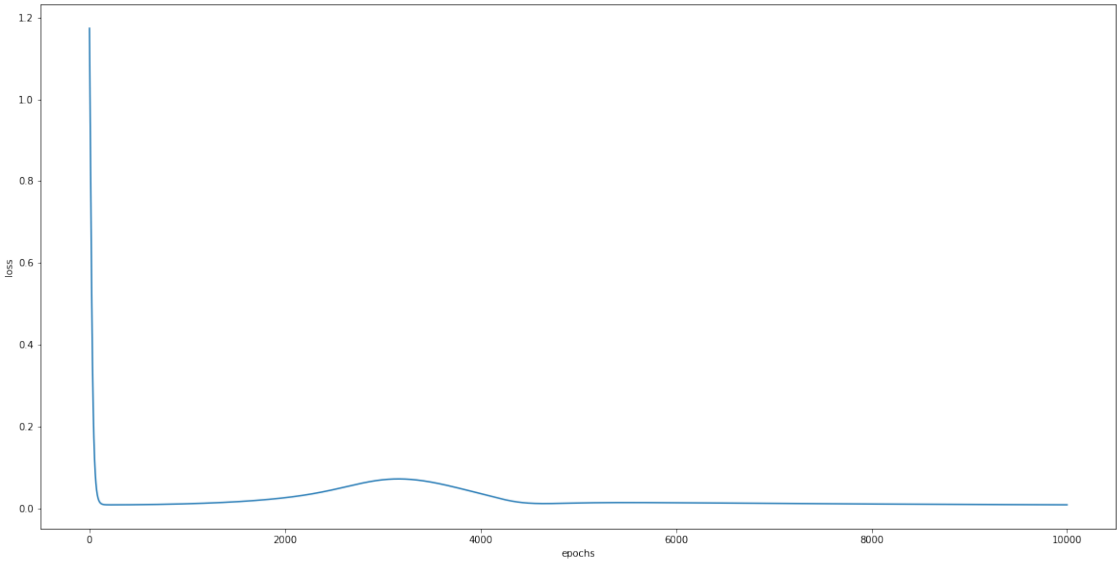
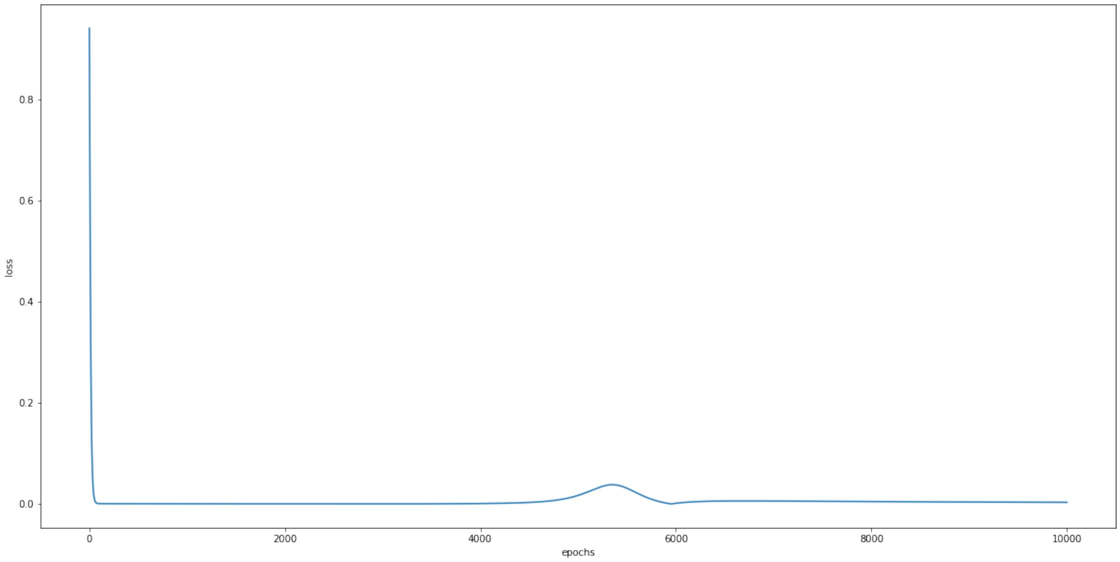
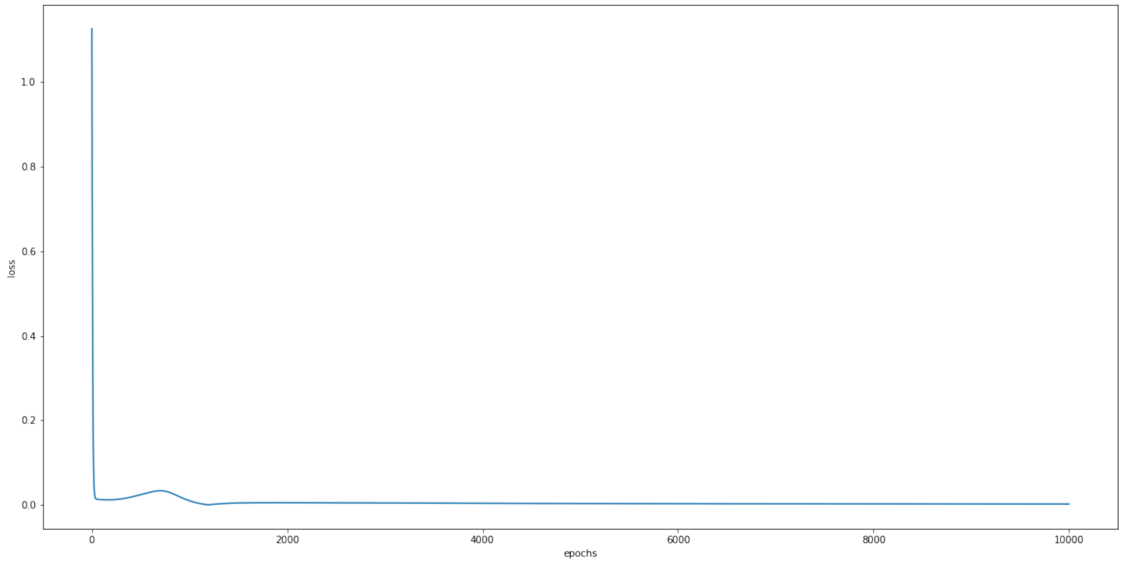
q2

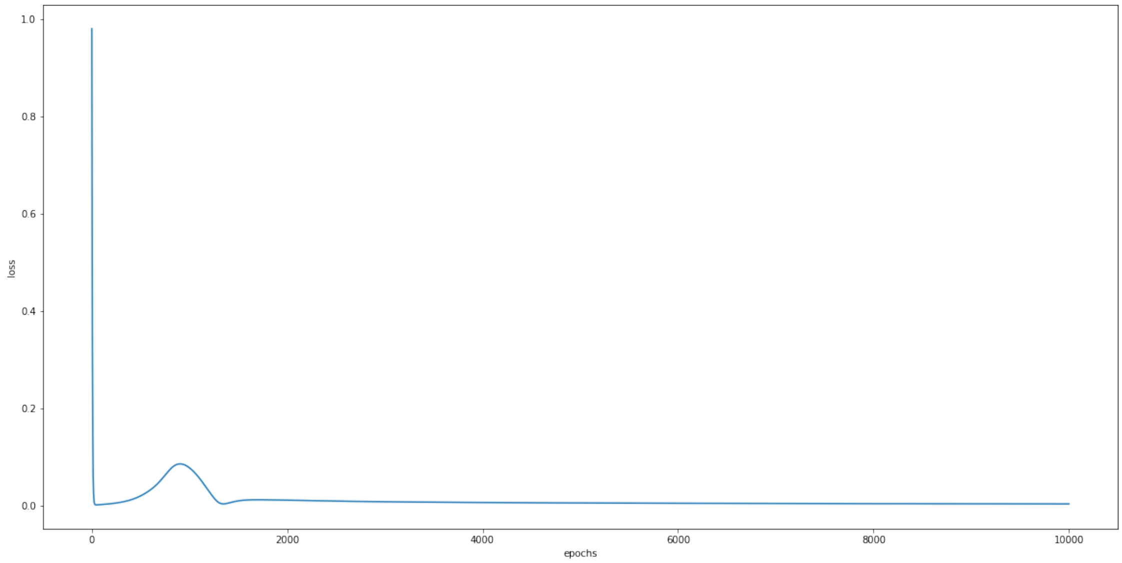
November 19, 2019

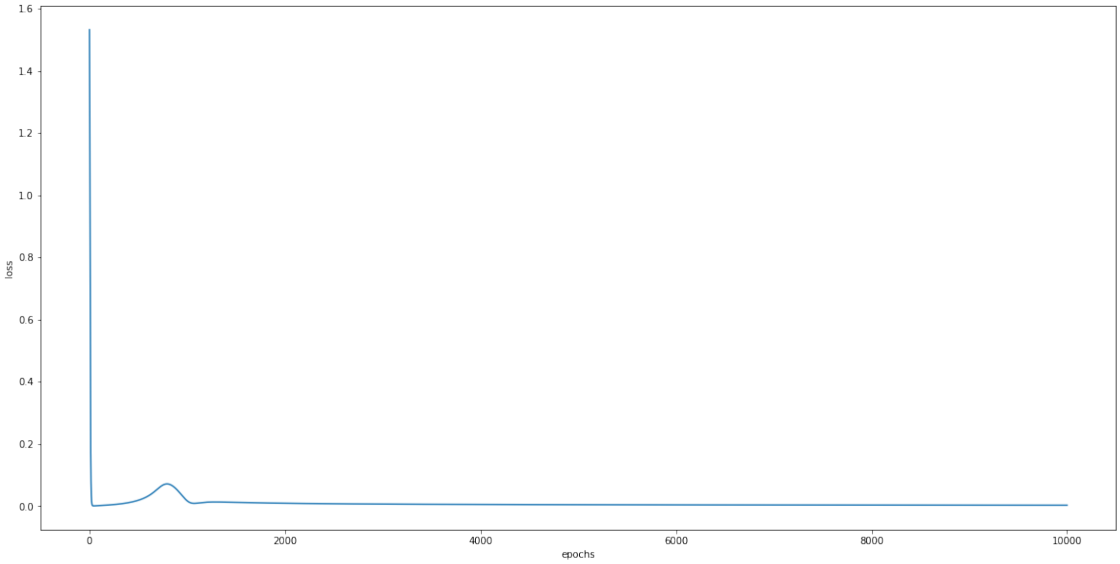
```
In [10]: import numpy as np
         import matplotlib.pyplot as plt

In [11]: #inputs
         inputs_xor = np.array([[0,0], [0,1],[1,0],[1,1]])
         exp_output_xor = np.array([[0],[1],[1],[0]])

         inputs_nand = np.array([[0,0], [0,1],[1,0],[1,1]])
         exp_output_nand = np.array([[1],[1],[1],[0]])

In [12]: def sigmoid (x):
             return 1/(1+np.exp(-x))

In [13]: def sigmoid_derivative (x):
             return x*(1-x)

In [14]: def train(inputs, exp_output, epochs = 10000, learning_rate = 0.1):
             input_layer_neurons = 2
             hidden_layer_neurons = 2
             output_layer_neurons = 1

             hidden_layer_weights = np.random.uniform(size=(input_layer_neurons, hidden_layer_n
             hidden_bias = np.random.uniform(size=(1,hidden_layer_neurons))
             output_layer_weight = np.random.uniform(size=(hidden_layer_neurons,output_layer_ne
             output_bias = np.random.uniform(size=(1,output_layer_neurons))

             loss = []
             epochs_arr = []

             for epoch in range(epochs):
                 hidden_layer_activation = np.dot(inputs, hidden_layer_weights)
                 hidden_layer_activation += hidden_bias
                 hidden_layer_output = sigmoid(hidden_layer_activation)

                 output_layer_activation = np.dot(hidden_layer_output, output_layer_weight)
                 output_layer_activation += output_bias

                 predicted_output = sigmoid(output_layer_activation)
                 #error
                 error = exp_output - predicted_output
                 derivative_predicted_output = error*sigmoid_derivative(predicted_output)

                 error_hidden_layer = derivative_predicted_output.dot(output_layer_weight.T)
                 derivative_hidden_layer_output = error_hidden_layer*sigmoid_derivative(hidden_

                 output_layer_weight += hidden_layer_output.T.dot(derivative_predicted_output)
                 output_bias += np.sum(derivative_predicted_output, axis=0 , keepdims=True) * l
                 hidden_layer_weights += inputs.T.dot(derivative_hidden_layer_output) * learnin
                 hidden_bias += np.sum(derivative_hidden_layer_output, axis=0, keepdims=True) *

                 epochs_arr.append(epoch+1)
                 loss.append(np.sum(error))

             return epochs_arr, loss

In [15]: #XOR

         loss_lr_data = []
         lr_val = []

         for lr in range(9):
             epochs_arr , loss = train(inputs_xor, exp_output_xor, learning_rate=(lr+1)/10)
             loss = np.absolute(loss)

             lr_val.append((lr+1)/10)
             loss_lr_data.append(loss[-1])


             %matplotlib inline
             plt.rcParams['figure.figsize'] = [20,10]
             plt.xlabel('epochs')
             plt.ylabel('loss')
             plt.plot(epochs_arr, loss)
             plt.show()
```

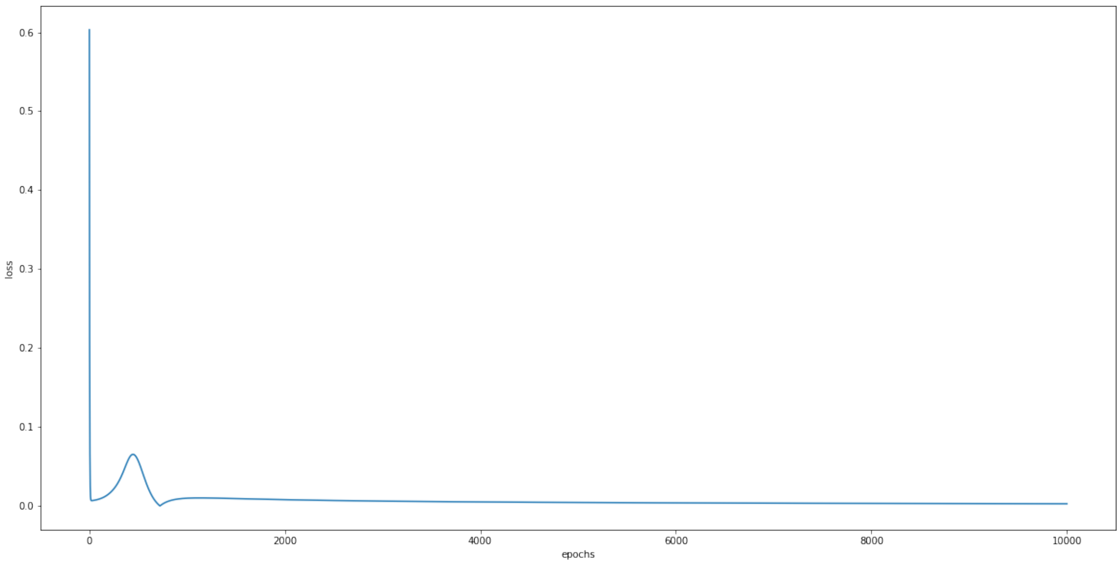

1.2
1.0
0.8
0.6
0.4
0.2
0.0
loss
0
2000
4000
6000
8000
10000
epochs

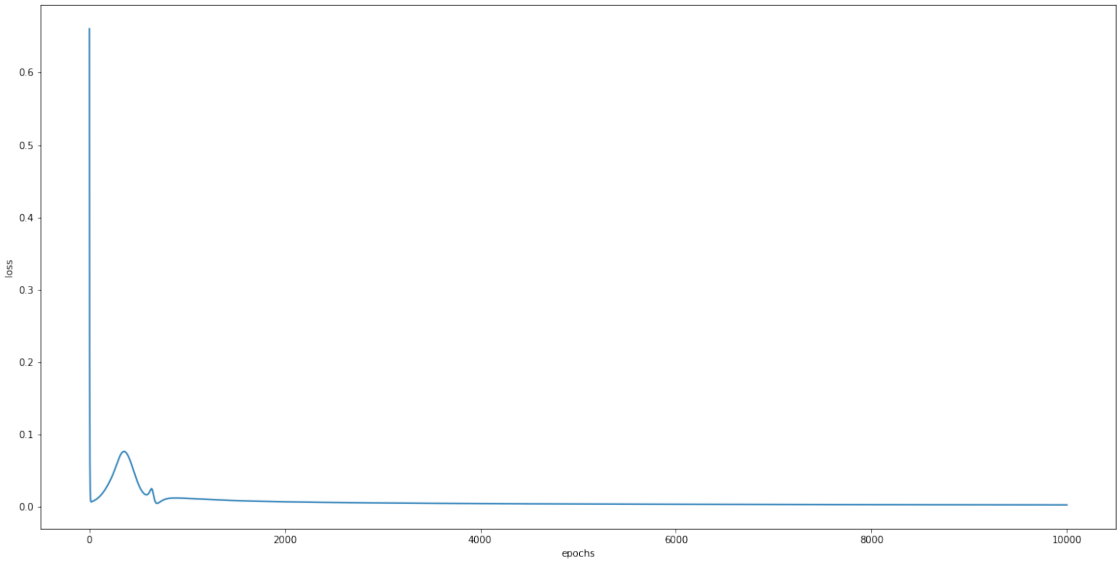

0.8
0.6
0.4
0.2
0.0
loss
0
2000
4000
6000
8000
10000
epochs

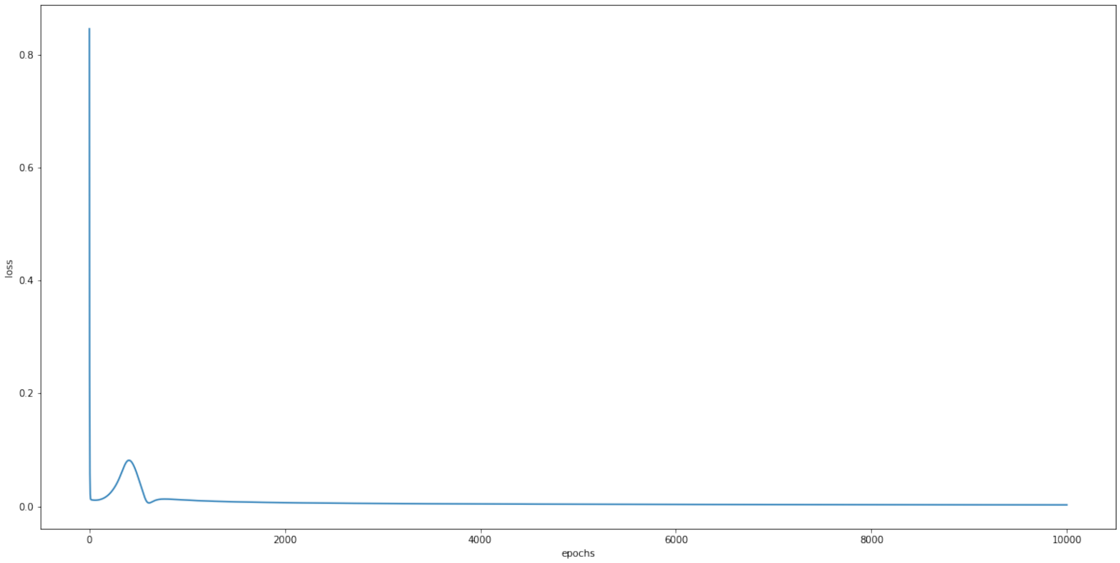

loss
1.0
0.8
0.6
0.4
0.2
0.0
0
2000
4000
6000
8000
10000
epochs

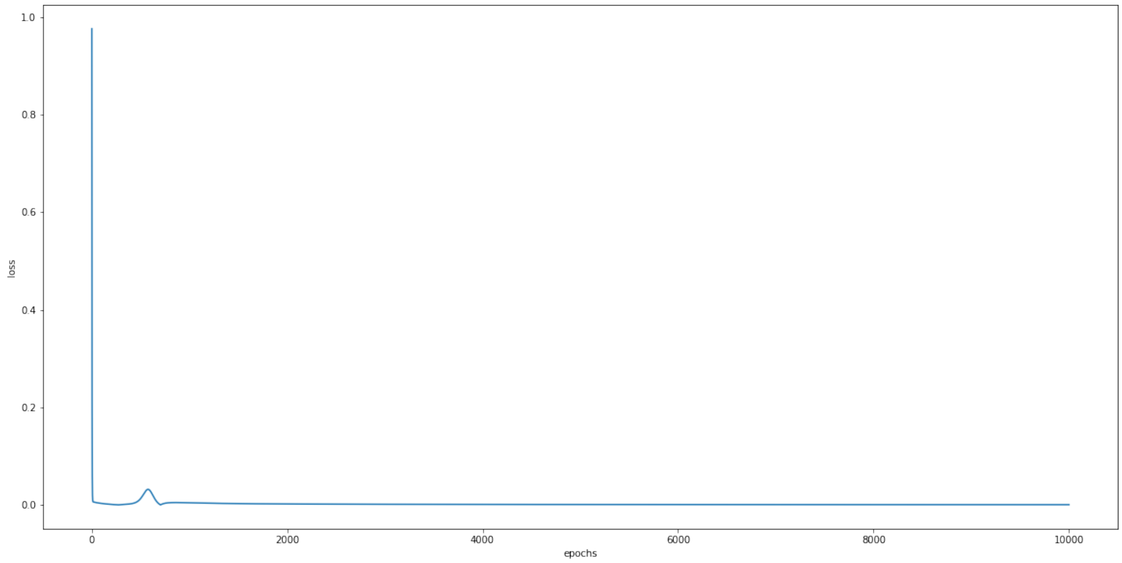

loss
1.0
0.8
0.6
0.4
0.2
0.0
0
2000
4000
6000
8000
10000
epochs


1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
loss
0
2000
4000
6000
8000
10000
epochs

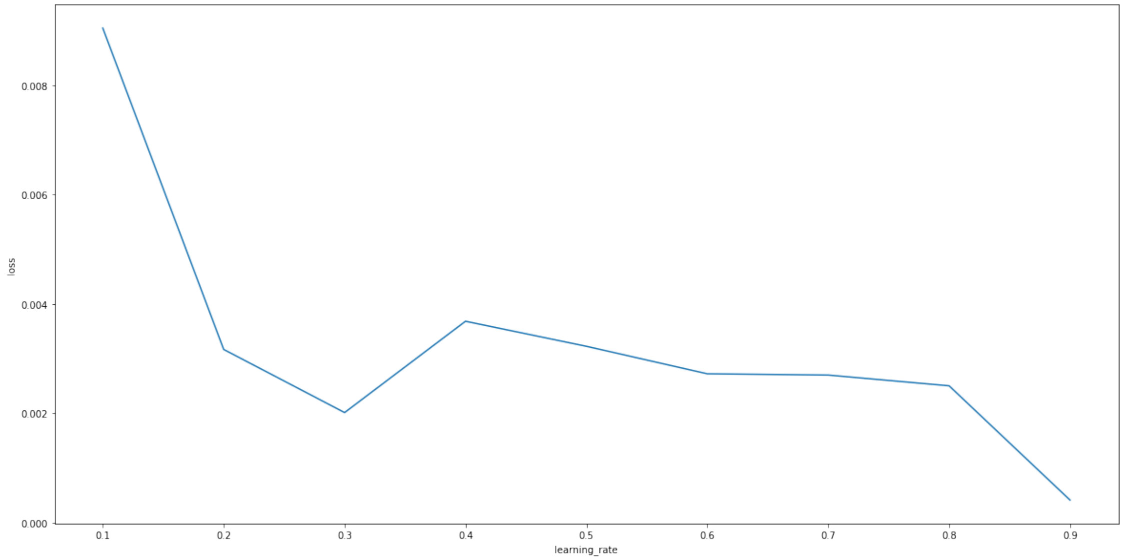

0.6
0.5
0.4
0.3
0.2
0.1
0.0
loss
0
2000
4000
6000
8000
10000
epochs


0.6
0.5
0.4
0.3
0.2
0.1
0.0
loss
0
2000
4000
6000
8000
10000
epochs


0.8
0.6
0.4
0.2
0.0
loss
0
2000
4000
6000
8000
10000
epochs

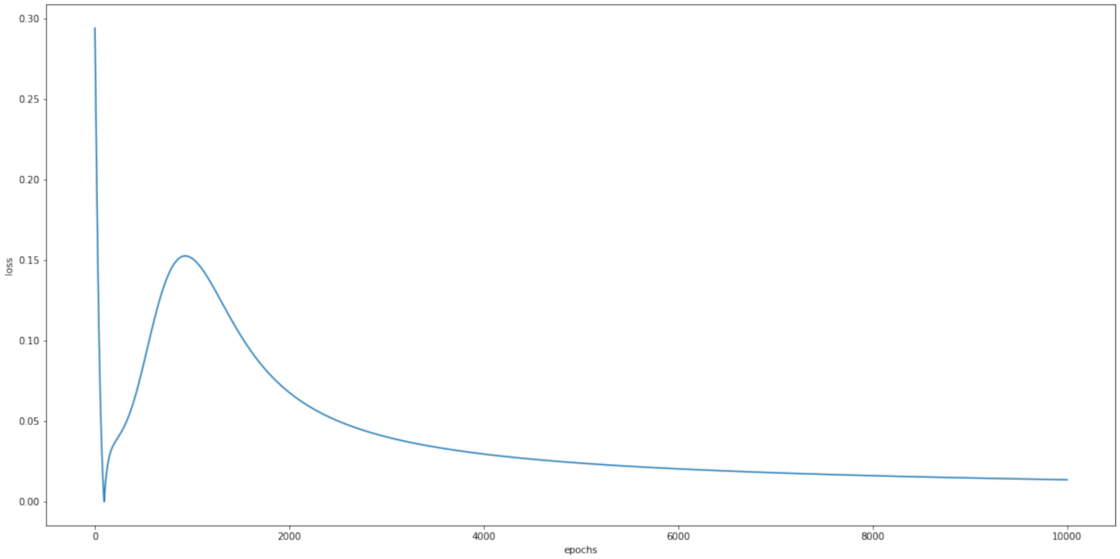


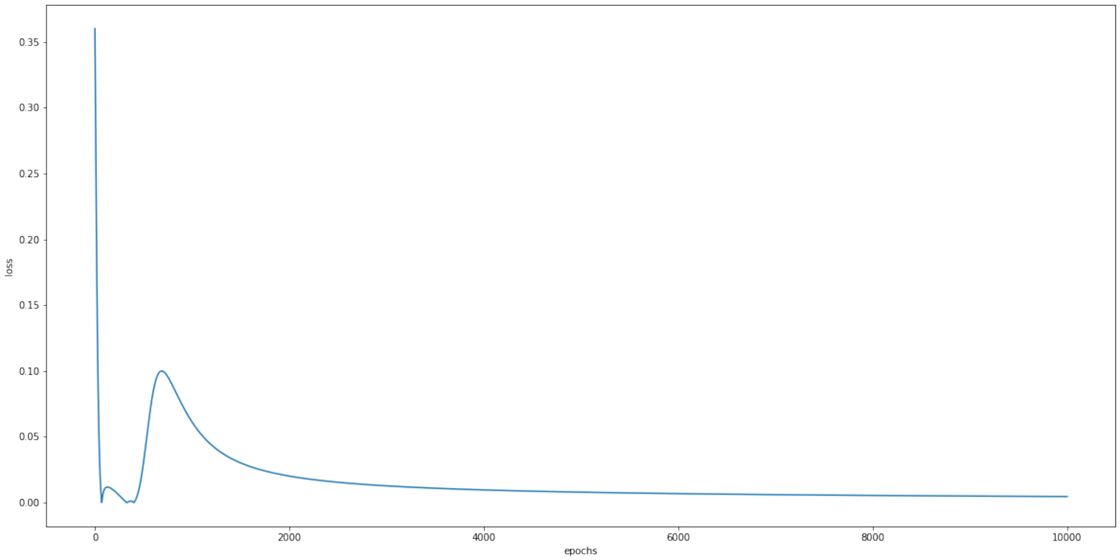
```
In [16]: %matplotlib inline
         plt.rcParams['figure.figsize'] = [20,10]
         plt.xlabel('learning_rate')
         plt.ylabel('loss')
         plt.plot(lr_val, loss_lr_data)
         plt.show()
```

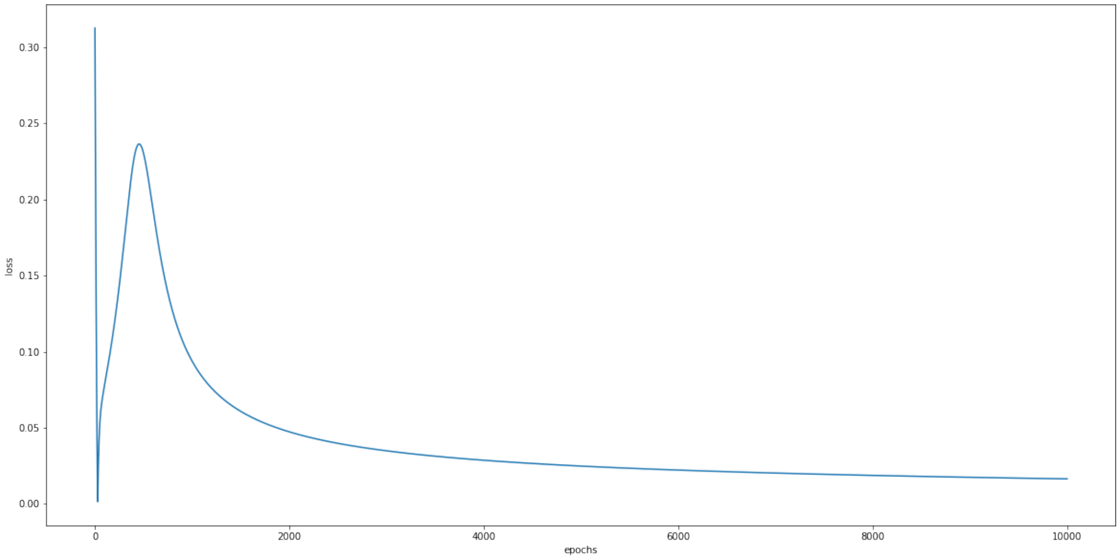


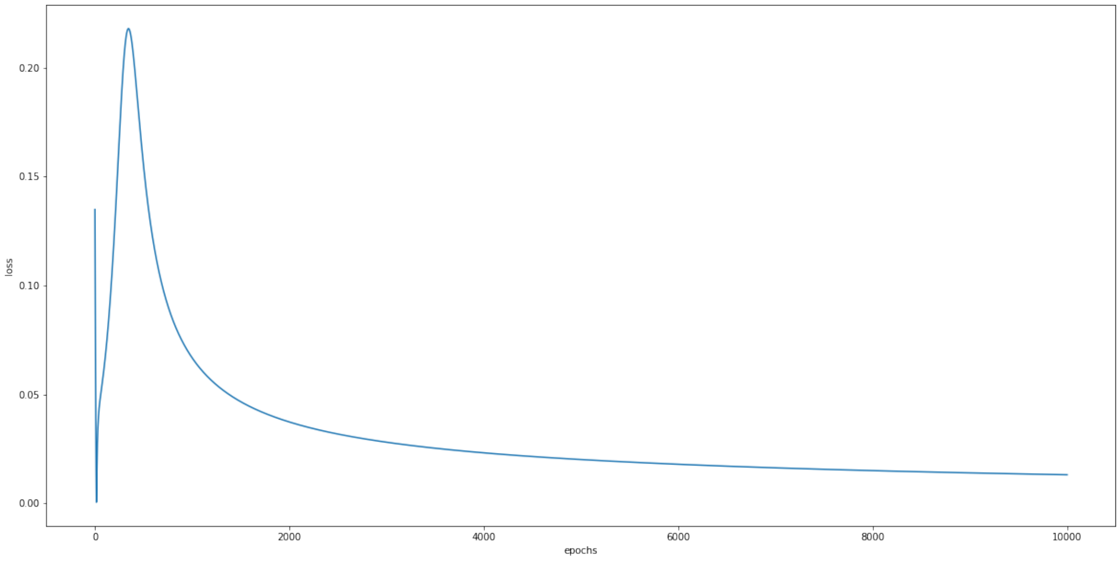
```
In [17]: # NAND
         loss_lr_data = []
```

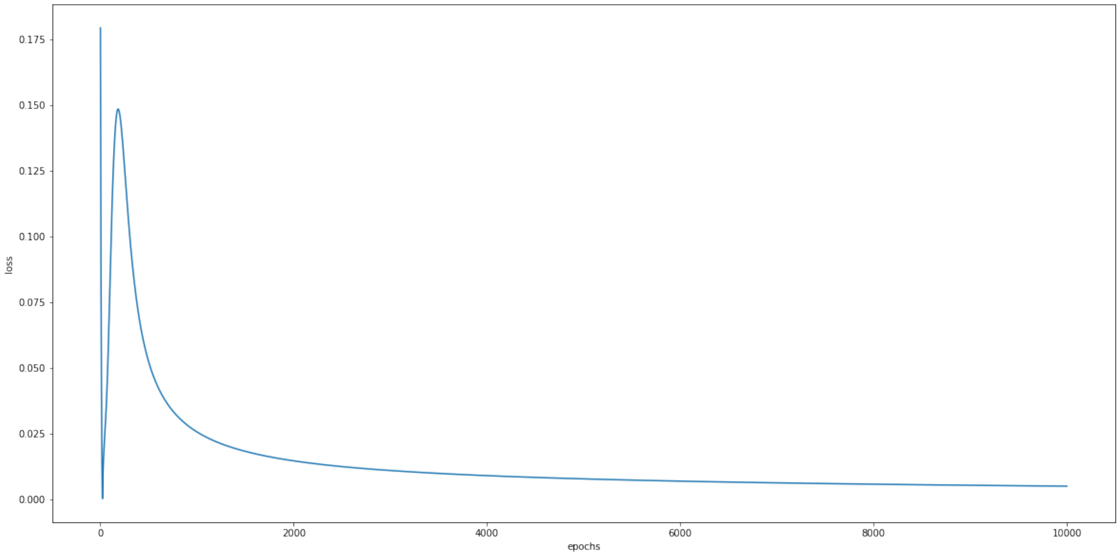
```
lr_val = []

for lr in range(9):
    epochs_arr , loss = train(inputs_nand, exp_output_nand, learning_rate=(lr+1)/10)
    loss = np.absolute(loss)

    lr_val.append((lr+1)/10)
    loss_lr_data.append(loss[-1])


    %matplotlib inline
    plt.rcParams['figure.figsize'] = [20,10]
    plt.xlabel('epochs')
    plt.ylabel('loss')
    plt.plot(epochs_arr, loss)
    plt.show()
```

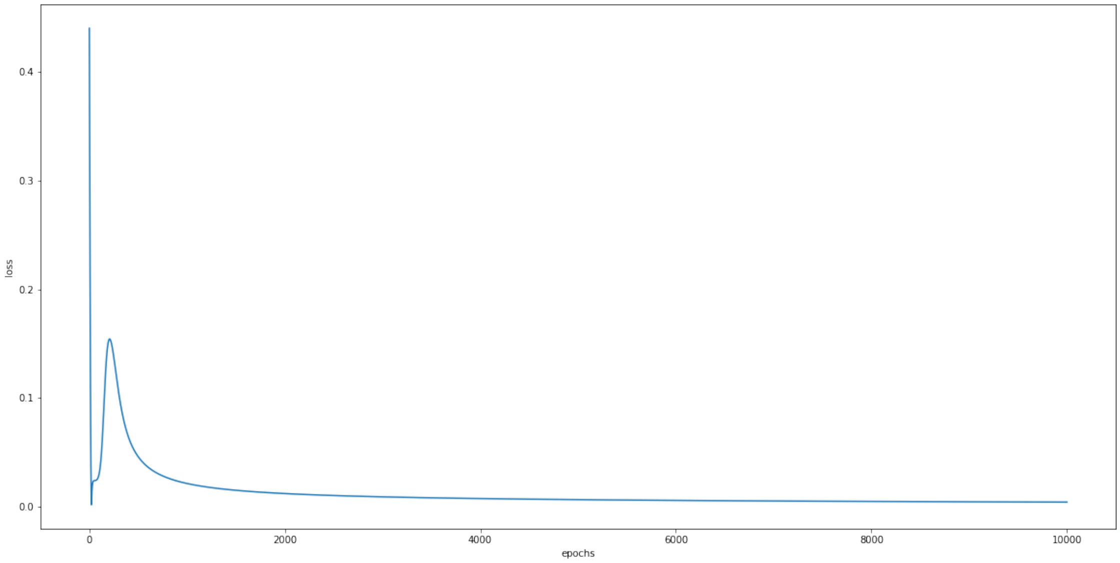


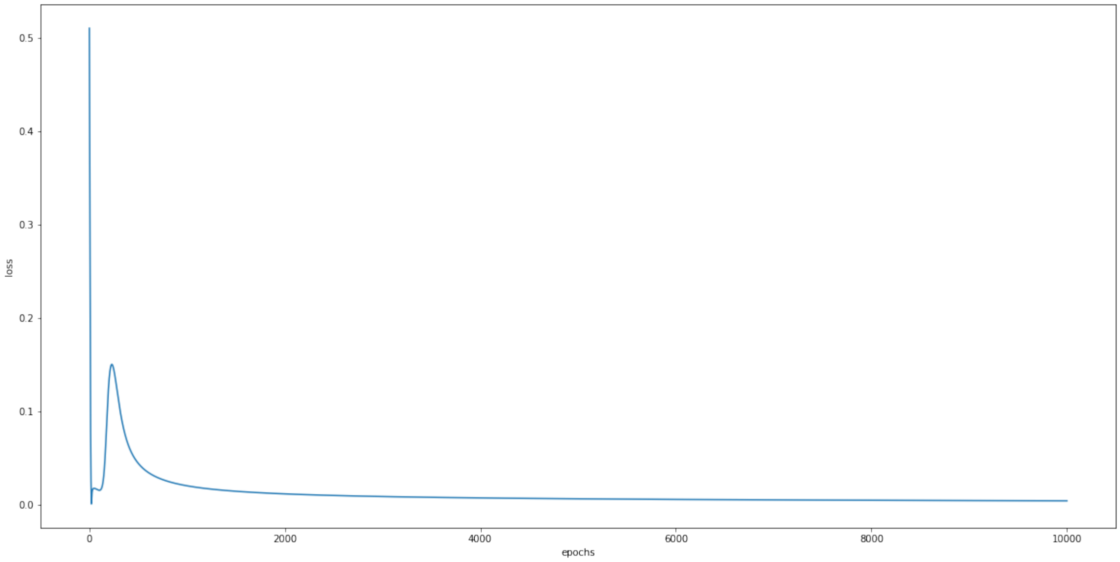

0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
loss
0
2000
4000
6000
8000
10000
epochs

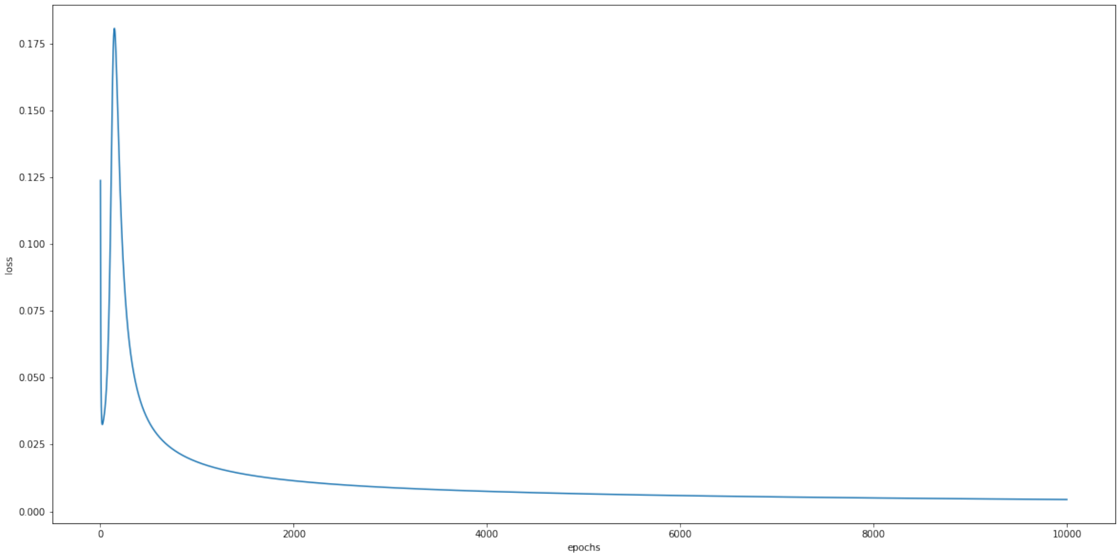

0.30
0.25
0.20
0.15
0.10
0.05
0.00
loss
0
2000
4000
6000
8000
10000
epochs

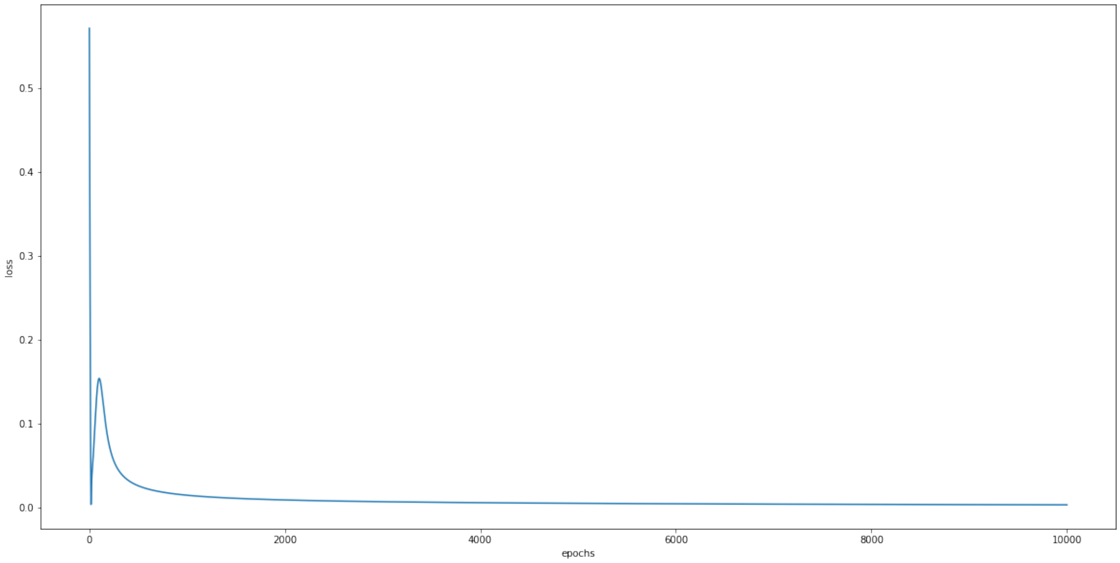

0.20
0.15
0.10
0.05
0.00
loss
0
2000
4000
6000
8000
10000
epochs


0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
loss
0
2000
4000
6000
8000
10000
epochs

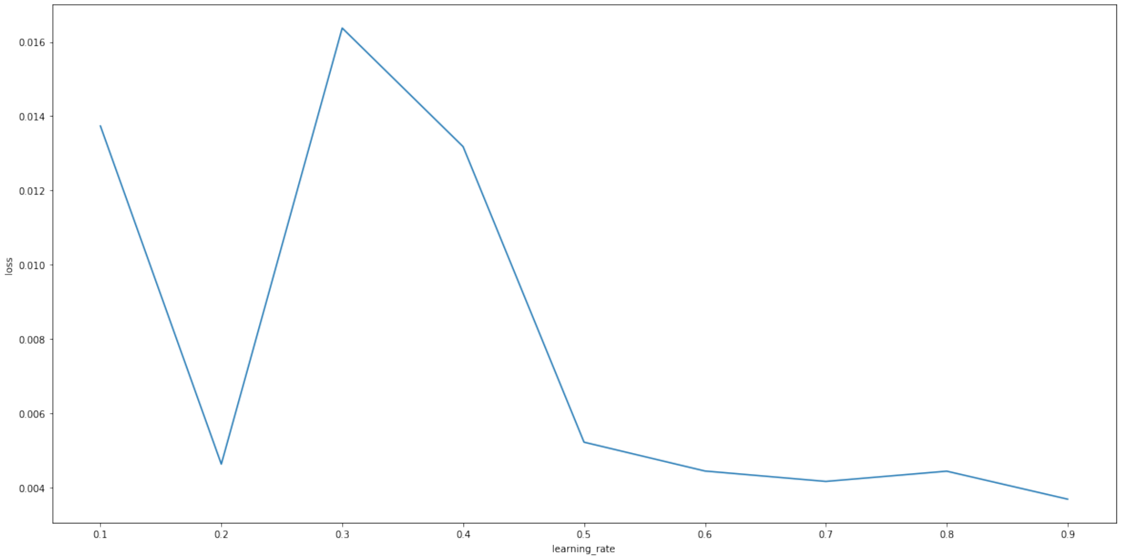

loss
0.4
0.3
0.2
0.1
0.0
0
2000
4000
6000
8000
10000
epochs


loss
0.5
0.4
0.3
0.2
0.1
0.0
0
2000
4000
6000
8000
10000
epochs





```
In [18]: %matplotlib inline
         plt.rcParams['figure.figsize'] = [20,10]
         plt.xlabel('learning_rate')
         plt.ylabel('loss')
         plt.plot(lr_val, loss_lr_data)
         plt.show()
```


0.016
0.014
0.012
0.010
0.008
0.006
0.004
loss
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
learning_rate