(accuracy)
    return loss accuracy
```

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=tra
nsforms.ToTensor())
```

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

```
In [7]:
```

```
# Create the validation dataset
validation_dataset = dsets.MNIST(root='./data', train=False, download=True, transfo
rm=transforms.ToTensor())
```

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

In [8]:

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

Create the criterion function

```
In [9]:
```

```
# Create the criterion function
criterion = nn.CrossEntropyLoss()
```

Create a list that contains layer size

```
In [10]:
```

```
# Create the parameters
input_dim = 28 * 28
output_dim = 10
layers = [input_dim, 100, 200, 100, output_dim]
```

Test PyTorch Default Initialization, Xavier Initialization and Uniform Initialization

Train the network using PyTorch Default Initialization

```
In [ ]:
```

```
# Train the model with the default initialization

model = Net(layers)
learning_rate = 0.01
optimizer = torch.optim.SGD(model.parameters(), lr=learning_rate)
training_results = train(model, criterion, train_loader,validation_loader, optimize
r, epochs=30)
```

Train the network using He Initialization function

```
In [ ]:
```

```
# Train the model with the He initialization

model_He = Net_He(layers)
optimizer = torch.optim.SGD(model_He.parameters(), lr=learning_rate)
training_results_He = train(model_He, criterion, train_loader, validation_loader, o
ptimizer, epochs=30)
```

Train the network using Uniform Initialization function

```
In [ ]:
```

```
# Train the model with the Uniform initialization

model_Uniform = Net_Uniform(layers)
optimizer = torch.optim.SGD(model_Uniform.parameters(), lr=learning_rate)
training_results_Uniform = train(model_Uniform, criterion, train_loader, validation
_loader, optimizer, epochs=30)
```

Analyze Results

Compare the training loss for each activation

```
In [ ]:
```

```
# Plot the loss

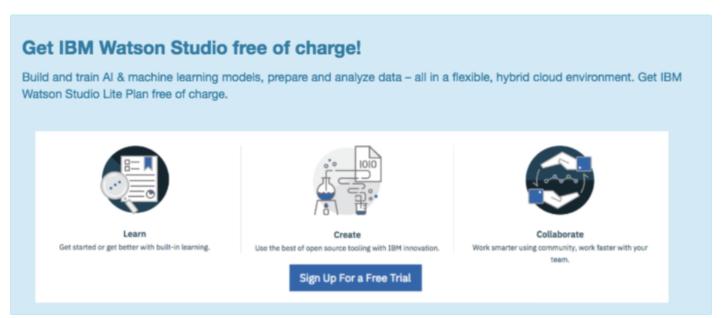
plt.plot(training_results_He['training_loss'], label='He')
plt.plot(training_results['training_loss'], label='Default')
plt.plot(training_results_Uniform['training_loss'], label='Uniform')
plt.ylabel('loss')
plt.xlabel('iteration ')
plt.title('training loss iterations')
plt.legend()
```

Compare the validation loss for each model

```
In [ ]:
```

```
# Plot the accuracy

plt.plot(training_results_He['validation_accuracy'], label='He')
plt.plot(training_results['validation_accuracy'], label='Default')
plt.plot(training_results_Uniform['validation_accuracy'], label='Uniform')
plt.ylabel('validation accuracy')
plt.xlabel('epochs ')
plt.legend()
plt.show()
```



(http://cocl.us/pytorch_link_bottom)

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