Experiment 11

Problem Statement:

Write code for to implement autoencoders for dimensionality reduction.

GitHub & Google Colab Link:

GitHub Link: https://github.com/piyush-gambhir/ncu-lab-manual-and-end-semester-projects/blob/main/NCU-CSL312%20-%20DL%20-%20Lab%20Manual/Experiment%2011/Experiment%2011.ipynb

Google Colab Link:

Open in Colab

Installing Dependencies:

In [ ]:

```
! pip install tabulate numpy pandas matplotlib seaborn
```

```
Requirement already satisfied: tabulate in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packa
ges (0.9.0)
Requirement already satisfied: numpy in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages
(1.26.4)
Requirement already satisfied: pandas in c:\users\mainp\appdata\local\programs\python\python311\lib\site-package
s (2.2.2)
Requirement already satisfied: matplotlib in c:\users\mainp\appdata\local\programs\python\python311\lib\site-pac
kages (3.8.4)
Requirement already satisfied: seaborn in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packag
es (0.13.2)
Requirement already satisfied: python-dateutil>=2.8.2 in c:\users\mainp\appdata\local\programs\python\python311\
lib\site-packages (from pandas) (2.9.0.post0)
Requirement already satisfied: pytz>=2020.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-p
ackages (from pandas) (2024.1)
Requirement already satisfied: tzdata>=2022.7 in c:\users\mainp\appdata\local\programs\python\python311\lib\site
-packages (from pandas) (2024.1)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\si
te-packages (from matplotlib) (1.2.1)
Requirement already satisfied: cycler>=0.10 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-p
ackages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\s
ite-packages (from matplotlib) (4.51.0)
Requirement already satisfied: kiwisolver>=1.3.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\s
ite-packages (from matplotlib) (1.4.5)
Requirement already satisfied: packaging>=20.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\sit
e-packages (from matplotlib) (24.0)
Requirement already satisfied: pillow>=8 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-pack
ages (from matplotlib) (10.3.0)
Requirement already satisfied: pyparsing>=2.3.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\si
te-packages (from matplotlib) (3.1.2)
Requirement already satisfied: six>=1.5 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packa
ges (from python-dateutil>=2.8.2->pandas) (1.16.0)
```

Code

In [ ]:

```
import tensorflow as tf
from tensorflow.keras import layers, models
from tensorflow.keras.datasets import mnist
import numpy as np
from tensorflow.keras.datasets import mnist
import numpy as np
```

In [ ]:

```
def build_autoencoder(input_dim, encoding_dim):
    # Input layer
    input_layer = layers.Input(shape=(input_dim,))

    # Encoder part
    encoded = layers.Dense(encoding_dim, activation='relu')(input_layer)

    # Decoder part
    decoded = layers.Dense(input_dim, activation='sigmoid')(encoded)

    # Autoencoder model
    autoencoder = models.Model(input_layer, decoded)
    # Encoder model
    encoder = models.Model(input_layer, encoded)

    # Decoder model
    encoded_input = layers.Input(shape=(encoding_dim,))
    decoder_layer = autoencoder.layers[-1]
    decoder = models.Model(encoded_input, decoder_layer(encoded_input))

    # Compile the model
    autoencoder.compile(optimizer='adam', loss='binary_crossentropy')

    return autoencoder, encoder, decoder


# Example usage
input_dim = 784  # for MNIST dataset, for example
encoding_dim = 32  # size of the encoded representations

autoencoder, encoder, decoder = build_autoencoder(input_dim, encoding_dim)
```

In [ ]:

```
# Load the dataset
(x_train, _), (x_test, _) = mnist.load_data()
x_train = x_train.astype('float32') / 255.
x_test = x_test.astype('float32') / 255.
x_train = x_train.reshape((len(x_train), np.prod(x_train.shape[1:])))
x_test = x_test.reshape((len(x_test), np.prod(x_test.shape[1:])))

# Train the model
autoencoder.fit(x_train, x_train,
                epochs=50,
                batch_size=256,
                shuffle=True,
                validation_data=(x_test, x_test))
```

```
Epoch 1/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 33s 46ms/step - loss: 0.3900 - val_loss: 0.1918
Epoch 2/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 8s 33ms/step - loss: 0.1821 - val_loss: 0.1546
Epoch 3/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 8s 32ms/step - loss: 0.1501 - val_loss: 0.1352
Epoch 4/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 22ms/step - loss: 0.1332 - val_loss: 0.1234
Epoch 5/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 5s 20ms/step - loss: 0.1227 - val_loss: 0.1151
Epoch 6/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 5s 21ms/step - loss: 0.1147 - val_loss: 0.1086
Epoch 7/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 24ms/step - loss: 0.1086 - val_loss: 0.1040
Epoch 8/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 24ms/step - loss: 0.1042 - val_loss: 0.1006
Epoch 9/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 5s 22ms/step - loss: 0.1013 - val_loss: 0.0982
Epoch 10/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 7s 29ms/step - loss: 0.0990 - val_loss: 0.0967
Epoch 11/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 7s 28ms/step - loss: 0.0980 - val_loss: 0.0956
Epoch 12/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 9s 33ms/step - loss: 0.0968 - val_loss: 0.0950
Epoch 13/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 7s 28ms/step - loss: 0.0962 - val_loss: 0.0944
Epoch 14/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 8s 32ms/step - loss: 0.0957 - val_loss: 0.0941
Epoch 15/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 12s 38ms/step - loss: 0.0954 - val_loss: 0.0939
Epoch 16/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 22ms/step - loss: 0.0951 - val_loss: 0.0937
Epoch 17/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 26ms/step - loss: 0.0952 - val_loss: 0.0935
Epoch 18/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 7s 29ms/step - loss: 0.0949 - val_loss: 0.0934
Epoch 19/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 22ms/step - loss: 0.0950 - val_loss: 0.0933
Epoch 20/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 22ms/step - loss: 0.0947 - val_loss: 0.0932
Epoch 21/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 9s 35ms/step - loss: 0.0946 - val_loss: 0.0933
Epoch 22/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 8s 33ms/step - loss: 0.0946 - val_loss: 0.0931
Epoch 23/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 7s 28ms/step - loss: 0.0945 - val_loss: 0.0930
Epoch 24/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 8s 29ms/step - loss: 0.0942 - val_loss: 0.0930
```

```
Epoch 25/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 7s 29ms/step - loss: 0.0943 - val_loss: 0.0929
Epoch 26/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 7s 26ms/step - loss: 0.0941 - val_loss: 0.0929
Epoch 27/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 8s 28ms/step - loss: 0.0941 - val_loss: 0.0929
Epoch 28/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 24ms/step - loss: 0.0942 - val_loss: 0.0929
Epoch 29/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 24ms/step - loss: 0.0943 - val_loss: 0.0928
Epoch 30/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 5s 22ms/step - loss: 0.0940 - val_loss: 0.0928
Epoch 31/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 5s 20ms/step - loss: 0.0942 - val_loss: 0.0929
Epoch 32/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 8s 32ms/step - loss: 0.0941 - val_loss: 0.0928
Epoch 33/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 9s 30ms/step - loss: 0.0939 - val_loss: 0.0927
Epoch 34/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 24ms/step - loss: 0.0942 - val_loss: 0.0928
Epoch 35/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 26ms/step - loss: 0.0942 - val_loss: 0.0927
Epoch 36/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 24ms/step - loss: 0.0940 - val_loss: 0.0927
Epoch 37/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 9s 19ms/step - loss: 0.0939 - val_loss: 0.0927
Epoch 38/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 5s 20ms/step - loss: 0.0937 - val_loss: 0.0927
Epoch 39/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 5s 20ms/step - loss: 0.0937 - val_loss: 0.0927
Epoch 40/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 7s 30ms/step - loss: 0.0939 - val_loss: 0.0927
Epoch 41/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 25ms/step - loss: 0.0937 - val_loss: 0.0927
Epoch 42/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 23ms/step - loss: 0.0939 - val_loss: 0.0926
Epoch 43/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 8s 28ms/step - loss: 0.0939 - val_loss: 0.0926
Epoch 44/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 23ms/step - loss: 0.0937 - val_loss: 0.0926
Epoch 45/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 6s 24ms/step - loss: 0.0937 - val_loss: 0.0926
Epoch 46/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 12s 29ms/step - loss: 0.0937 - val_loss: 0.0926
Epoch 47/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 8s 29ms/step - loss: 0.0937 - val_loss: 0.0926
Epoch 48/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 8s 32ms/step - loss: 0.0936 - val_loss: 0.0925
Epoch 49/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 9s 27ms/step - loss: 0.0938 - val_loss: 0.0926
Epoch 50/50
235/235 ━━━━━━━━━━━━━━━━━━━━ 8s 31ms/step - loss: 0.0938 - val_loss: 0.0926
```

```
Out[ ]: <keras.src.callbacks.history.History at 0x2136bad0190>
```

```
In [ ]: # Encode and decode some digits
        encoded_imgs = encoder.predict(x_test)
        decoded_imgs = decoder.predict(encoded_imgs)
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 5s 12ms/step
313/313 ━━━━━━━━━━━━━━━━━━━━ 3s 9ms/step
```

```
In [ ]: print(encoded_imgs)
        print(decoded_imgs)
```

```
[[ 4.8924747  4.854765  19.067812  ...  5.504808   5.4497395  2.1827724]
 [ 4.0562053 13.565552   4.074698  ...  1.4419191  0.         8.971487 ]
 [ 3.1474488  5.143187   1.97202   ...  3.2207503  6.151232   1.3175982]
 ...
 [ 6.1489973  7.2654934 10.844839  ...  9.386098  17.036064   8.341909 ]
 [ 9.1034565 15.411163  12.721321  ...  6.8218656 11.226105   5.956751 ]
 [ 8.579408  14.425247   4.92264   ...  2.6878972 11.392425  15.453175 ]]
[[3.1163815e-12 1.9494430e-11 3.7714480e-12 ... 1.5472892e-11
  8.5135119e-12 8.9639268e-12]
 [7.7605576e-13 1.3833495e-13 3.6490160e-13 ... 4.9805028e-13
  4.4932832e-13 4.2463724e-13]
 [4.5002420e-08 9.3934155e-08 1.4190249e-07 ... 1.1176658e-07
  1.2157908e-07 6.2087160e-08]
 ...
 [1.1408125e-15 5.5730435e-15 6.8818923e-16 ... 1.4479383e-14
  4.4140759e-15 4.3717132e-15]
 [2.6627597e-14 2.3799994e-14 3.5908365e-15 ... 7.6461285e-14
  9.6528213e-15 9.0713807e-14]
 [4.0111335e-20 5.0645143e-21 1.3480784e-21 ... 3.6208830e-20
  3.9058418e-21 8.7213360e-21]]
```