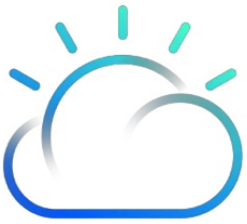


Watson Studio democratizes machine learning and deep learning to accelerate infusion of AI in your business to drive innovation. Watson Studio provides a suite of tools and a collaborative environment for data scientists, developers and domain experts.

(http://cocl.us/pytorch_link_top)

Initialization with Same Weights

Table of Contents

In this lab, we will see the problem of initializing the weights with the same value. We will see that even for a simple network, our model will not train properly. .

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 0x7f52139fd3f0>
```

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()
[:, 1], c=Y.numpy().reshape(-1))
            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 with Same Weights Initialization define, 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
- outputs))
    return out
```

Define the Neural Network

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)
```

This is the PyTorch default installation

In [8]:

```
model.state_dict()
```

Out[8]:

```
OrderedDict([('linear1.weight',
              tensor([[-0.0075],
                      [ 0.5364]])),
             ('linear1.bias', tensor([-0.8230, -0.7359])),
             ('linear2.weight', tensor([[-0.2723,  0.1896]])),
             ('linear2.bias', tensor([-0.0140]))])
```

Same Weights Initialization with all ones for weights and zeros for the bias.

In [9]:

```
model.state_dict()['linear1.weight'][0]=1.0
model.state_dict()['linear1.weight'][1]=1.0
model.state_dict()['linear1.bias'][0]=0.0
model.state_dict()['linear1.bias'][1]=0.0
model.state_dict()['linear2.weight'][0]=1.0
model.state_dict()['linear2.bias'][0]=0.0
model.state_dict()
```

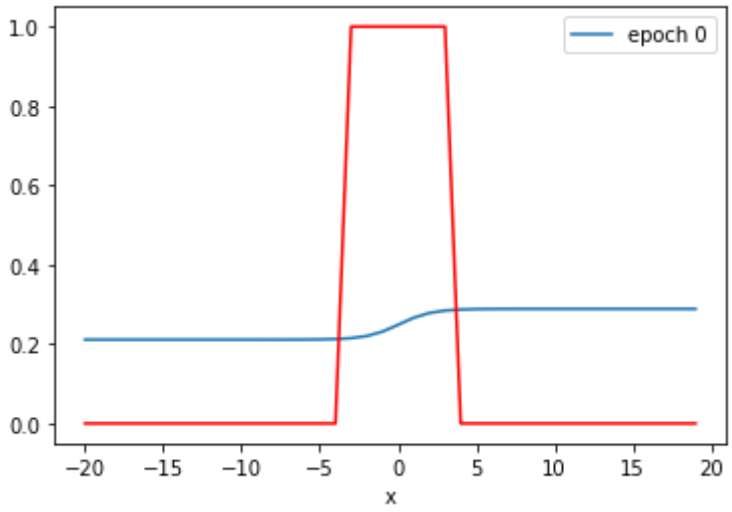
Out[9]:

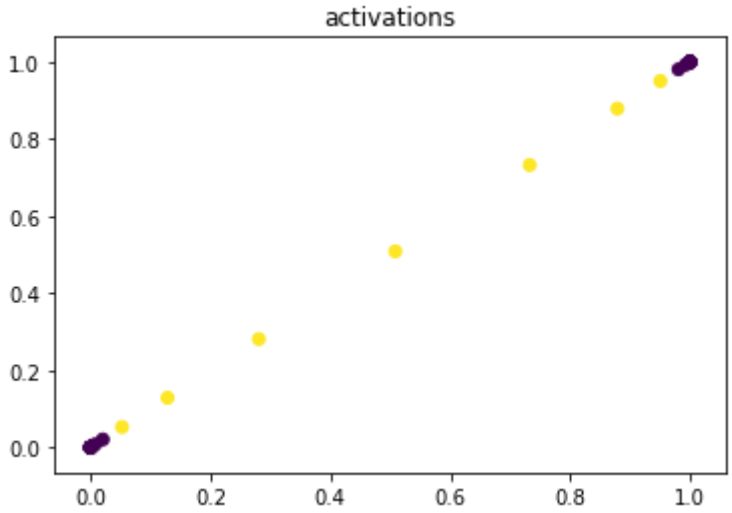
```
OrderedDict([('linear1.weight',
              tensor([[1.],
                      [1.]])),
             ('linear1.bias', tensor([0., 0.])),
             ('linear2.weight', tensor([[1., 1.]])),
             ('linear2.bias', tensor([0.]))])
```

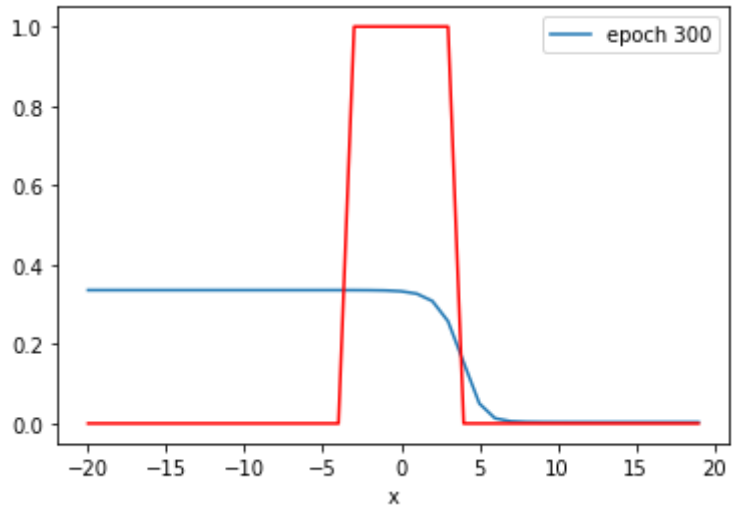
Optimizer, and Train the Model:

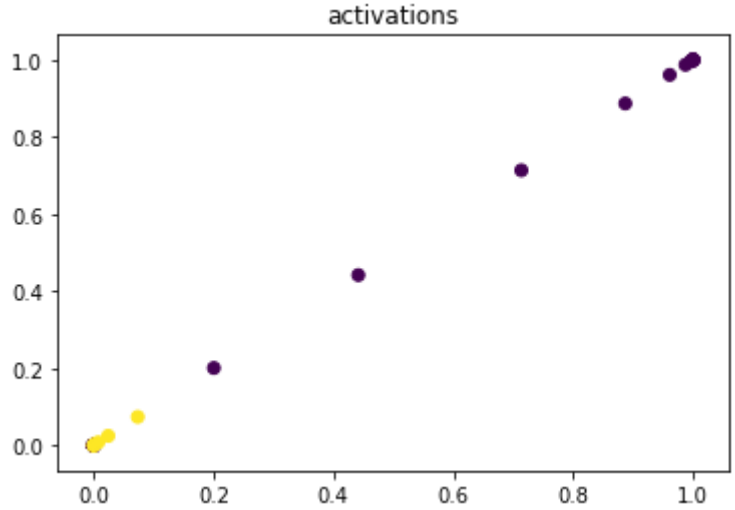
In [10]:

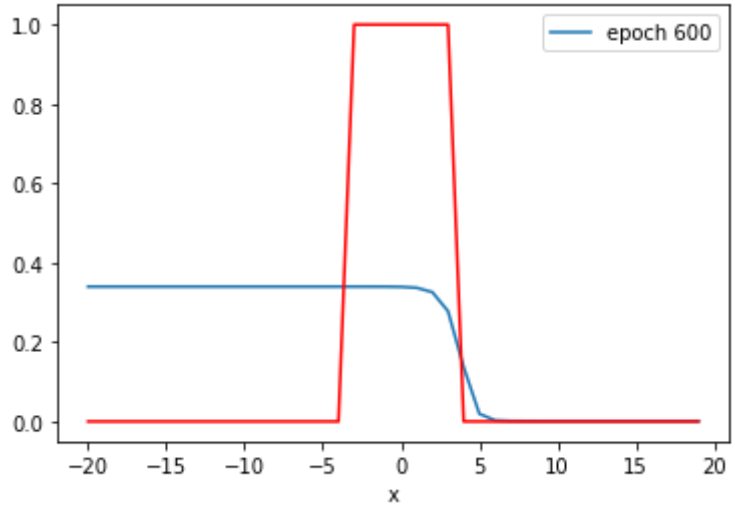
```
#optimizer
optimizer = torch.optim.SGD(model.parameters(), lr=learning_rate)
#train the model usein
cost_cross = train(Y, X, model, optimizer, criterion_cross, epochs=1000)
#plot the loss
plt.plot(cost_cross)
plt.xlabel('epoch')
plt.title('cross entropy loss')
```

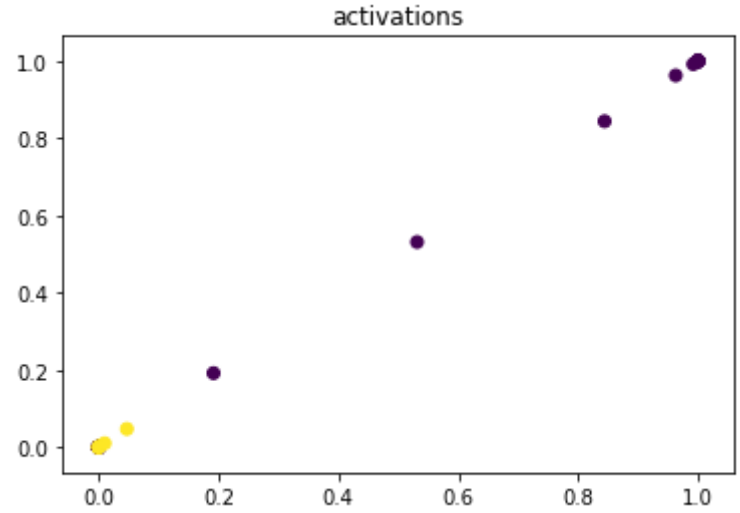

epoch 0
1.0
0.8
0.6
0.4
0.2
0.0
−20
−15
−10
−5
0
5
10
15
20
x

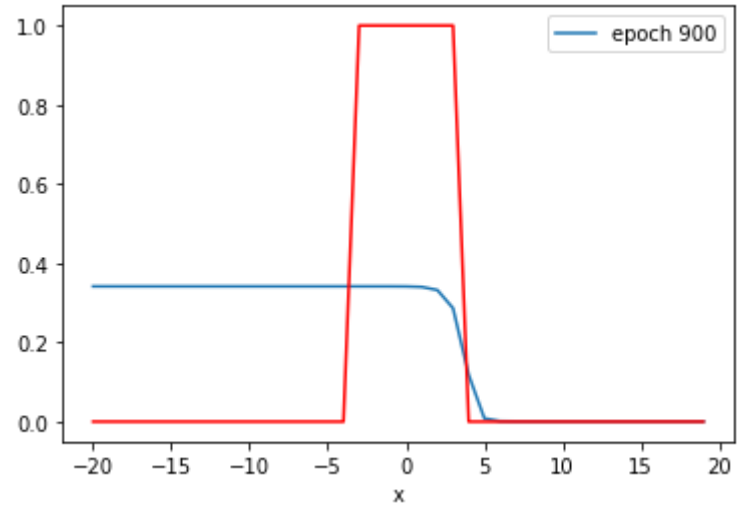

activations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

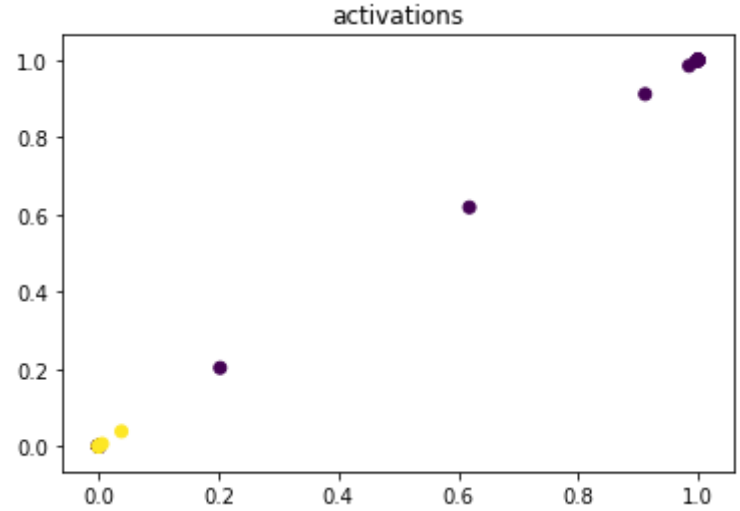

epoch 300
1.0
0.8
0.6
0.4
0.2
0.0
−20
−15
−10
−5
0
5
10
15
20
x


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

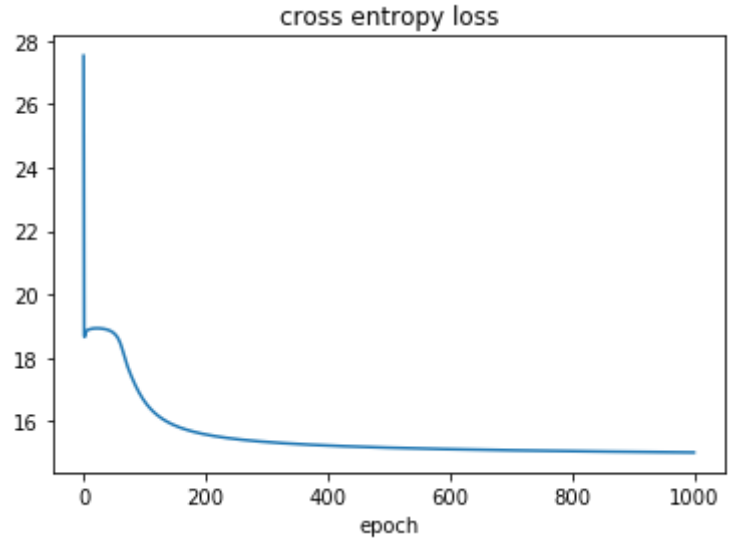






Out[10]:

```
Text(0.5, 1.0, 'cross entropy loss')
```



By examining the output of the paramters all thought they have changed they are identical.

In [11]:

```
model.state_dict()
```

Out[11]:

```
OrderedDict([('linear1.weight',
              tensor([[1.9340],
                      [1.9340]])),
             ('linear1.bias', tensor([-9.0725, -9.0725])),
             ('linear2.weight', tensor([[-3.3976, -3.3976]])),
             ('linear2.bias', tensor([-0.6546]))])
```

In [12]:

```
yhat=model(torch.tensor([[-2.0],[0.0],[2.0]]))
yhat
```

Out[12]:

```
tensor([[0.3420],
        [0.3418],
        [0.3337]], grad_fn=<SigmoidBackward>)
```

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

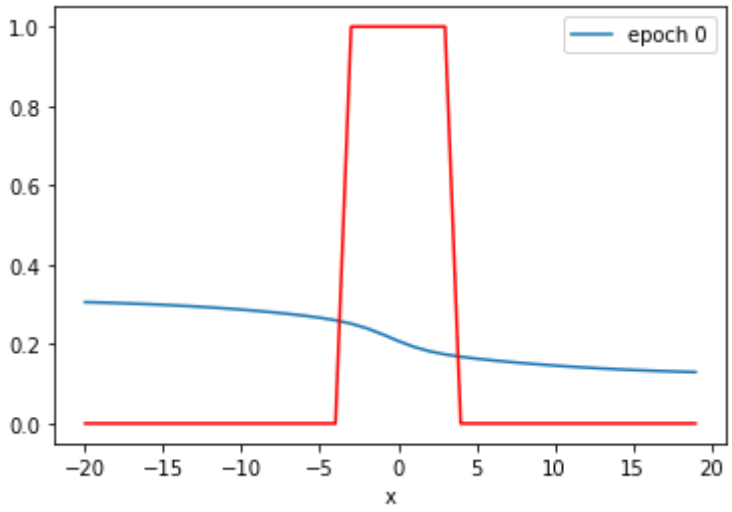
In [13]:

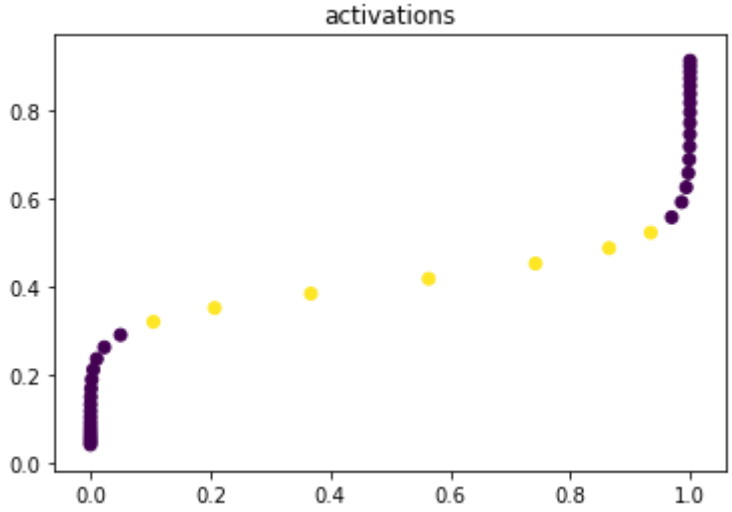
```
# Train the model
# size of input
D_in = 1
# size of hidden layer
H = 2
# number of outputs
D_out = 1
# learning rate
learning_rate = 0.1
# create the model
model = Net(D_in, H, D_out)
```

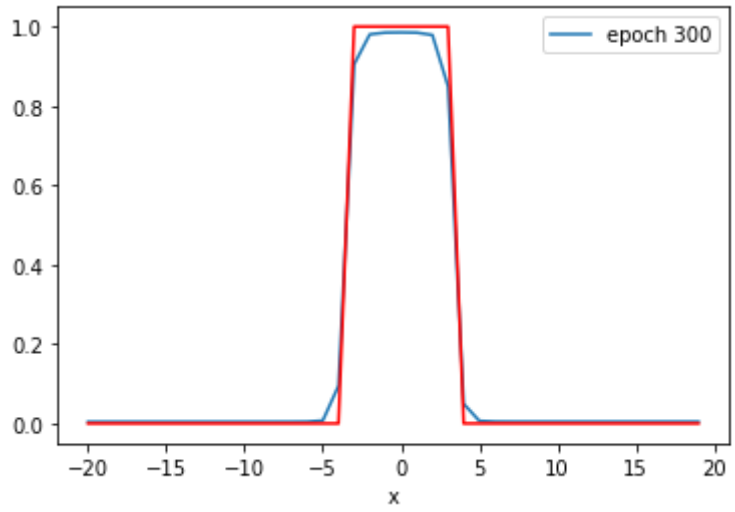
Repeat the previous steps above by using the MSE cost or total loss:

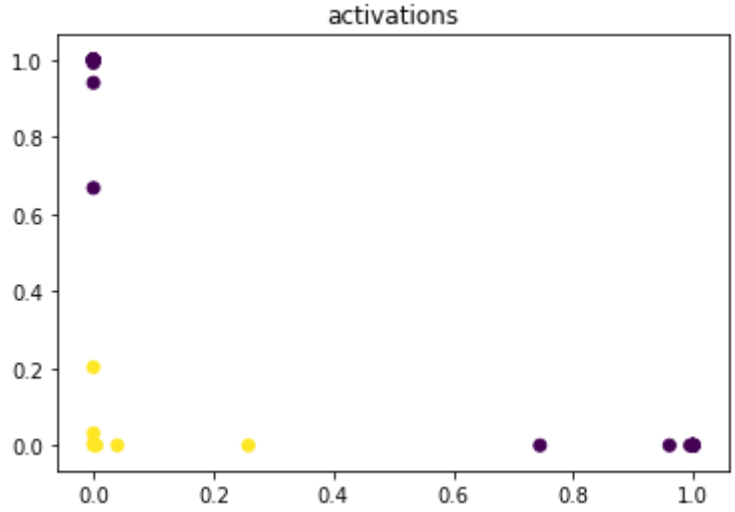
In [14]:

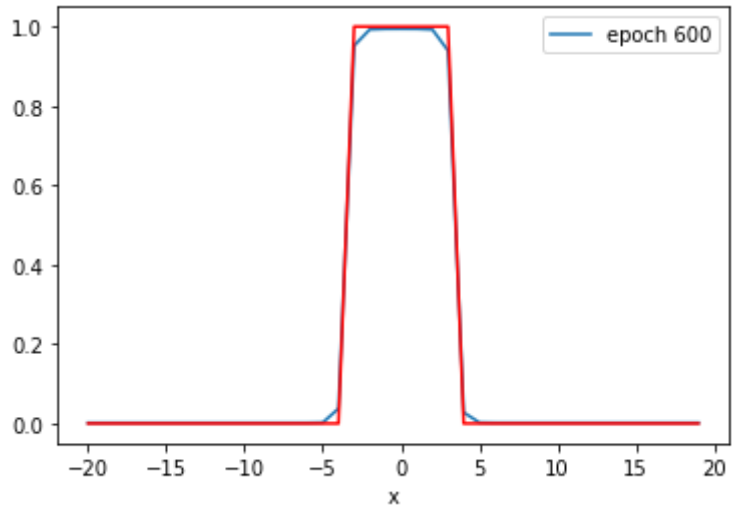
```
#optimizer
optimizer = torch.optim.SGD(model.parameters(), lr=learning_rate)
#train the model usein
cost_cross = train(Y, X, model, optimizer, criterion_cross, epochs=1000)
#plot the loss
plt.plot(cost_cross)
plt.xlabel('epoch')
plt.title('cross entropy loss')
```

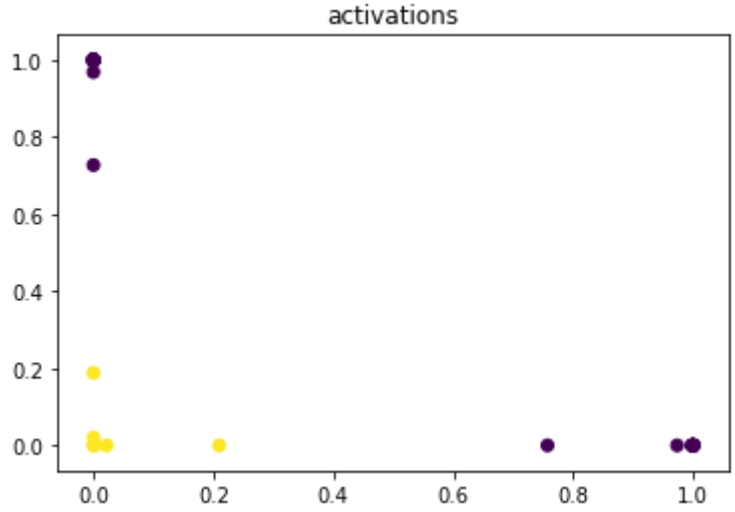

epoch 0
1.0
0.8
0.6
0.4
0.2
0.0
−20
−15
−10
−5
0
5
10
15
20
x

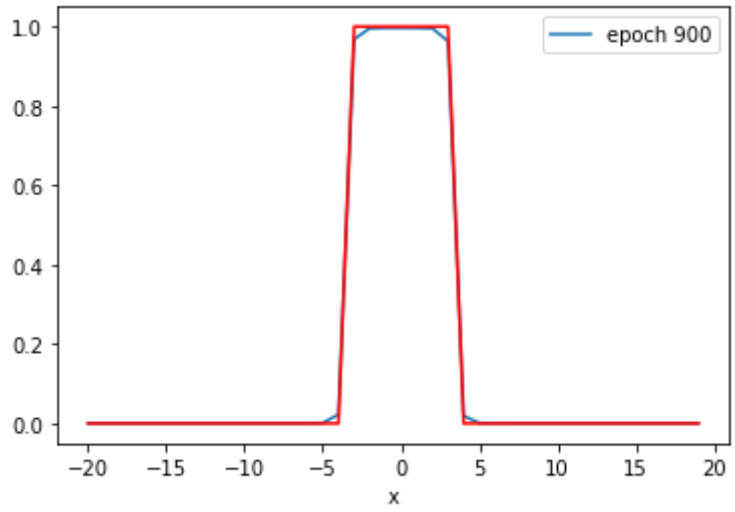

activations
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

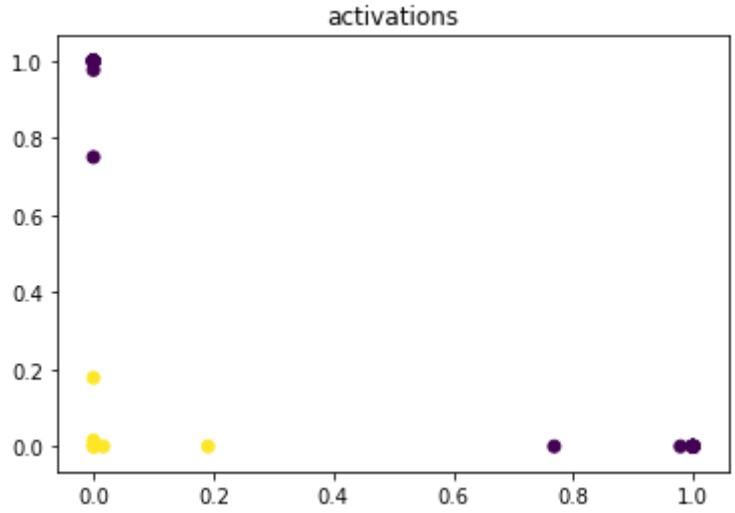

epoch 300
1.0
0.8
0.6
0.4
0.2
0.0
−20
−15
−10
−5
0
5
10
15
20
x


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

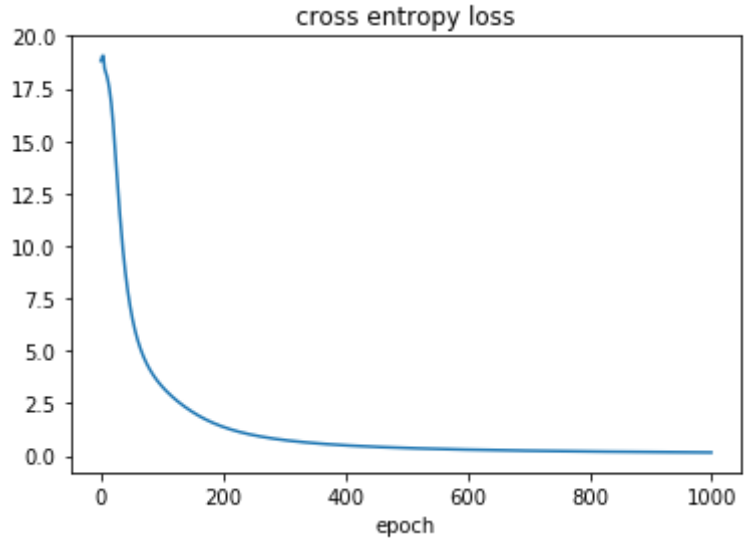

activations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0





Out[14]:

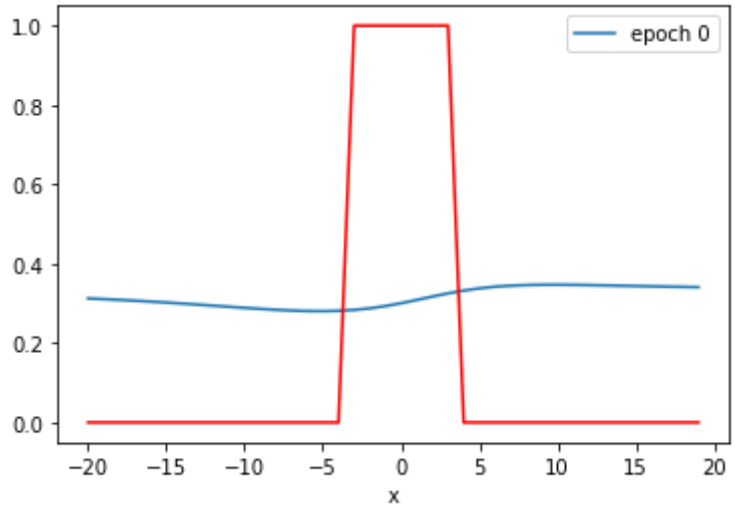
```
Text(0.5, 1.0, 'cross entropy loss')
```

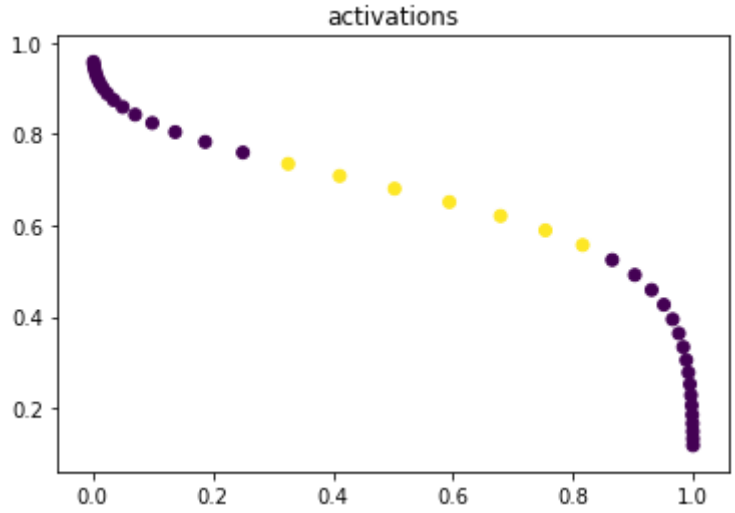

cross entropy loss
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
0
200
400
600
800
1000
epoch

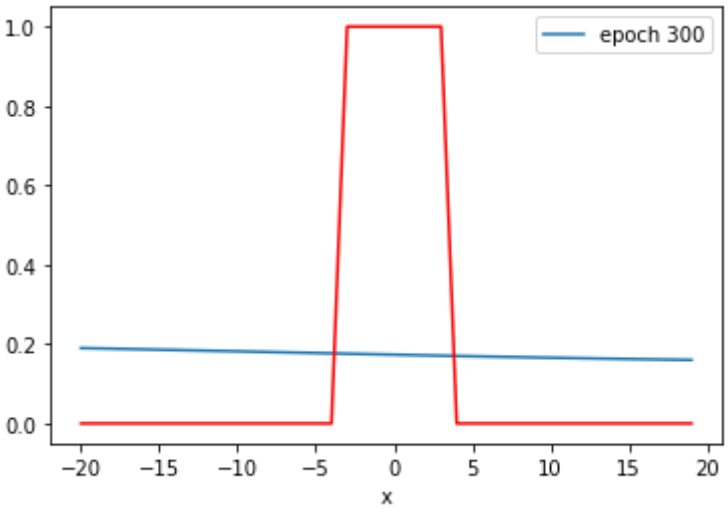
In [15]:

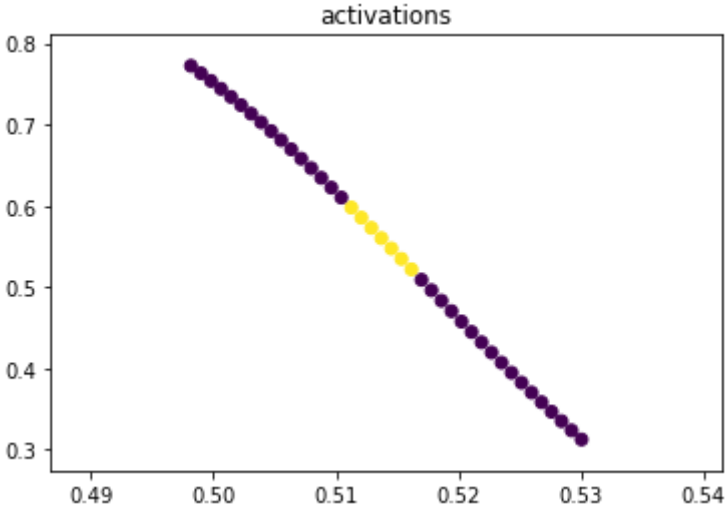
```
learning_rate = 0.1
criterion_mse=nn.MSELoss()
model=Net(D_in,H,D_out)
optimizer=torch.optim.SGD(model.parameters(), lr=learning_rate)
cost_mse=train(Y,X,model,optimizer,criterion_mse,epochs=1000)
plt.plot(cost_mse)
plt.xlabel('epoch')
plt.title('MSE loss ')
```

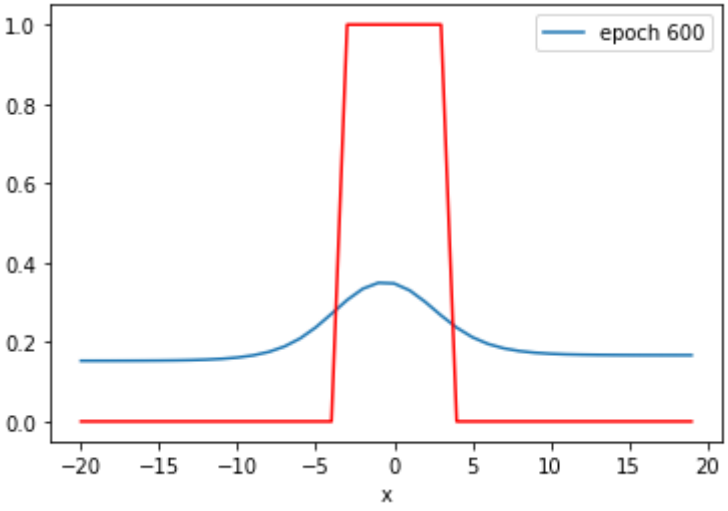
```
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages/torch/n
n/modules/loss.py:431: UserWarning: Using a target size (torch.Size
([])) that is different to the input size (torch.Size([1])). This will
likely lead to incorrect results due to broadcasting. Please ensure the
y have the same size.
  return F.mse_loss(input, target, reduction=self.reduction)
```

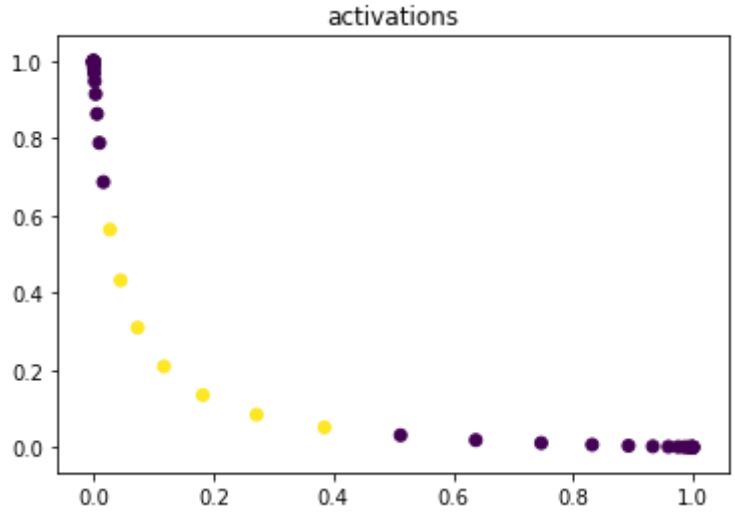


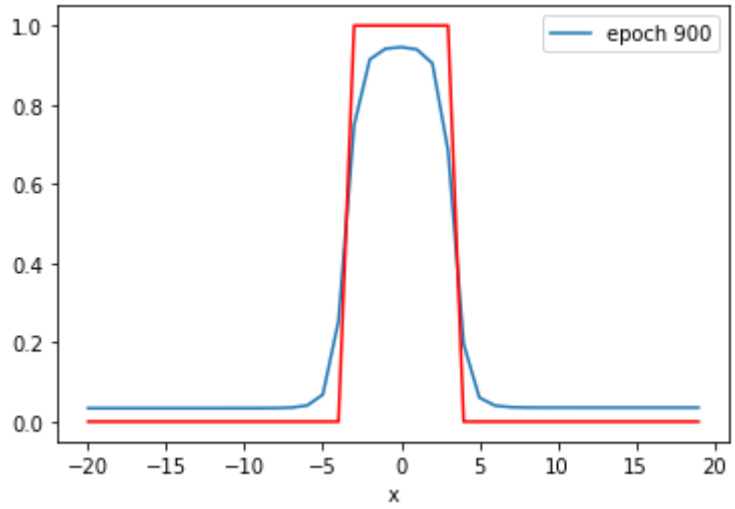


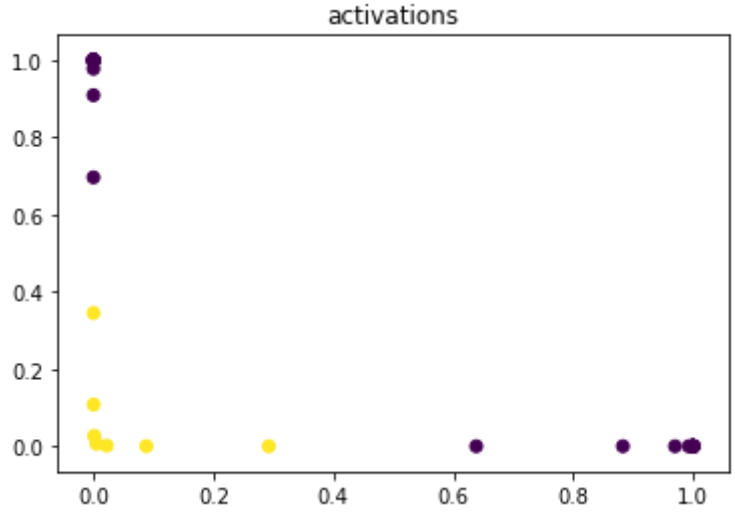

epoch 300
1.0
0.8
0.6
0.4
0.2
0.0
−20
−15
−10
−5
0
5
10
15
20
x


activations
0.8
0.7
0.6
0.5
0.4
0.3
0.49
0.50
0.51
0.52
0.53
0.54


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

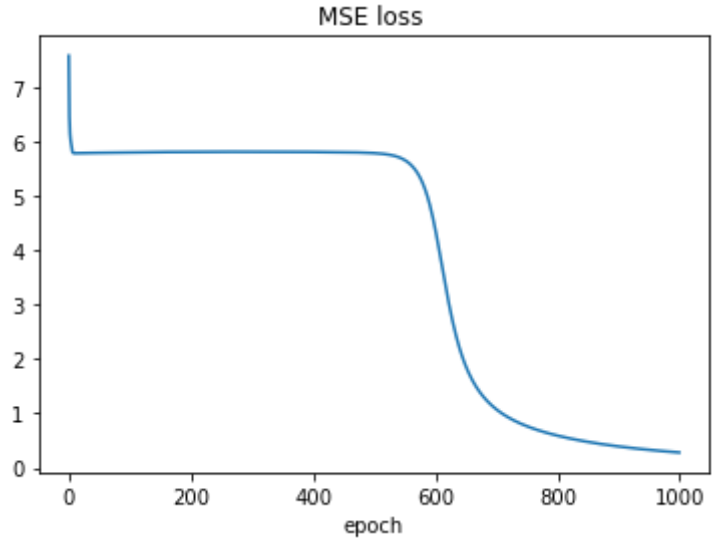

activations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


epoch 900
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

Out[15]:

```
Text(0.5, 1.0, 'MSE loss ')
```



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

About the Authors:

Joseph Santarcangelo (https://www.linkedin.com/in/joseph-s-50398b136/) has a PhD in Electrical Engineering, his research focused on using machine learning, signal processing, and computer vision to determine how videos impact human cognition. Joseph has been working for IBM since he completed his PhD.

Other contributors: Michelle Carey (https://www.linkedin.com/in/michelleccarey/), Mavis Zhou (www.linkedin.com/in/jiahui-mavis-zhou-a4537814a)