**Project 3: Classification Using Neural Networks and Deep Learning**

**Student ID:1228855799**

**1.Evaluate function**

def evaluate(net, images, labels):

acc = 0

loss = 0

batch\_size = 1

for batch\_index in range(0, images.shape[0], batch\_size):

x = images[batch\_index]

y = labels[batch\_index]

# forward pass

for l in range(net.lay\_num):

output = net.layers[l].forward(x)

x = output

loss += cross\_entropy(output, y)

if np.argmax(output) == np.argmax(y):

acc += 1

return acc/images.shape[0], loss/images.shape[0]

**2.result**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Epoch | Training Accuracy | Training Loss | Testing Accuracy | Testing Loss |
| 0 | 0.2965 | 1.3830875032182841 | 0.3 | 1.3830887906368359 |
| 1 | 0.309 | 1.3536456949413702 | 0.3025 | 1.3552335026855165 |
| 2 | 0.4705 | 1.0915077176182397 | 0.5125 | 1.0862454486735826 |
| 3 | 0.612 | 0.95172967880122605 | 0.59 | 0.95303149334059123 |
| 4 | 0.6675 | 0.82984300895682073 | 0.6425 | 0.85814790074973657 |
| 5 | 0.7005 | 0.75603867928898849 | 0.67 | 0.80745050396905127 |
| 6 | 0.7245 | 0.70178852994077268 | 0.6925 | 0.77150155679334165 |
| 7 | 0.7485 | 0.64920300268843656 | 0.7125 | 0.73643288036561028 |
| 8 | 0.7655 | 0.60696330362291773 | 0.71 | 0.70198813911769153 |
| 9 | 0.782 | 0.57060625920707908 | 0.72 | 0.68439108756924927 |

Training Accuracy, Training Loss, Testing Accuracy, Testing Loss output for epoch = 0.782, 0.57060625920707908, 0.72, 0.68439108756924927 were submitted.

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**3.Conclusion**  
As the number of tests increases, the accuracy of the training and the accuracy of the testing continues to increase. The lost value of training and the lost value of testing generated by the process keeps decreasing.