Simple One Hidden Layer Neural Network

Objective

- How to create simple Neural Network in pytorch.

Table of Contents

In this lab, you will use a single-layer neural network to classify non linearly seprable data in 1-Ddatabase.

Estimated Time Needed: **25 min**

Preparation

We'll need the following libraries

In [1]:
```
# Import the libraries we need for this lab

import torch
import torch.nn as nn
from torch import sigmoid
import matplotlib.pylab as plt
import numpy as np
torch.manual_seed(0)
```

Out[1]:
```
<torch._C.Generator at 0x22e7fac6390>
```

Used for plotting the model

In [2]:
```
# The function for plotting the model

def PlotStuff(X, Y, model, epoch, leg=True):

    plt.plot(X.numpy(), model(X).detach().numpy(), label=('epoch ' + str(epoch)))
    plt.plot(X.numpy(), Y.numpy(), 'r')
    plt.xlabel('x')
    if leg == True:
        plt.legend()
```

```
    else:
        pass
```

Neural Network Module and Training Function

Define the activations and the output of the first linear layer as an attribute. Note that this is not good practice.

In [3]:
```
# Define the class Net

class Net(nn.Module):

    # Constructor
    def __init__(self, D_in, H, D_out):
        super(Net, self).__init__()
        # hidden layer
        self.linear1 = nn.Linear(D_in, H)
        self.linear2 = nn.Linear(H, D_out)
        # Define the first linear layer as an attribute, this is not good practice
        self.a1 = None
        self.l1 = None
        self.l2=None

    # Prediction
    def forward(self, x):
        self.l1 = self.linear1(x)
        self.a1 = sigmoid(self.l1)
        self.l2=self.linear2(self.a1)
        yhat = sigmoid(self.linear2(self.a1))
        return yhat
```

Define the training function:

In [4]:
```
# Define the training function

def train(Y, X, model, optimizer, criterion, epochs=1000):
    cost = []
    total=0
    for epoch in range(epochs):
        total=0
        for y, x in zip(Y, X):
            yhat = model(x)
            loss = criterion(yhat, y)
            loss.backward()
            optimizer.step()
            optimizer.zero_grad()
            #cumulative loss
            total+=loss.item()
        cost.append(total)
        if epoch % 300 == 0:
            PlotStuff(X, Y, model, epoch, leg=True)
            plt.show()
```

```
            model(X)
            plt.scatter(model.a1.detach().numpy()[:, 0], model.a1.detach().numpy()[
            plt.title('activations')
            plt.show()
    return cost
```

Make Some Data

In [5]:
```
# Make some data

X = torch.arange(-20, 20, 1).view(-1, 1).type(torch.FloatTensor)
Y = torch.zeros(X.shape[0])
Y[(X[:, 0] > -4) & (X[:, 0] < 4)] = 1.0
```

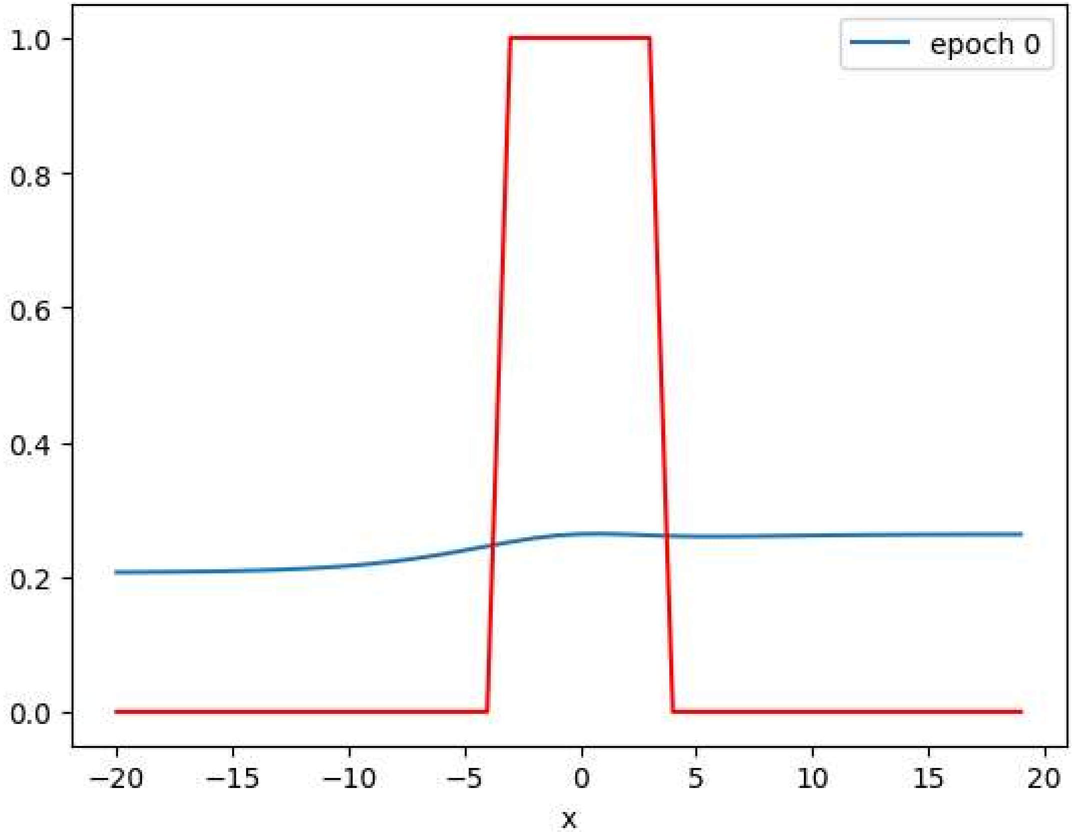
Define the Neural Network, Criterion Function, Optimizer and Train the Model

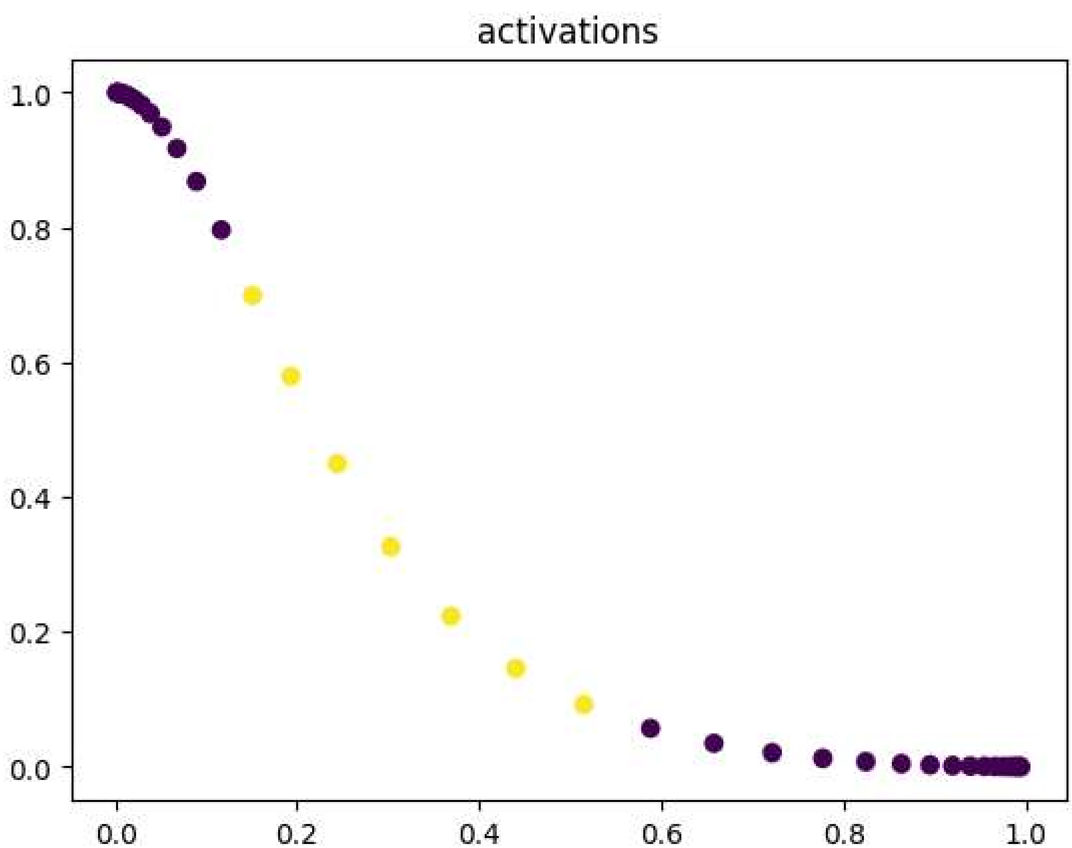
Create the Cross-Entropy loss function:

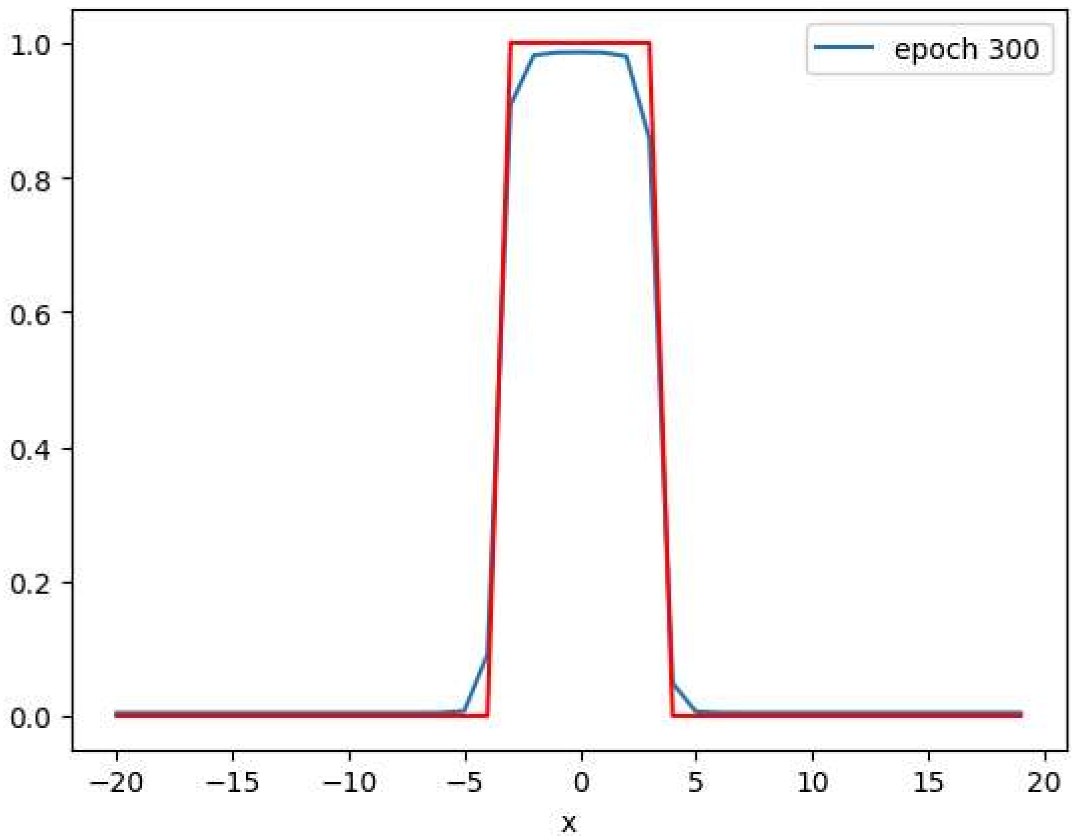
In [6]:
```
# The loss function

def criterion_cross(outputs, labels):
    out = -1 * torch.mean(labels * torch.log(outputs) + (1 - labels) * torch.log(1
    return out
```

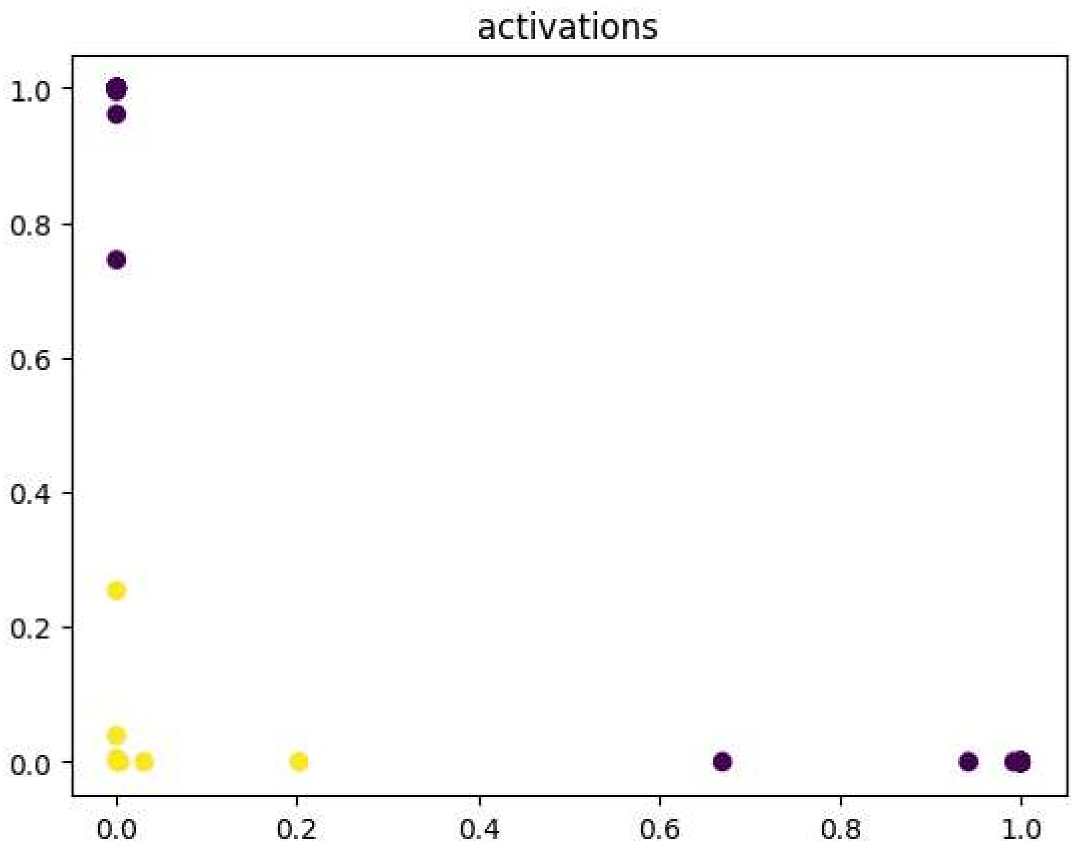
Define the Neural Network, Optimizer, and Train the Model:

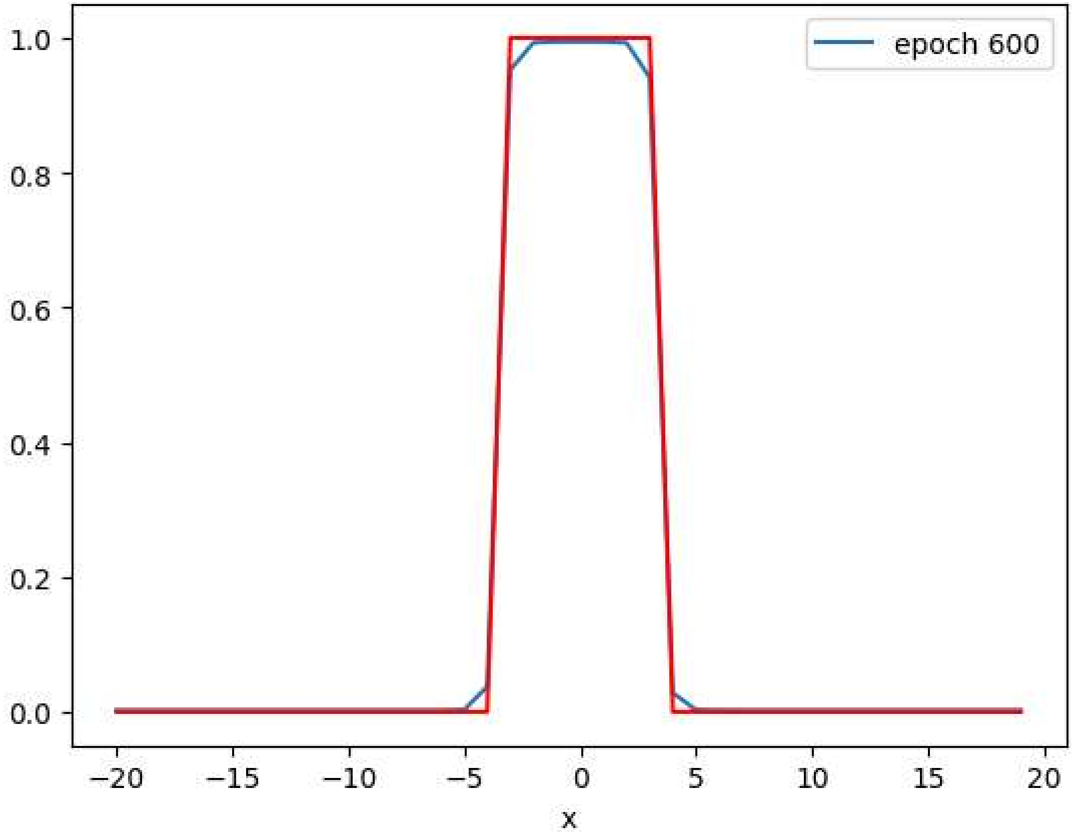
In [7]:
```
# Train the model
# size of input
D_in = 1
# size of hidden layer
H = 2
# number of outputs
D_out = 1
# learning rate
learning_rate = 0.1
# create the model
model = Net(D_in, H, D_out)
#optimizer
optimizer = torch.optim.SGD(model.parameters(), lr=learning_rate)
#train the model usein
cost_cross = train(Y, X, model, optimizer, criterion_cross, epochs=1000)
#plot the loss
plt.plot(cost_cross)
plt.xlabel('epoch')
plt.title('cross entropy loss')
```

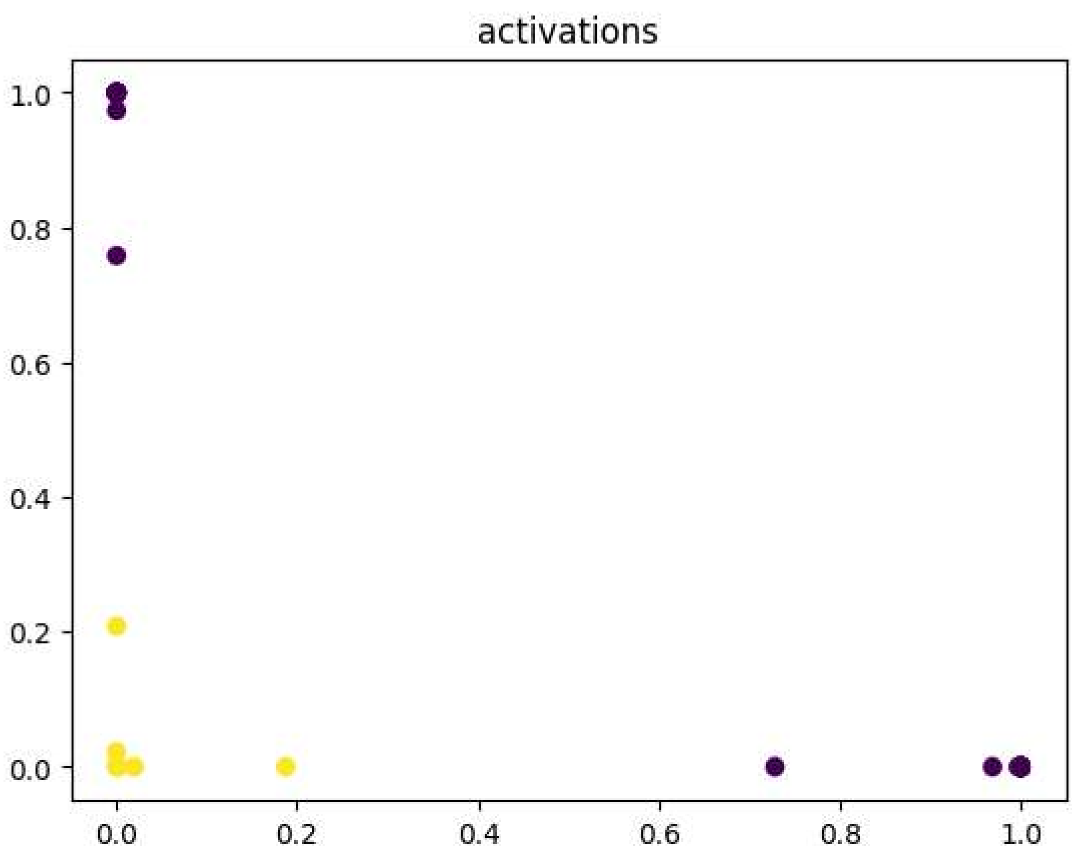

epoch 0
1.0
0.8
0.6
0.4
0.2
0.0
−20
−15
−10
−5
0
5
10
15
20
x

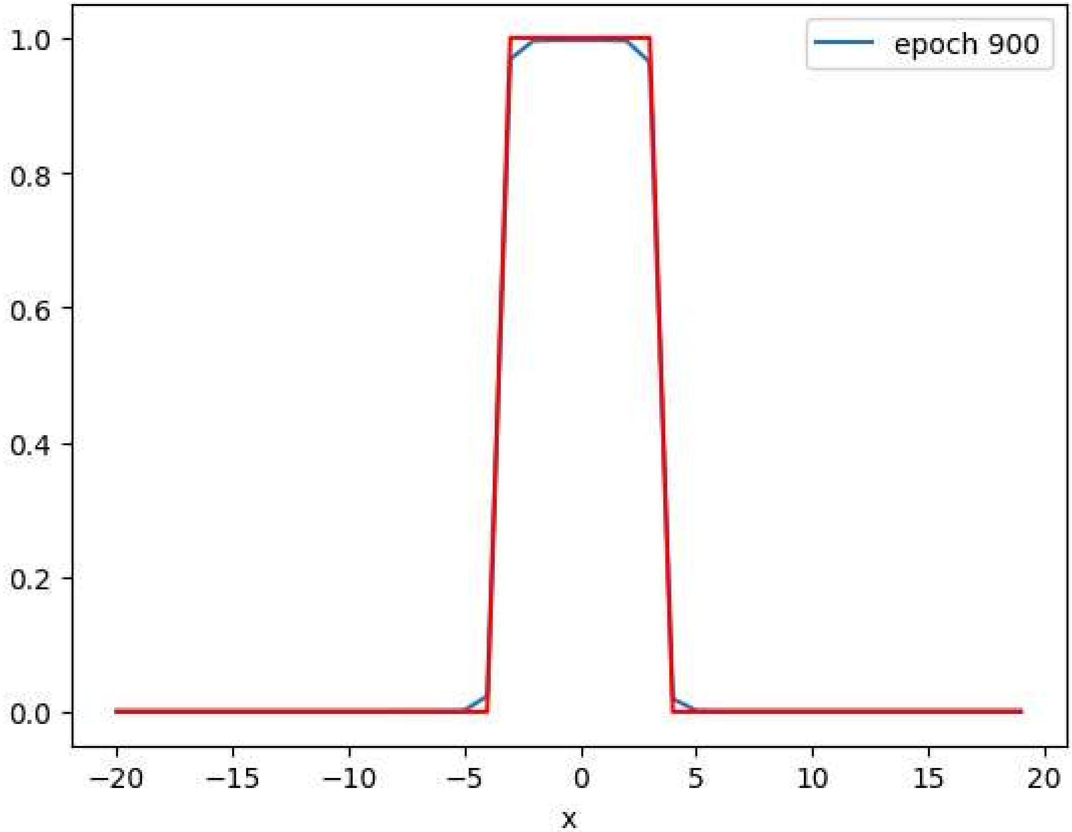

activations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

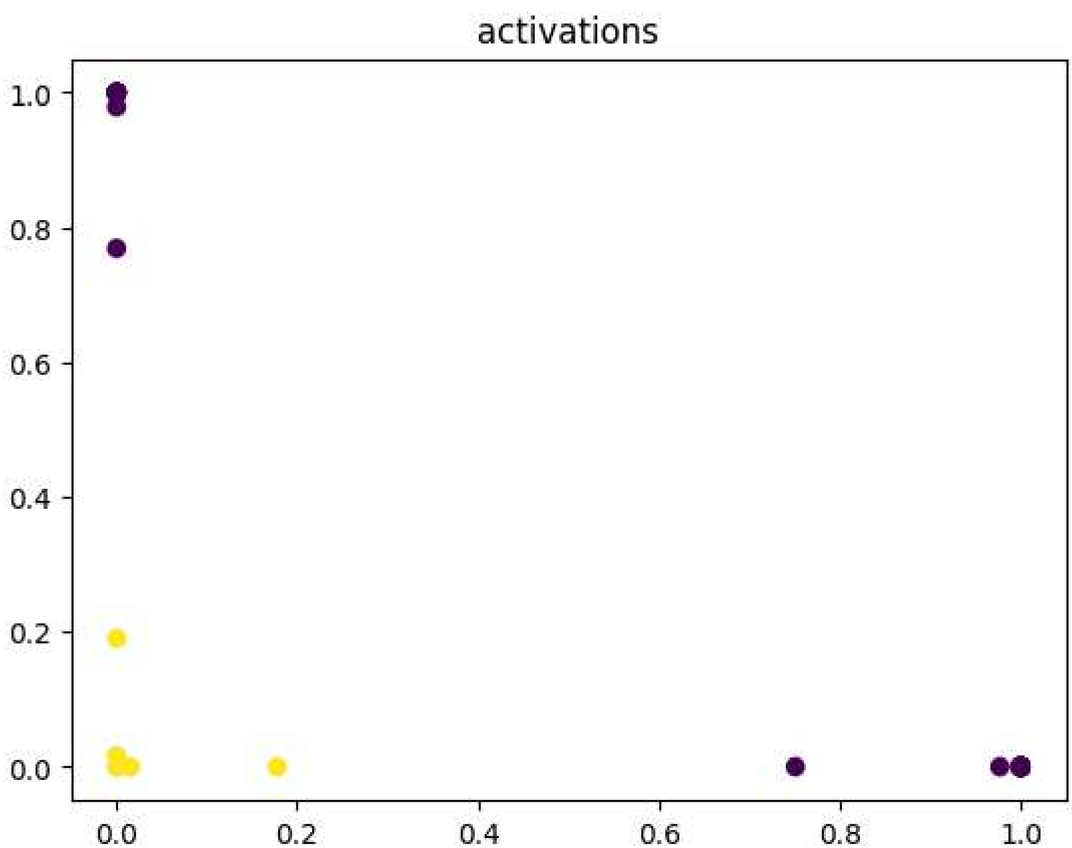

epoch 300
x
1.0
0.8
0.6
0.4
0.2
0.0
−20
−15
−10
−5
0
5
10
15
20


activations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

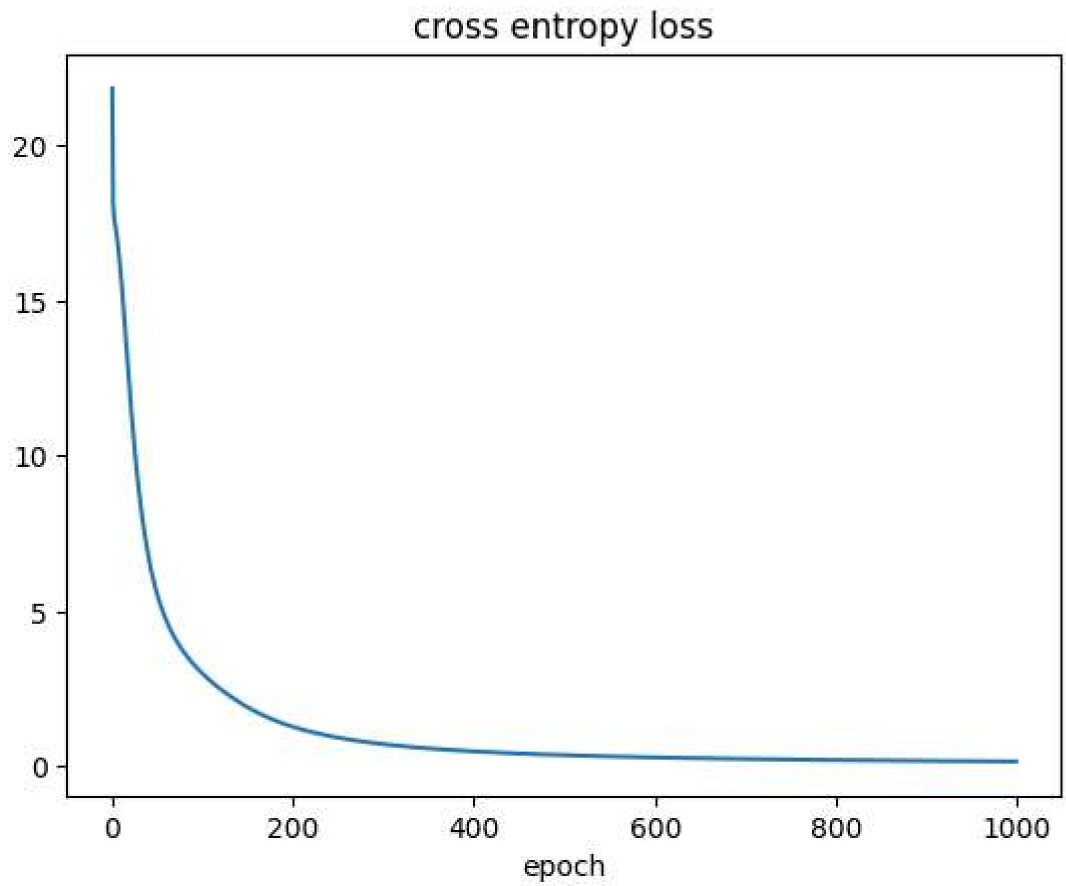

epoch 600
x
1.0
0.8
0.6
0.4
0.2
0.0
−20
−15
−10
−5
0
5
10
15
20


activations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0






```
Out[7]: Text(0.5, 1.0, 'cross entropy loss')
```



By examining the output of the activation, you see by the 600th epoch that the data has been mapped to a linearly separable space.

we can make a prediction for a arbitrary one tensors

In [8]:
```
x=torch.tensor([0.0])
yhat=model(x)
yhat
```

Out[8]:
```
tensor([0.9969], grad_fn=<SigmoidBackward0>)
```

we can make a prediction for some arbitrary one tensors

In [9]:
```
X_=torch.tensor([[0.0],[2.0],[3.0]])
Yhat=model(X_)
Yhat
```

Out[9]:
```
tensor([[0.9969],
        [0.9963],
        [0.9680]], grad_fn=<SigmoidBackward0>)
```

we can threshold the predication

In [10]:
```
Yhat=Yhat>0.5
Yhat
```

Out[10]:
```
tensor([[True],
        [True],
        [True]])
```

Practice

Repeat the previous steps above by using the MSE cost or total loss:

In [11]:
```
# Practice: Train the model with MSE Loss Function

# Type your code here
```

Double-click **here** for the solution.