
# Ahsanullah University of Science and Technology

## Department of Computer Science & Engineering

**Course No. :** CSE 4238
**Course Name :** Soft Computing Lab

**Assignment No. : 01**

**Submitted To**

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**Section :** A (A2)

## Task Name

To work with deep neural networks.

## Model Architecture

As per the report instructions, The Neural Network has 5 hidden layers with 100 nodes in each of the layers. The optimization function used in this model is Stochastic Gradient Descent (SGD) with a learning rate of 0.001.

The proposed CNN Model is a 13-layer convolutional neural network. It contains 6 convolution layers with kernel size of 3x3. The activation function used in these layers is the ReLU activation function which introduces non-linearity. For the first layer, the input dimensions had to be specified, which, in this case, is 32x32x3, which means each image will be a 3 channel 32x32 image. This layer is followed by a Max Pooling layer with pool size 2x2. There are 6 convolutional layers each followed by ReLU activation function and 2x2 Max pooling. The values obtained from the last pooling layer are then flattened as one dimensional tensors. There are three fully connected layers with 1024 nodes in the first layer, 512 nodes, 256 nodes in the second and third layer respectively. The optimization function used in this model is Adam optimizer with a learning rate of 0.001. Summary of the architecture is displayed on Table 1.

Table 1
**Model Architecture Summary**

| Layer No (type) | Output Shape | Connected to |
|---|---|---|
| (Input Layer) | 32, 32, 3 | - |
| (1) Conv2D | 32, 32, 32 | Input Layer |
| (2)Conv2D | 32, 32, 64 | 1 |
| (3)Maxpool2D | 16, 16, 64 | 2 |
| (4)Conv2D | 16, 16, 128 | 3 |
| (5)Conv2D | 16, 16, 128 | 4 |
| (6)Maxpool2D | 8, 8, 128 | 5 |
| (7)Conv2D | 8, 8, 256 | 6 |
| (8)Conv2D | 8, 8, 256 | 7 |
| (9)Maxpool2D | 4, 4, 256 | 8 |
| (10)Flatten | 4096 | 9 |

| | | |
|---|---|---|
| (11)Dense | 1024 | 10 |
| (12)Dense | 512 | 11 |
| Output(Dense) | 4 | 12 |

## **Hyperparameters:**

Different hyperparameters used in two models are stated in Table 2

Table 2

| Hyperparameter | Neural Network | Convolutional Neural Network |
|---|---|---|
| Epoch | 200 | 200 |
| Learning Rate | 0.001 | 0.001 |
| Optimizer | Stochastic Gradient Descent (SGD) | Adam |
| Batch Size | 20 | 20 |
| Activation Function | ReLu (hidden layers)<br>Linear(Output) | ReLu (Hidden layers)<br>Linear (Output) |
| Loss | Cross Entropy Loss | Cross Entropy Loss |

## Results:

For the neural network model -

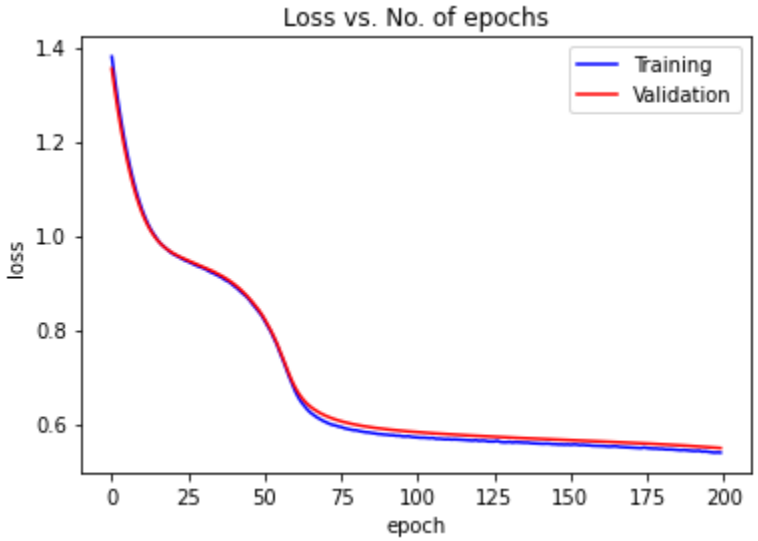


**Fig 1. Train and Validation Loss Graph against Epoch (NN Model)**

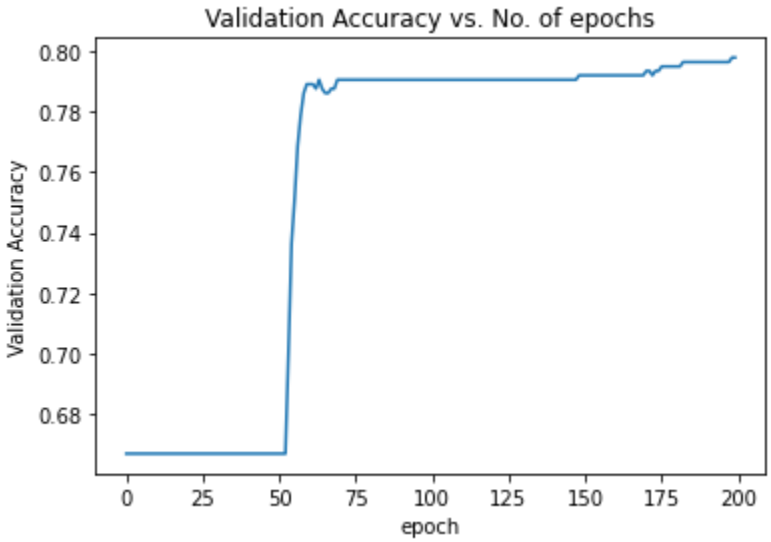


**Fig 2. Accuracy Graph against Epoch for Validation Dataset (NN Model)**

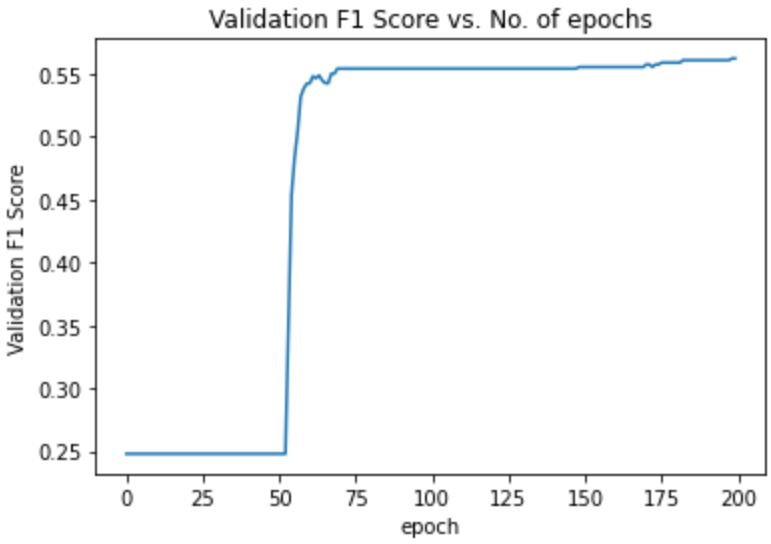


**Fig 3. F1 Score against Epoch Graph for Validation Dataset (NN Model)**

For the Convolutional Neural Network Model:

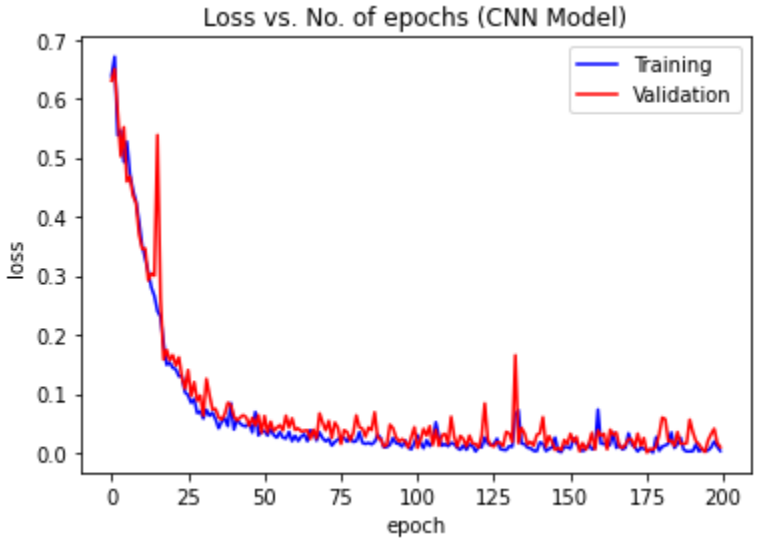


**Fig 4. Train and Validation Loss Graph against Epoch (CNN Model)**

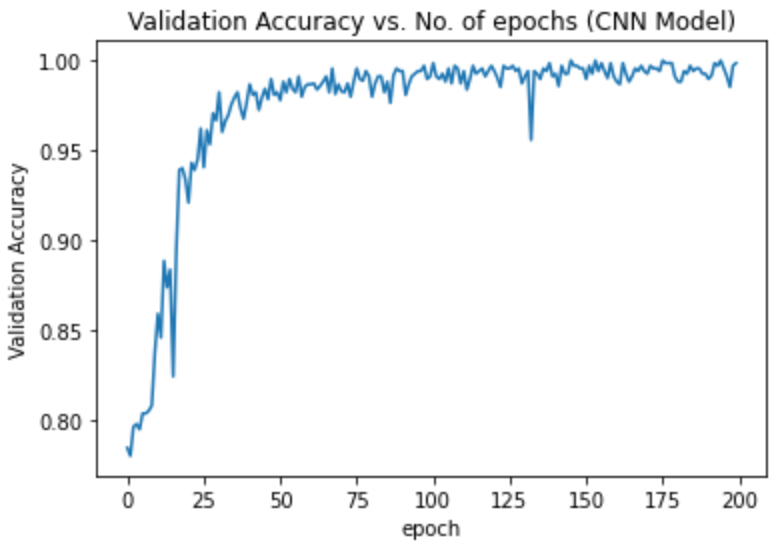


**Fig 5. Accuracy Graph against Epoch for Validation Dataset (CNN Model)**

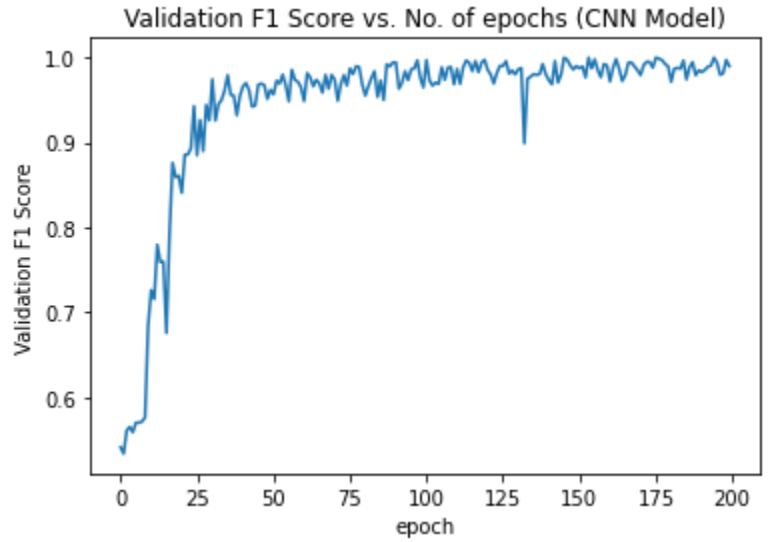


**Fig 6. F1 Score against Epoch Graph for Validation Dataset (CNN Model)**

## Performance Metrics:

Performance metrics differences are stated below in Table 3.

Table 3

| | Neural Network | Convolution Neural Network |
|---|---|---|
| Accuracy | 80.2% | 99.7% |
| Precision | 52% | 97.7% |
| Recall | 58.1% | 98.04% |
| F1 Score | 54.7% | 97.91% |

For the given dataset, I trained the neural network model with given hyperparameters of learning rate = 0.001, epoch = 200, number of hidden layers = 5, number of nodes in each hidden layer = 100 and batch size of 20. The dataset has been splitted into 65:15:20 train, validation and test dataset ratio.
On the validation dataset, the neural network model completed training with 79.8% accuracy, 59.8% recall, 53.8% precision and 56.2% f1 score value.

From the performance metric it is seen that the accuracy is decent whereas the recall, precision and f1 score is very low.
Precision is a measure of how often your predictions for the positive class are actually true. As we are getting average precision value which means very few of our positive predictions are true and average recall means most of the positive values are not predicted.

In the Convolutional Neural Network Model (CNN), the model achieved 99.85% of accuracy, 99.02% of recall, 98.96% of precision and 98.99% of f1 score values on the validation dataset at epoch 200.

From the performance metric of CNN, it can be derived that the model performs very well on the dataset given. It achieved almost near perfect score in every performance metric as well as very good performance on the test dataset.

**Github Link :**

**https://github.com/ShreyaChakraborty50/Soft_Computing_Lab/blob/main/170204050_Assignment1_CSE4238.ipynb**