Task3: Stacked autoencoder (with 3 autoencoders) based pre-training of a DFNN based classifier for Image dataset 3

Hyper parameters: Seed - 42 Learning rate - 0.0003 Threshold- 1e-6

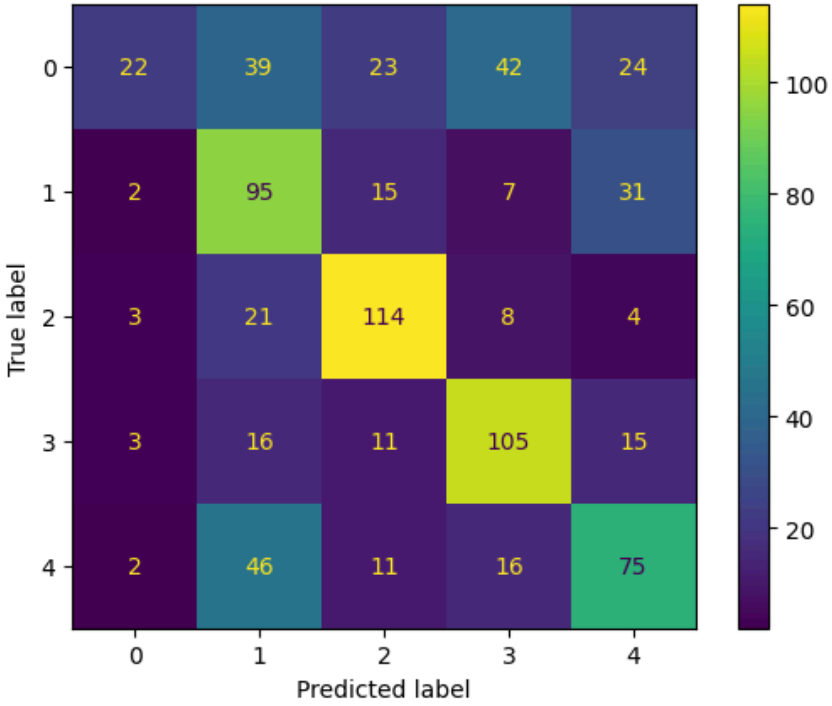
AutoEncoder node Structure: Input layer to Bottleneck layer

- AANN 1 -->36-->30-->26
- AANN 2 -->26-->20-->16
- AANN 3 -->16-->10-->6

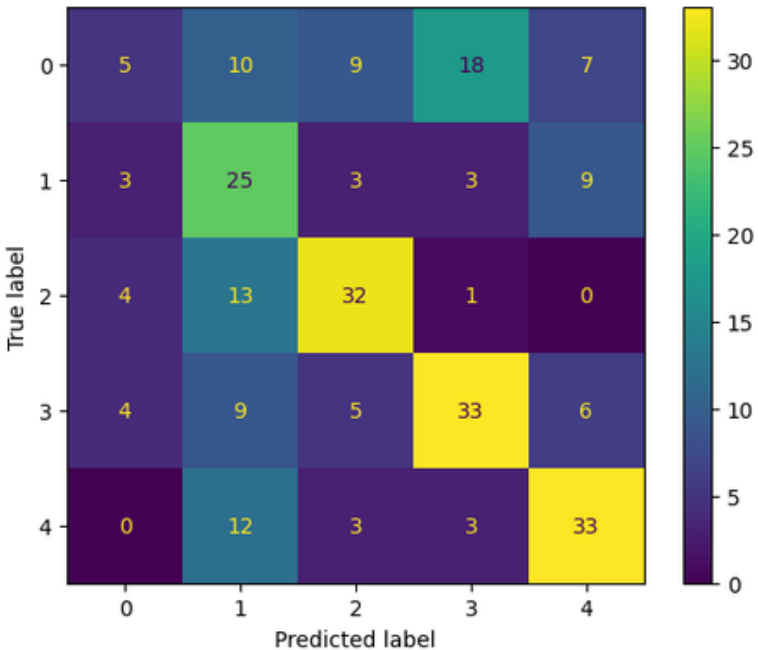
Stacked AutoEncoder

- Autoencoder: A neural network that learns to compress and reconstruct input data, capturing essential features in a lower-dimensional space.
- Stacked Autoencoder: A deep network formed by stacking multiple autoencoders, where each layer refines learned features to improve representation learning
- Epochs to converge -166
- Training accuracy - 54%
- Validation accuracy - 44%

Confusion matrix for train data



Confusion matrix for test data



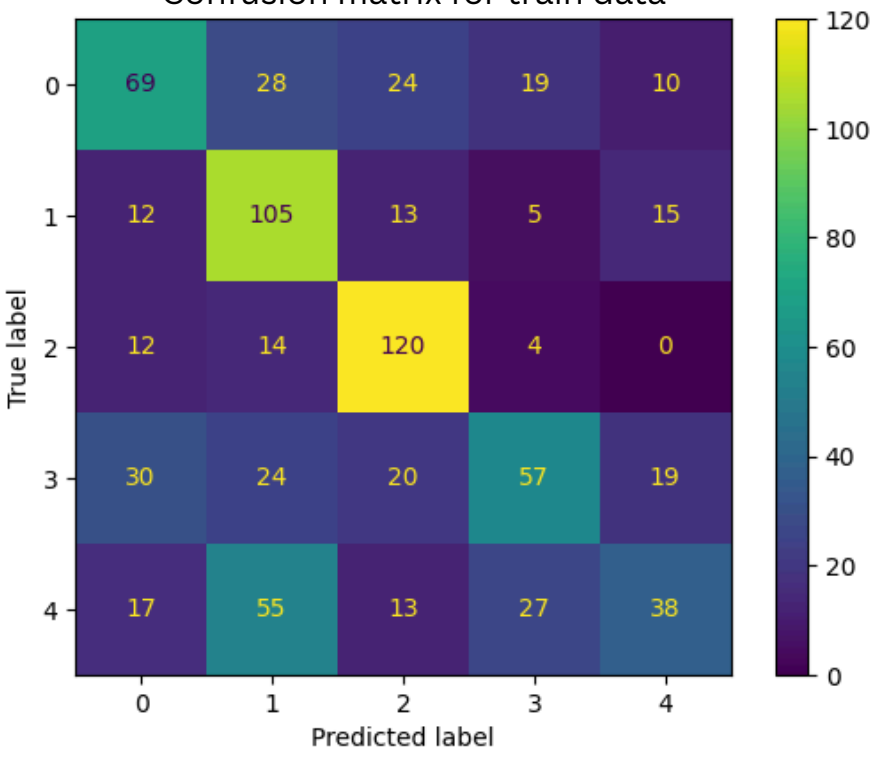
Deep Feed Forward Neural Network (DFNN) - without pre-training

- A multilayer neural network where information flows in one direction, from input to output, without cycles or loops. Trained in a usual way with random initialization.

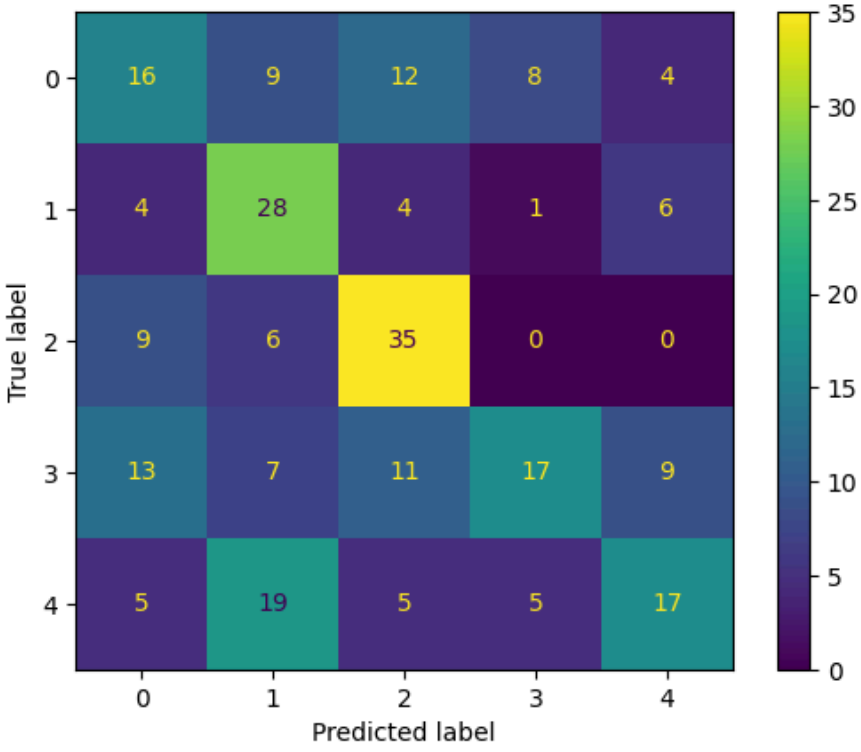
- Linear Layer 1 -->36-->26
- Tanh activation
- Linear Layer 2 -->26-->16
- Tanh activation
- Linear Layer 3 -->16-->6
- Tanh activation
- Linear Layer 4-->6-->5

- Epochs to converge -213
- Training accuracy - 51.8667%
- Validation accuracy - 52%

Confusion matrix for train data



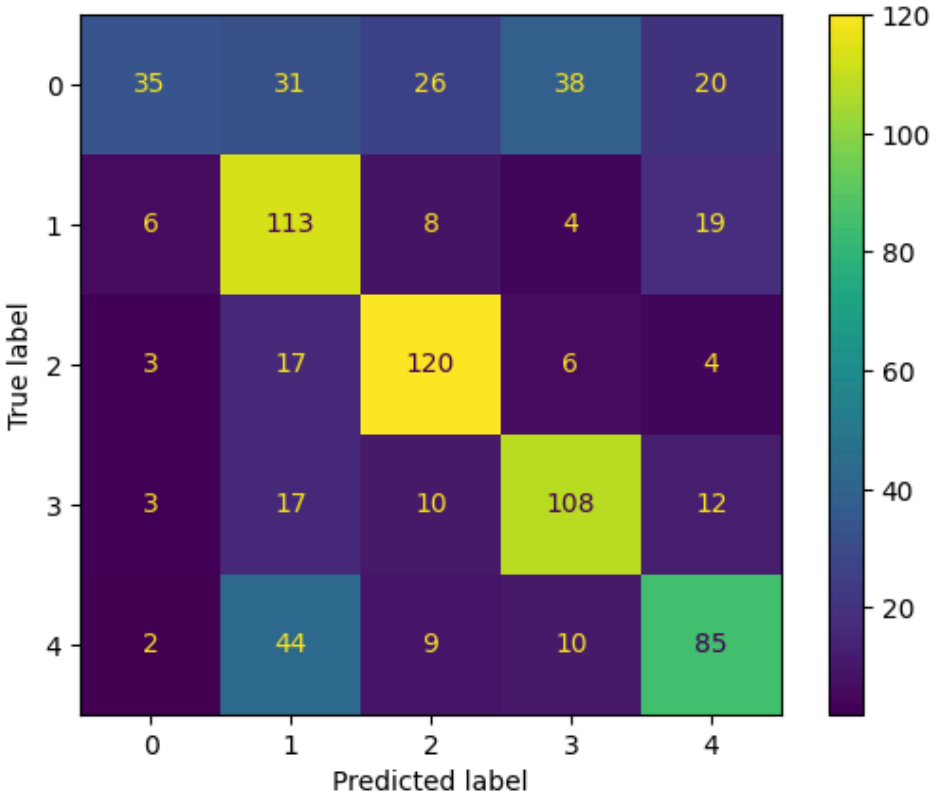
Confusion matrix for test data



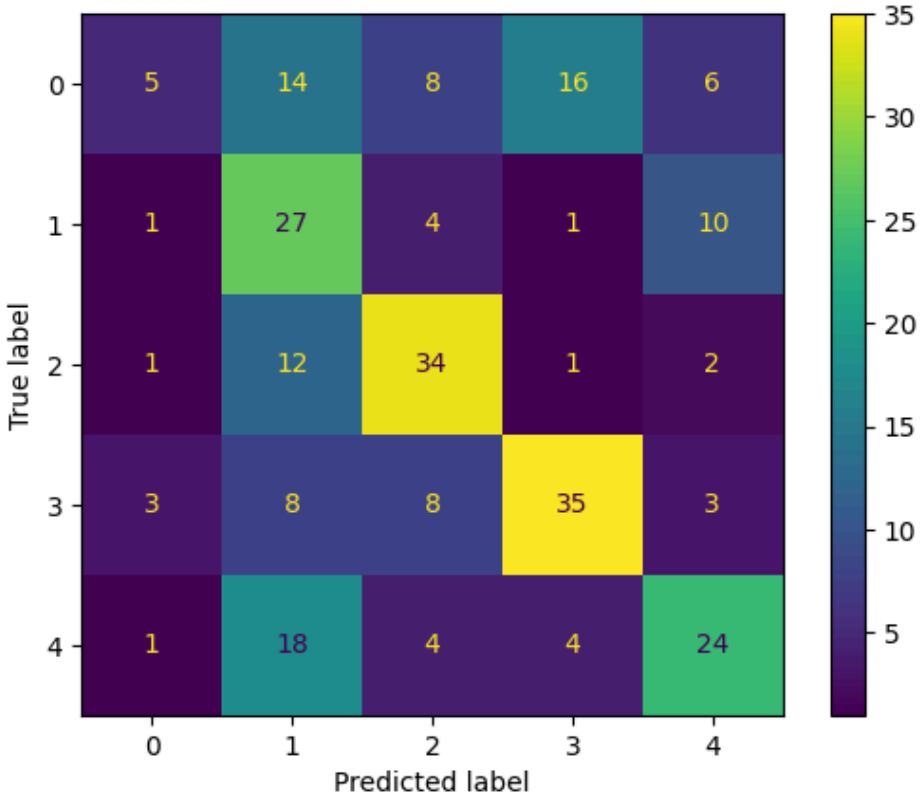
Deep Feed Forward Neural Network (DFNN) - with pre-training

- A DFNN initialized with feature representations learned from a stacked autoencoder, improving training efficiency and performance. The nodes are initialized with pre trained nodes from the Stacked AutoEncoder.
- Epochs to converge -326
- Training accuracy - 61%
- Validation accuracy - 60%

Confusion matrix for train data



Confusion matrix for test data



TRAINING PROCESS

- Training with AANNs: First we train each of the AANNs on unlabeled dataset to get a precise latent space representation for the input image data.
- Fine-tuning: After training each AANN we fine tune the Stacked Auto Encoders model using labeled dataset
- DFNN without pre-training: A DFNN model is trained with randomly initialized weights
- DFNN with pre-training: The latent space representations i.e the layers of the stacked Auto Encoder is used to initialize the layers of DFNN and then is trained on labeled dataset.
- The two models are then compared using confusion matrices.

OBSERVATIONS

- There is an significant increase in both the training and validation accuracy of a pre trained model when compared to the regularly trained one.
- The epochs to converge for a pre- trained model is slightly higher than that of a non-pretrained model but the computing resource for pre-training is higher as it involves training 3 AutoEncoders and fine tuning a Stacked AutoEncoder.
- The confusion matrix reveals that the pre-trained model performed better except for class 0 where it fails to classify correctly although there are equal number of training examples for each class.