**CSE-6363 Machine Learning, Spring 2022**

**Programming Assignment 2**

**Steps:**

1. Install torch and torch vision because the are the libraries needed for execution of CNN.
2. The execution of the model may need more space, so add cpu or gpu of cuda as it can switch accordingly.
3. The code will download the dataset and show the analysis and prediction of datasets.

We have used Lenet model of CNN. Lenet model consist following steps.

step 1:

1. The first step is the input provided to the model. The model requires 32 X 32 images. The images are grey scale and have normalized pixel values from 0-255.

step 2:

1. This layer is convolution layer with kernel size 5 and input channel of 1 and output of 6 channels. The feature allocation for this layer is 28 X 28.
2. After that the sampling is done giving 14 X 14 length, 6 function graph.

step 3:

1. This layer uses kernel of 5. To access the six-function input channel and process with padding zero to give 16 channel output that consist of 4 subsets of six channels.
2. The sub-sampling works as previous sampling layer of architecture.

step 4:

1. This layer with 120 convolution cores of 5X5 is attached to 16 neighbors.
2. The layer is most generalized this contains individual sample ideal to identify patterns.

**Analysis of Dataset:**

1. The mnist dataset is used to identify integers from 1 to 9.
2. The challenge of this dataset is that the values or images are handwritten so classifying the data set is difficult.
3. The next challenge is to predict the element belongs to which classification. As the image will have many different shapes.
4. The train dataset has 60000 values which is ideally enough to create classification.
5. The test dataset has 10000 values so the image will be classified more accurately as per assumption.
6. Each image size in the dataset is of 28 X 28.
7. Each Image has value 1 that is white and 255 that is black.
8. Ideal images used for this model are grey scale pictures.
9. The dataset with more values is considered as train datasets. The dataset with less row is considered test dataset.
10. The data set have raw values which is difficult to understand or predict.So we need convolution neural network.

**Analysis of results:**

1. The input values are in raw format, so we need softmax function of CNN to undestand. The softmax is part of crossEntropyloss function which is used in keeping log of the loss to measure performance of classification.
2. We are using learning rate of 0.001 for the calculation.

Table

Description automatically generated

1. This the preview of dataset which will be used to train the model.
2. We are using epoch of 10 to check performance of the trained model.
3. We are measuring the performance by calculating loss for train and test dataset and accuracy it can classify.
4. We are getting accuracy of 95 to 98 percent with 10 epochs.

Chart

Description automatically generated

1. The blue line in the graph is the training loss values. The line of loss keeps on decreasing per iteration or epoch. The maximum dip in the graph is at the second iteration. So, the result is quite appropriate, and loss is decreasing per iteration.
2. The orange is the representation of test dataset loss. As per our observation the loss rate is quite low for test dataset. There are certain places where it may increase, we can see some bumps, but he overall output is mostly accurate. A picture containing text, crossword puzzle, shoji

   Description automatically generated
3. According to the plotting in above graph all the images are classified accurately if not appropriate then it will show the actual number in red and predicted. As our values are all blue all the values are predicted accurately.

Text

Description automatically generated

1. This representation shows the percentage to which the number are predicted are correct. Most of the number are predicted. So the result is satisfactory.

**References:**

* <https://github.com/rohan-paul/MachineLearning-DeepLearning-Code-for-my-YouTube-Channel/blob/master/Computer_Vision/43_LeNet5_Colab_From_Scratch_PyTorch.ipynb>
* <https://www.youtube.com/watch?v=Uq5sQUoLXpA>
* <https://towardsdatascience.com/implementing-yann-lecuns-lenet-5-in-pytorch-5e05a0911320>
* <https://github.com/utkuozbulak/pytorch-custom-dataset-examples/blob/master/README.md#incorporating-pandas>