

## Assignment 5

Yazeed Alsobuh

### 1. Give the structure of your ANN

- The neural network consists of 3 layers, the first layer is the input layer which has 784 nodes each node corresponds to a pixel in the image. And then comes the hidden layer which has 10 nodes and it uses ReLU activation function. And finally the output layer which has 10 nodes each corresponds to the 10 possible classes of the images (0 - 9), and it uses softmax activation function. The learning rate, which is a hyperparameter that determines how much the weights are updated in each iteration of the training process, is chosen to be 0.1, it was chosen empirically as it provided good results during testing.

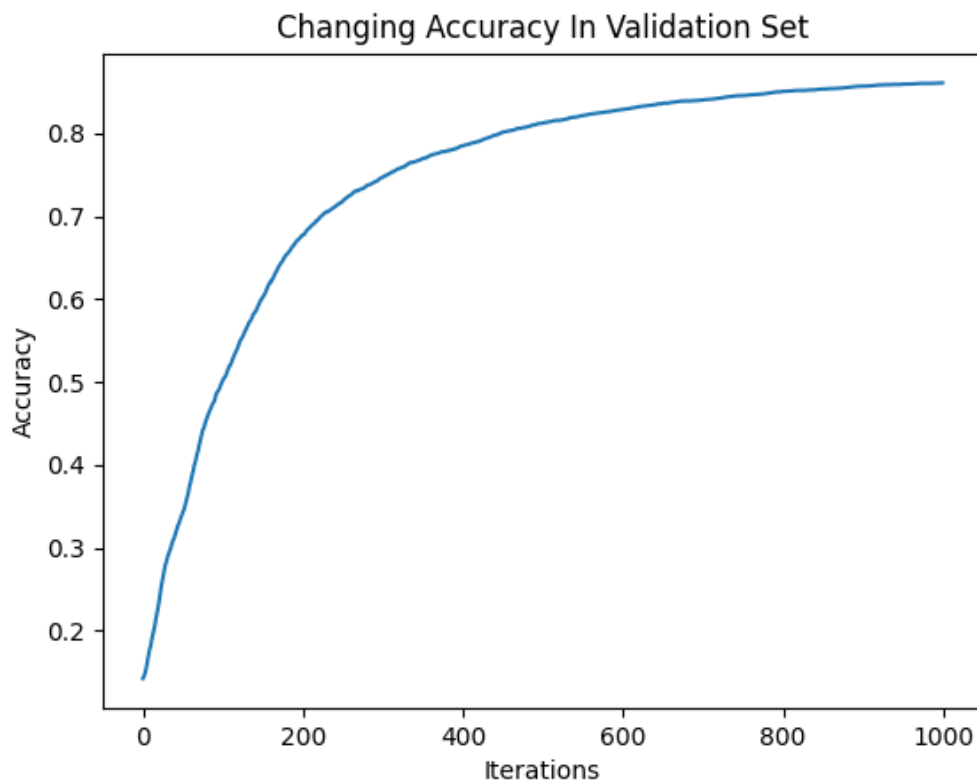
### 2. Give the equations that you used to update the weights explaining all the parameters on them

- The `update_params` function in this code is responsible for updating the weights and biases of the neural network based on the gradients calculated during backpropagation. It takes as input the current values of the parameters, the calculated gradients, and the learning rate  $\alpha$ .
- $W1 = W1 - \alpha * dW1$ : update the weights of the hidden layer
- $W2 = W2 - \alpha * dW2$ : update the weights of the output layer
  - **Alpha**: learning rate
  - **dW1**: the gradient of the loss function with respect to the weights of the hidden layer
  - **dW2**: the gradient of the loss function with respect to the weights of the output layer
- After updating the parameters, the updated values of  $W1$ ,  $b1$ ,  $W2$ , and  $b2$  are returned by the function

**3. Give the percentage of correctness of the total test data set (20% of all cases) and give the percentage of correctness of each of the classes in the test data set**

- Correctness of the test data set is 85.86%
- Correctness of each of the classes in the test data set
  - Class 0 - 92.65%
  - Class 1 - 95.71%
  - Class 2 - 84.56%
  - Class 3 - 82.24%
  - Class 4 - 84%
  - Class 5 - 72.39%
  - Class 6 - 94.89%
  - Class 7 - 79.83%
  - Class 8 - 88.35%
  - Class 9 - 81.98%

**4. Give a figure showing how the accuracy in the validation set is changing during the training process**



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