

Problem: Compare different autoencoder (AE) methods (Vanilla AE, Variational AE, Sparse AE, Contractive AE, and Stacked AE) and DNN classification for MATLAB MNIST image dataset of handwritten digits with the MATLAB code (MATLAB DNN toolbox).

1. In the MATLAB environment (for example, R2023b for NCU's campus license), load the MNIST image dataset with the following commands:

```
>> [XTrain, YTrain] = digitTrain4DArrayData;
```

```
>> [XTest, YTest] = digitTest4DArrayData;
```

The digits data set consists of 10,000 synthetic grayscale images of handwritten digits. Each image is 28-by-28 pixels and has an associated label denoting which digit the image represents (0–9). You will get 5000 images (XTrain) for training and 5000 images (XTest) for testing, and the associated label files are YTrain and YTest, respectively. For example, you can show the first image in XTest with the command:

```
>> imshow(XTest(:, :, 1, 1))
```



Use the MATLAB MNIST dataset to show the first 20 reconstructed MNIST training images with proper parameters for the following **five** convolutional AE methods: (a) Vanilla AE, (b) Variational AE, (c) Sparse AE, (d) Contractive AE, and (f) Stacked AE.

2. Add a DNN classifier (ex., 3 hidden layers) to the bottleneck and use the 5000 training images to train the DNN classifier with a proper batch size.
 - (i) Show the training progress with accuracy (%) and Loss in epochs (iterations).
 - (ii) Compare the accuracy of digits classification with the five AE methods for the 5000 test MNIST images.

