P2_Q1_C

November 15, 2022

[21]:

```
import torch
import torch.nn as nn
import torch.nn.functional as F
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

class Net(nn.Module):

    def __init__(self):
        super(Net, self).__init__()
        self.fc1 = nn.Linear(2, 2) #Hidden layer 1
        self.fc2 = nn.Linear(2, 2) #Hidden layer 2
        self.fc3 = nn.Linear(2, 2) #Hidden layer 3
        self.fc4 = nn.Linear(2, 2)

    def forward(self, x):
        x = F.relu(self.fc1(x))
        x = F.relu(self.fc2(x))
        x = F.relu(self.fc3(x))
        x = self.fc4(x)
        return F.log_softmax(x)
        #return F.softmax(x)
```

[22]:

```
def plot_data(X, y, filename):
    plt.scatter(X[:, 0], X[:, 1], c=y, cmap=plt.cm.Spectral, s = 1)
    plt.savefig(filename)
    plt.close()

def plot_decision_boundary(clf, X, y, filename):
    # Set min and max values and give it some padding
    #x_min, x_max = X[:, 0].min() - .1, X[:, 0].max() + .1
    #y_min, y_max = X[:, 1].min() - .1, X[:, 1].max() + .1
    x_min, x_max = -0.5, 1.5
    y_min, y_max = -0.5, 1.5
    h = 0.01
    # Generate a grid of points with distance h between them
    xx, yy = np.meshgrid(np.arange(x_min, x_max, h), np.arange(y_min, y_max, h))
    # Predict the function value for the whole gid
    #Z = clf.predict(np.c_[xx.ravel(), yy.ravel()])
    X_out = net(torch.tensor(np.c_[xx.ravel(), yy.ravel()], dtype = torch.
  ↪float))
    Z = X_out.data.max(1)[1]
    # Z.shape
    Z = Z.reshape(xx.shape)
    # Plot the contour and training examples
    plt.contourf(xx, yy, Z, cmap=plt.cm.Spectral)
    plt.scatter(X[:, 0], X[:, 1], c=y, cmap=plt.cm.Spectral, s = 1)
    plt.savefig(filename)
    plt.close()

data = pd.read_csv("XOR.csv") # UPDATE THE FILE NAME AND PATH TO MATCH YOUR␣
  ↪REQUIREMENT
X = data.values[:, 0:2]  # Take only the first two features.
X = torch.tensor(X, dtype = torch.float)
y = data.values[:, 2]
y = torch.tensor(y, dtype = torch.long)
plt.scatter(X[:, 0], X[:, 1], c=y, cmap=plt.cm.Spectral, s = 100)

#%% train
net = Net()

# create a stochastic gradient descent optimizer
learning_rate = 0.01
optimizer = torch.optim.Adam(net.parameters(), lr=learning_rate)
#optimizer = torch.optim.Adam(net.parameters(), lr=learning_rate)



# create a loss function
criterion = nn.CrossEntropyLoss()
#criterion = nn.NLLLoss()

#nepochs = 600
nepochs = 3000
#10000
data, target = X, y



for epoch in range(nepochs):
#    adjust learning rate if desired
#    if epoch % 3000 == 0 and epoch <= 24000:
#        for g in optimizer.param_groups:
#            g['lr'] = g['lr']/2
    optimizer.zero_grad()
    # forward propagate
    net_out = net(data)
    # compute loss
    loss = criterion(net_out, target)

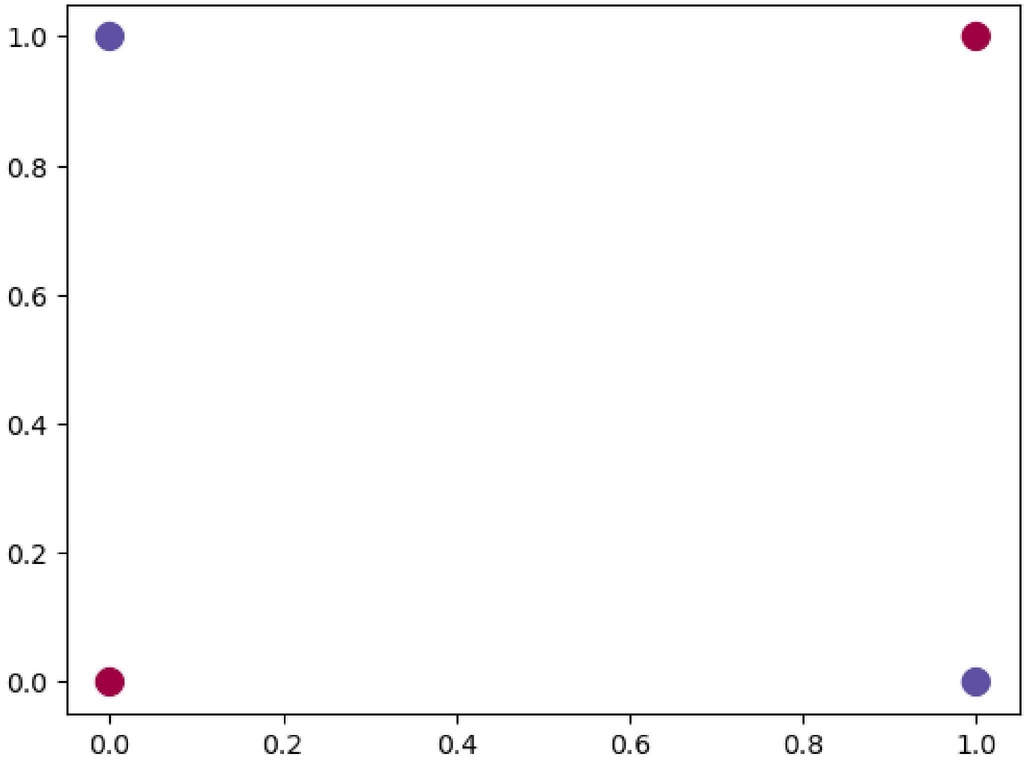
    # backpropagate
    loss.backward()
    # update parameters
    optimizer.step()
    # print out report

    if epoch % 10 == 0:
        print('Epoch ', epoch, 'Loss ', loss.item())
        #if(loss.item()<0.0001):
         #   break
        net_out = net(data)
        pred = net_out.data.max(1)[1]  # get the index of the max log-probability
        correctidx = pred.eq(target.data)
        ncorrect = correctidx.sum()
        accuracy = ncorrect.item()/len(data)
        print('Training accuracy is ', accuracy)
        if (accuracy==1):
            break
```

```
C:\Users\aradh\AppData\Local\Temp\ipykernel_64116\2042366125.py:22: UserWarning:
Implicit dimension choice for log_softmax has been deprecated. Change the call
to include dim=X as an argument.
  return F.log_softmax(x)
```

```
Epoch  0 Loss  0.7529647350311279
Training accuracy is  0.5
Epoch  10 Loss  0.6938625574111938
Training accuracy is  0.75
Epoch  20 Loss  0.6936883330345154
Training accuracy is  0.5
Epoch  30 Loss  0.6893919706344604
Training accuracy is  0.5
Epoch  40 Loss  0.682646632194519
Training accuracy is  0.5
Epoch  50 Loss  0.6749989986419678
Training accuracy is  0.5
Epoch  60 Loss  0.6615309715270996
Training accuracy is  0.5
Epoch  70 Loss  0.6377838850021362
```

```
Training accuracy is  0.75
Epoch  80 Loss  0.6046977639198303
Training accuracy is  0.75
Epoch  90 Loss  0.5577099919319153
Training accuracy is  0.75
Epoch  100 Loss  0.4990972578525543
Training accuracy is  0.75
Epoch  110 Loss  0.4278269112110138
Training accuracy is  0.75
Epoch  120 Loss  0.323006272315979
Training accuracy is  1.0
```



Epoch 120 Loss 0.323006272315979 Training accuracy is 1.0

[23]:
```
plt.scatter(X[:, 0], X[:, 1], c=pred, cmap=plt.cm.Spectral, s = 1)
plot_decision_boundary(net, X, y, 'P2_Q1_C')
```

```
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