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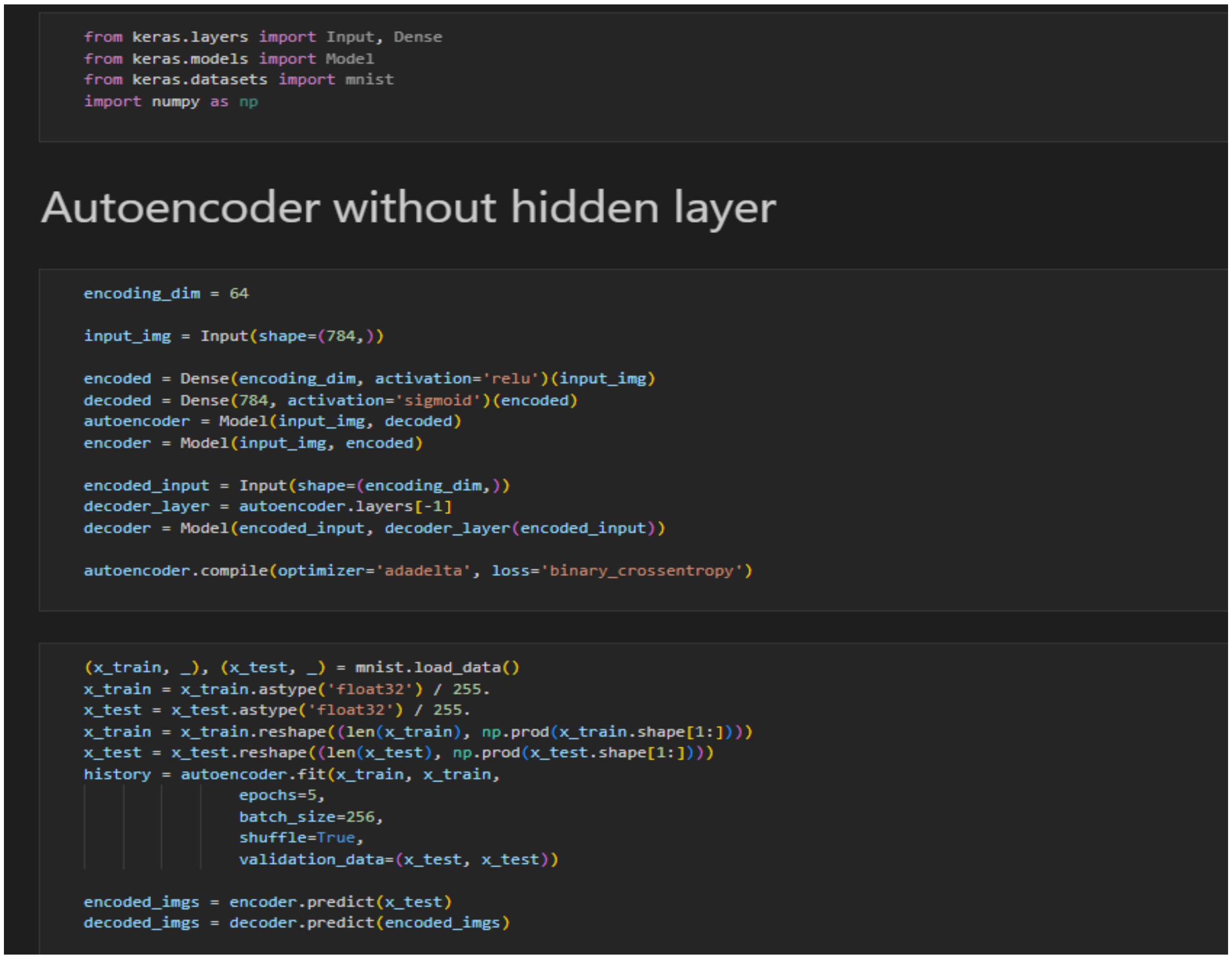
ASSIGNMENT 8

NEURAL NETWORKS AND DEEP LEARNING

Link for the recording: https://drive.google.com/file/d/1UaqIOt99hHSLQ8ON4x_1Tl2sKWoPpB12/view?usp=drive_link

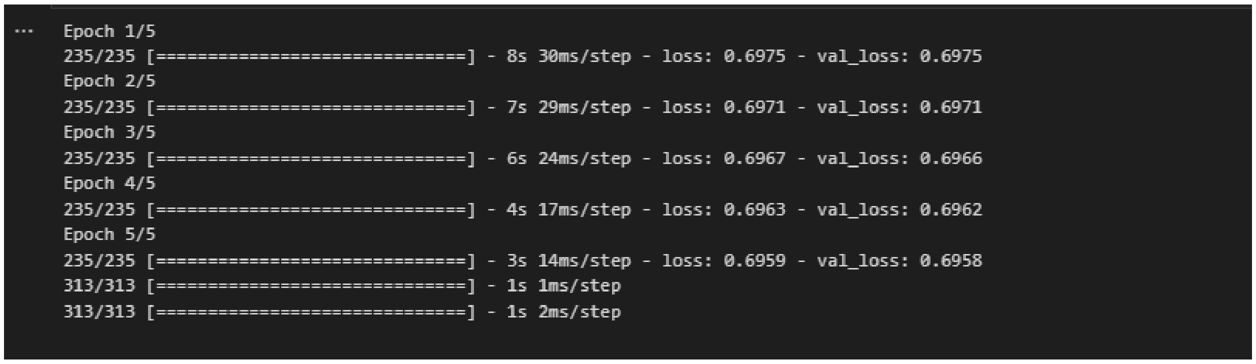


```
from keras.layers import Input, Dense
from keras.models import Model
from keras.datasets import mnist
import numpy as np
```

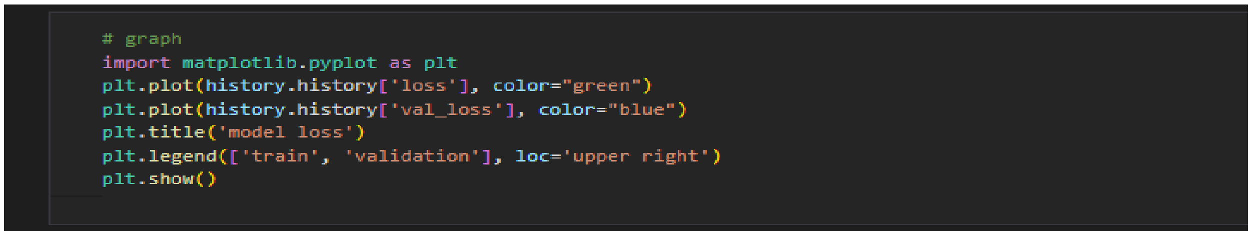
Autoencoder without hidden layer

```
encoding_dim = 64

input_img = Input(shape=(784,))

encoded = Dense(encoding_dim, activation='relu')(input_img)
decoded = Dense(784, activation='sigmoid')(encoded)
autoencoder = Model(input_img, decoded)
encoder = Model(input_img, encoded)

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

autoencoder.compile(optimizer='adadelta', loss='binary_crossentropy')
```

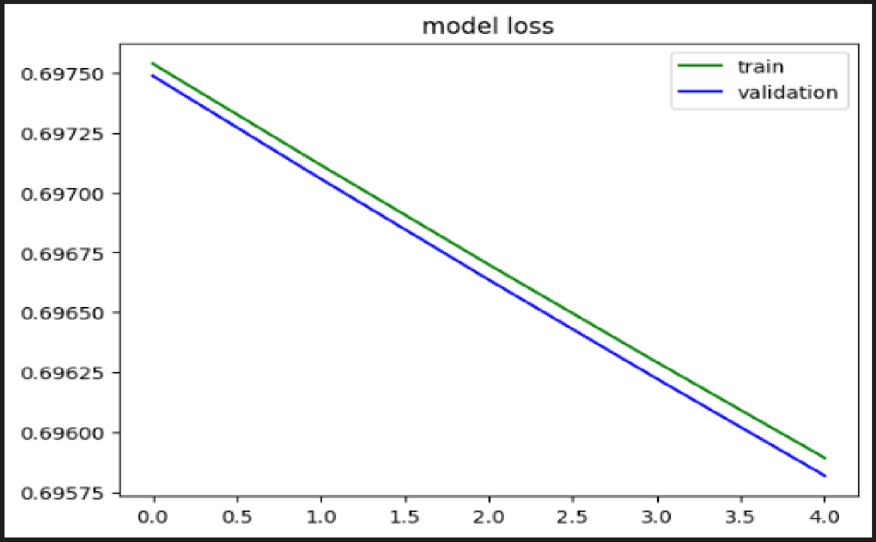
```
(x_train, _), (x_test, _) = mnist.load_data()
x_train = x_train.astype('float32') / 255.
x_test = x_test.astype('float32') / 255.
x_train = x_train.reshape((len(x_train), np.prod(x_train.shape[1:])))
x_test = x_test.reshape((len(x_test), np.prod(x_test.shape[1:])))
history = autoencoder.fit(x_train, x_train,
                epochs=5,
                batch_size=256,
                shuffle=True,
                validation_data=(x_test, x_test))

encoded_imgs = encoder.predict(x_test)
decoded_imgs = decoder.predict(encoded_imgs)
```

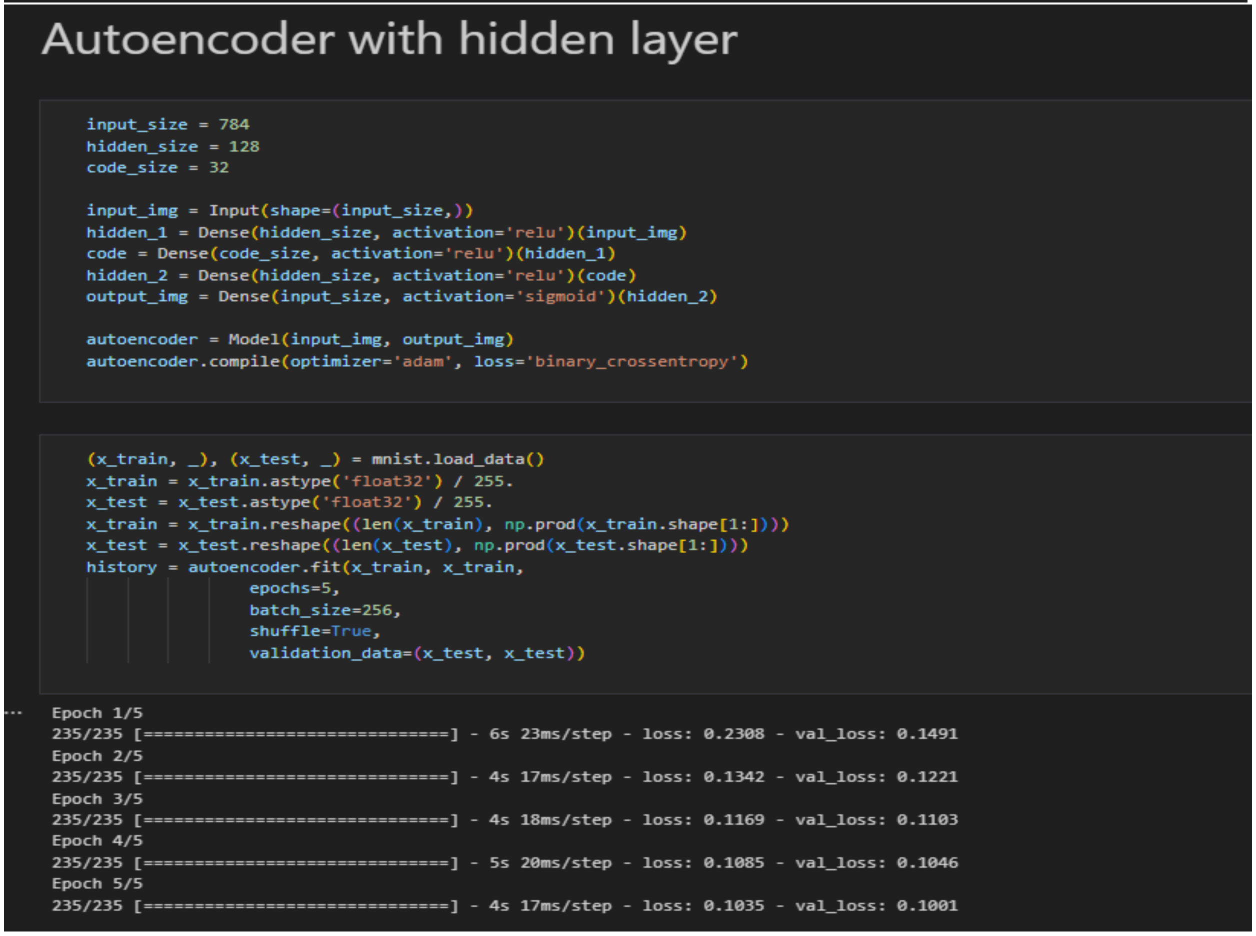


```
...  Epoch 1/5
     235/235 [==============================] - 8s 30ms/step - loss: 0.6975 - val_loss: 0.6975
     Epoch 2/5
     235/235 [==============================] - 7s 29ms/step - loss: 0.6971 - val_loss: 0.6971
     Epoch 3/5
     235/235 [==============================] - 6s 24ms/step - loss: 0.6967 - val_loss: 0.6966
     Epoch 4/5
     235/235 [==============================] - 4s 17ms/step - loss: 0.6963 - val_loss: 0.6962
     Epoch 5/5
     235/235 [==============================] - 3s 14ms/step - loss: 0.6959 - val_loss: 0.6958
     313/313 [==============================] - 1s 1ms/step
     313/313 [==============================] - 1s 2ms/step
```



```python
# graph
import matplotlib.pyplot as plt
plt.plot(history.history['loss'], color="green")
plt.plot(history.history['val_loss'], color="blue")
plt.title('model loss')
plt.legend(['train', 'validation'], loc='upper right')
plt.show()
```



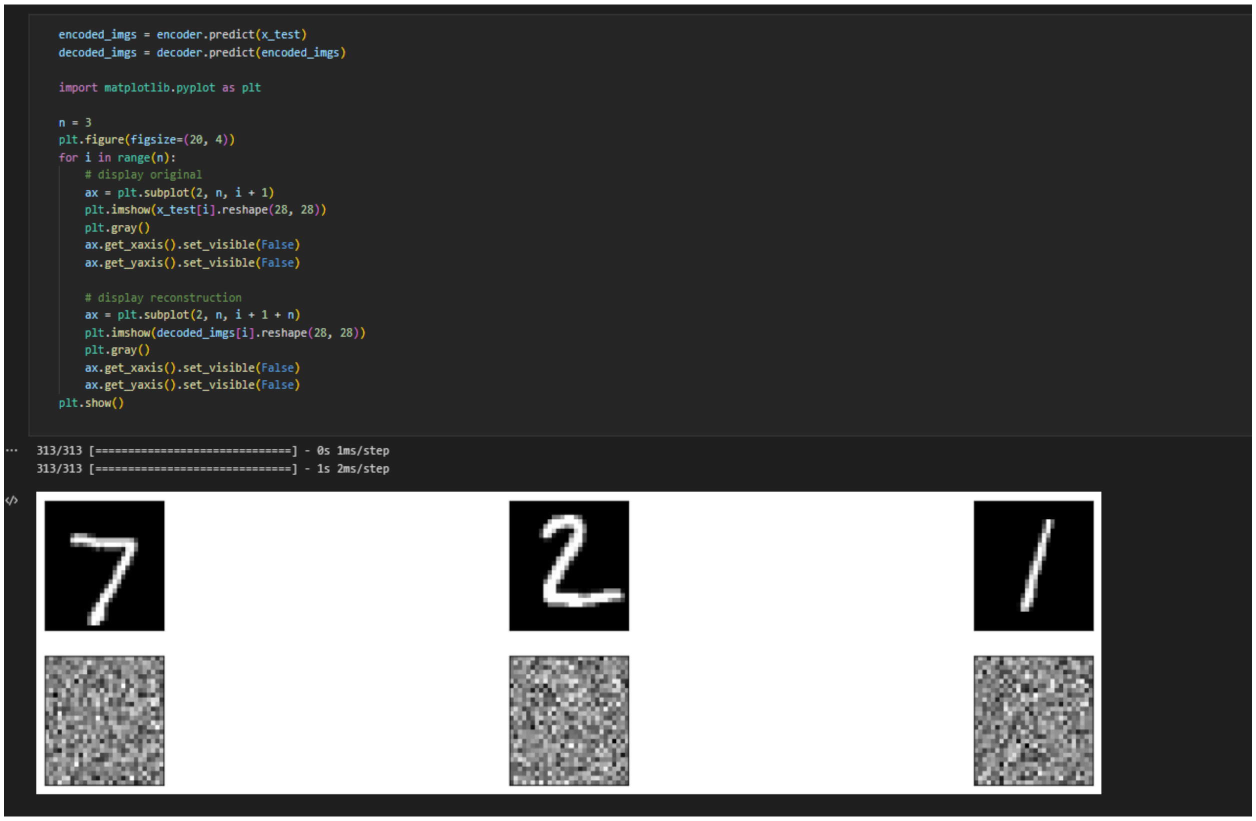


Autoencoder with hidden layer

```python
input_size = 784
hidden_size = 128
code_size = 32

input_img = Input(shape=(input_size,))
hidden_1 = Dense(hidden_size, activation='relu')(input_img)
code = Dense(code_size, activation='relu')(hidden_1)
hidden_2 = Dense(hidden_size, activation='relu')(code)
output_img = Dense(input_size, activation='sigmoid')(hidden_2)

autoencoder = Model(input_img, output_img)
autoencoder.compile(optimizer='adam', loss='binary_crossentropy')
```

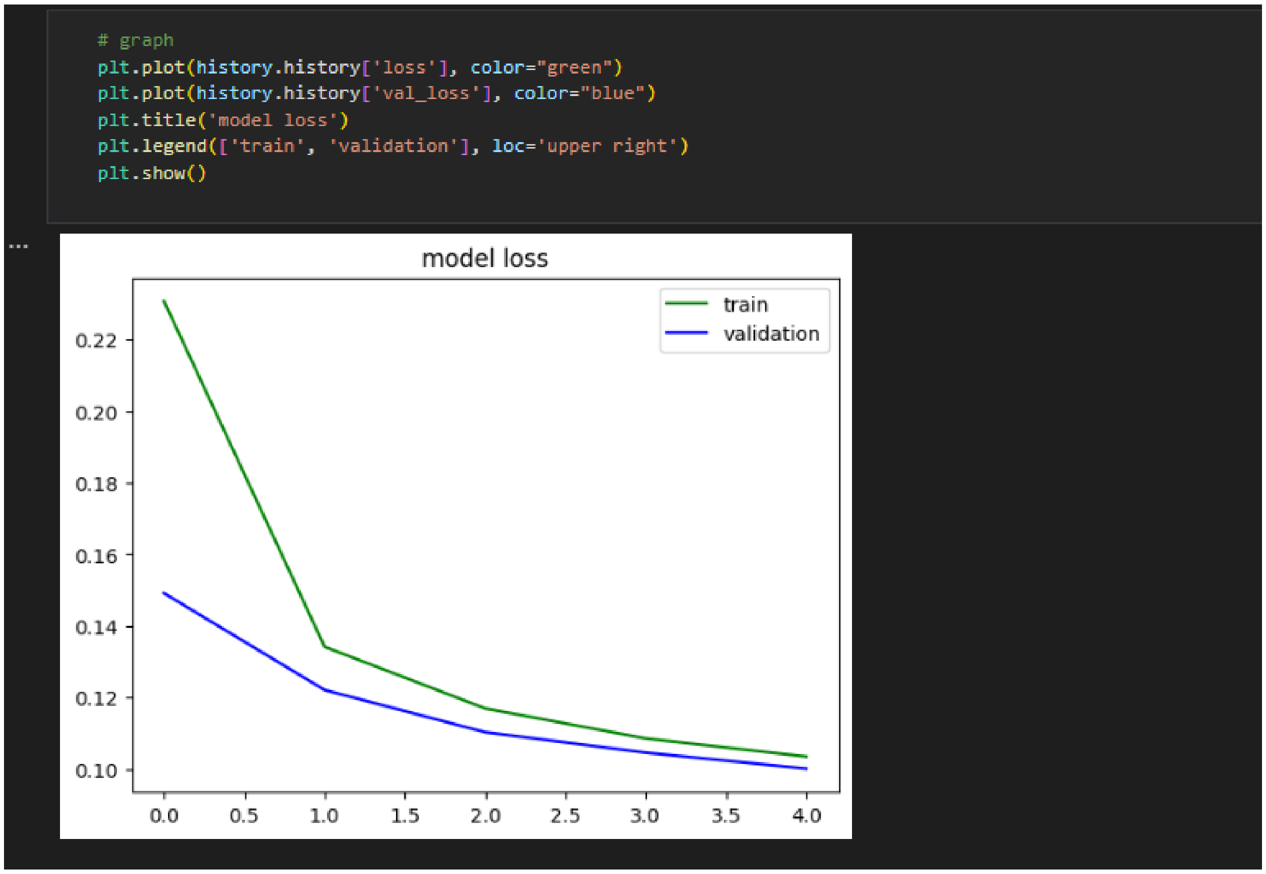
```python
(x_train, _), (x_test, _) = mnist.load_data()
x_train = x_train.astype('float32') / 255.
x_test = x_test.astype('float32') / 255.
x_train = x_train.reshape((len(x_train), np.prod(x_train.shape[1:])))
x_test = x_test.reshape((len(x_test), np.prod(x_test.shape[1:])))
history = autoencoder.fit(x_train, x_train,
                epochs=5,
                batch_size=256,
                shuffle=True,
                validation_data=(x_test, x_test))
```

```
Epoch 1/5
235/235 [==============================] - 6s 23ms/step - loss: 0.2308 - val_loss: 0.1491
Epoch 2/5
235/235 [==============================] - 4s 17ms/step - loss: 0.1342 - val_loss: 0.1221
Epoch 3/5
235/235 [==============================] - 4s 18ms/step - loss: 0.1169 - val_loss: 0.1103
Epoch 4/5
235/235 [==============================] - 5s 20ms/step - loss: 0.1085 - val_loss: 0.1046
Epoch 5/5
235/235 [==============================] - 4s 17ms/step - loss: 0.1035 - val_loss: 0.1001
```

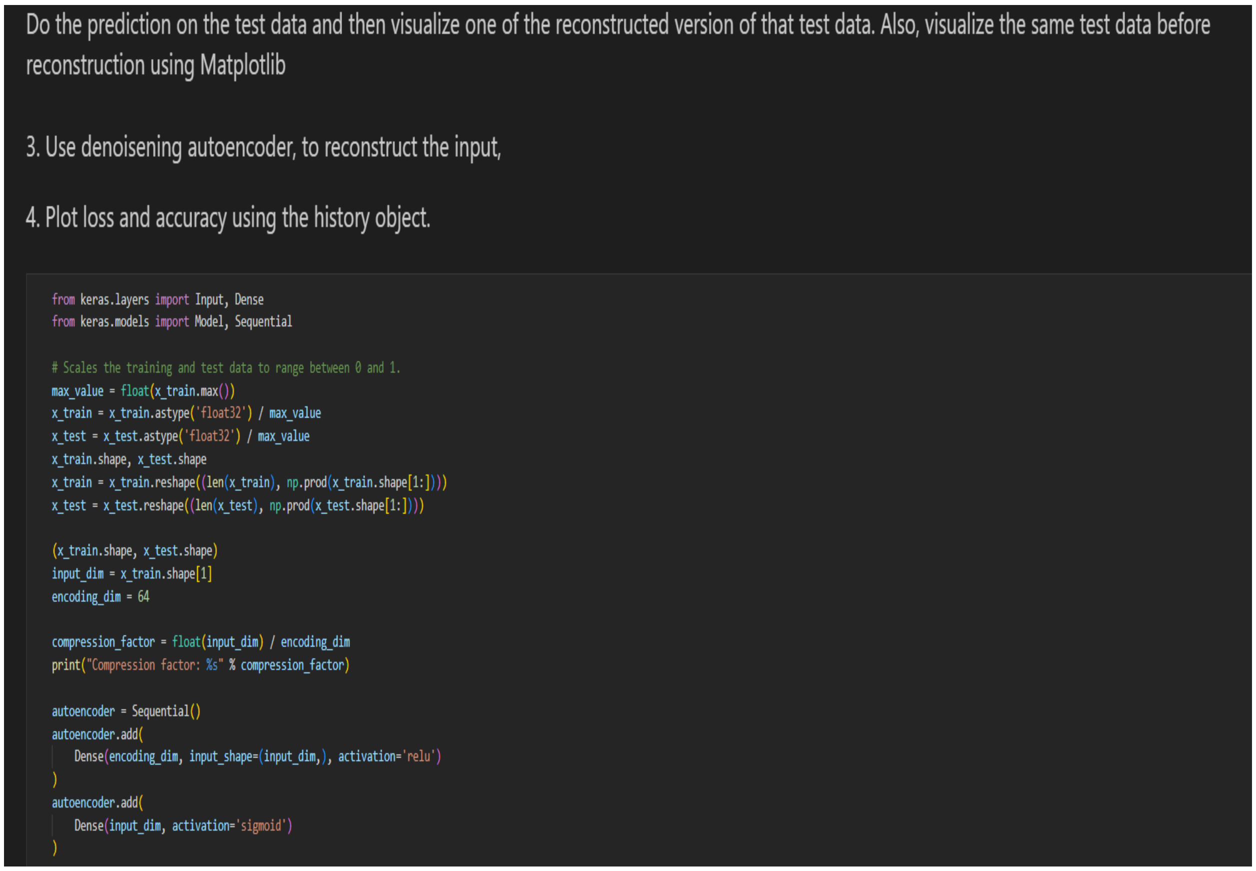


```python
encoded_imgs = encoder.predict(x_test)
decoded_imgs = decoder.predict(encoded_imgs)

import matplotlib.pyplot as plt

n = 3
plt.figure(figsize=(20, 4))
for i in range(n):
    # display original
    ax = plt.subplot(2, n, i + 1)
    plt.imshow(x_test[i].reshape(28, 28))
    plt.gray()
    ax.get_xaxis().set_visible(False)
    ax.get_yaxis().set_visible(False)

    # display reconstruction
    ax = plt.subplot(2, n, i + 1 + n)
    plt.imshow(decoded_imgs[i].reshape(28, 28))
    plt.gray()
    ax.get_xaxis().set_visible(False)
    ax.get_yaxis().set_visible(False)
plt.show()
```

```
313/313 [==============================] - 0s 1ms/step
313/313 [==============================] - 1s 2ms/step
```



```python
# graph
plt.plot(history.history['loss'], color="green")
plt.plot(history.history['val_loss'], color="blue")
plt.title('model loss')
plt.legend(['train', 'validation'], loc='upper right')
plt.show()
```

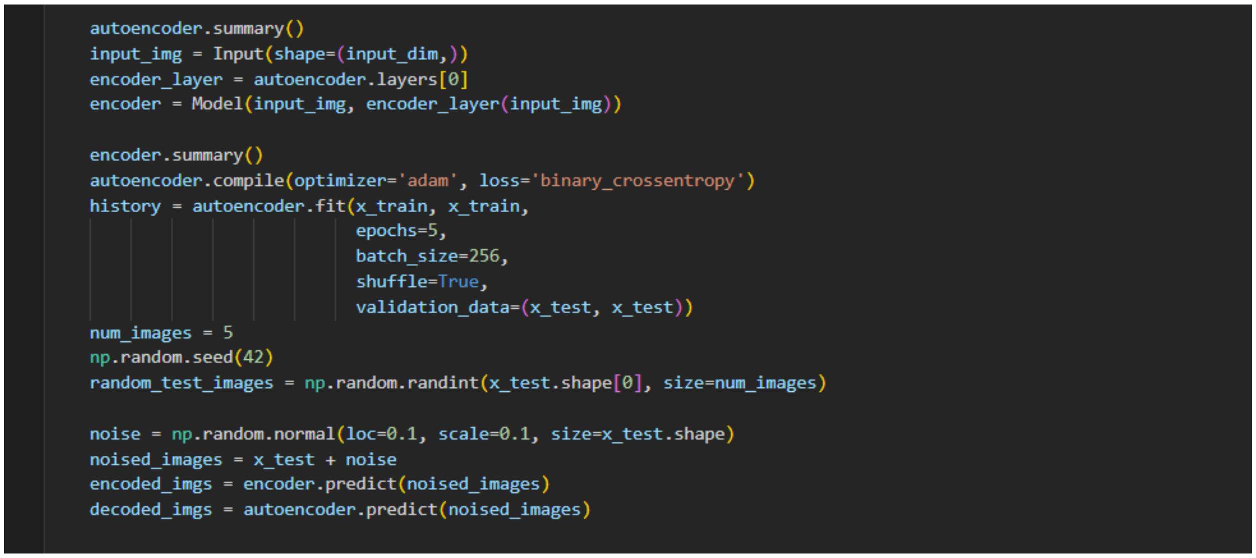


Do the prediction on the test data and then visualize one of the reconstructed version of that test data. Also, visualize the same test data before reconstruction using Matplotlib

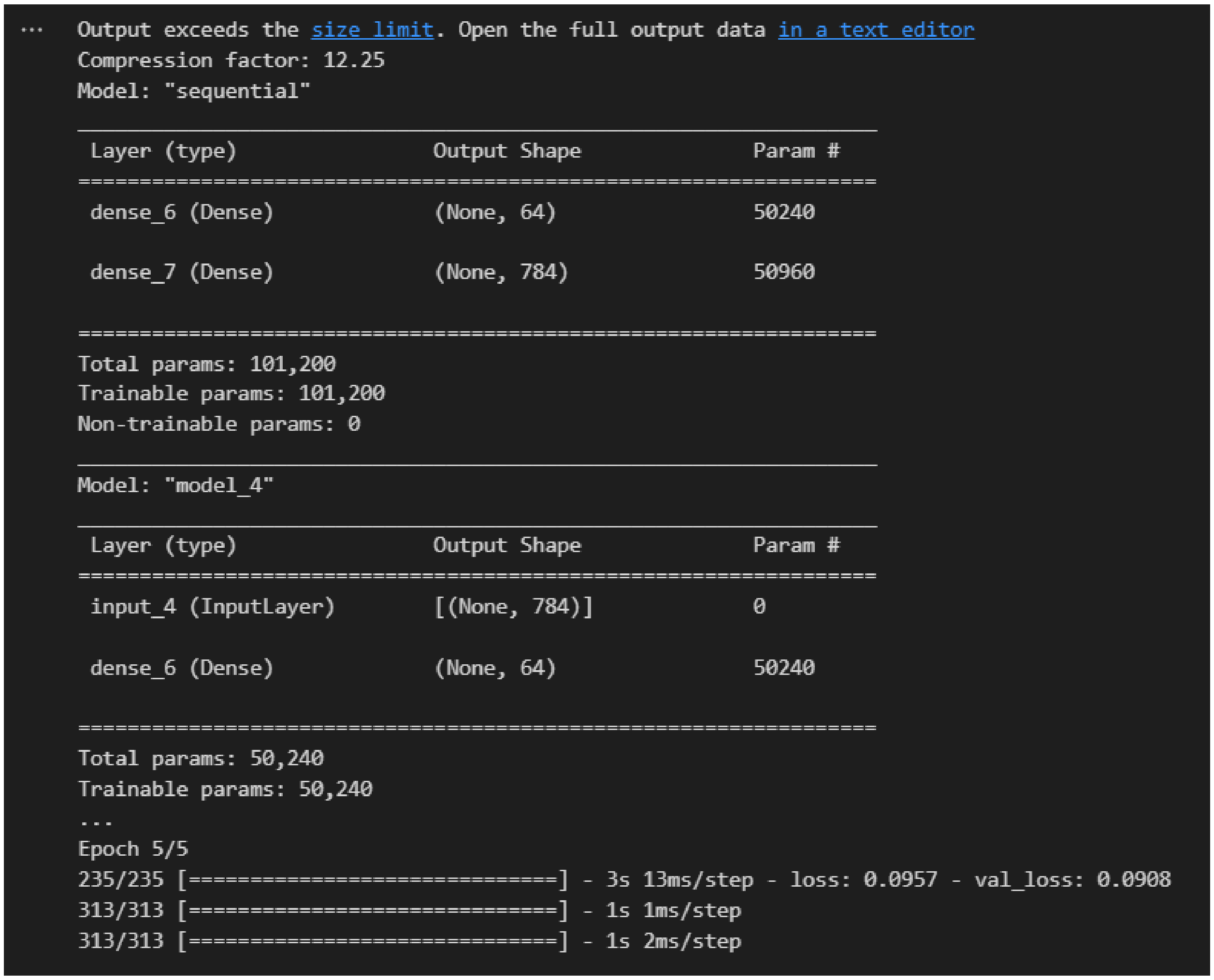
3. Use denoisening autoencoder, to reconstruct the input,

4. Plot loss and accuracy using the history object.

```python
from keras.layers import Input, Dense
from keras.models import Model, Sequential

# Scales the training and test data to range between 0 and 1.
max_value = float(x_train.max())
x_train = x_train.astype('float32') / max_value
x_test = x_test.astype('float32') / max_value
x_train.shape, x_test.shape
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:])))

(x_train.shape, x_test.shape)
input_dim = x_train.shape[1]
encoding_dim = 64

compression_factor = float(input_dim) / encoding_dim
print("Compression factor: %s" % compression_factor)

autoencoder = Sequential()
autoencoder.add(
    Dense(encoding_dim, input_shape=(input_dim,), activation='relu')
)
autoencoder.add(
    Dense(input_dim, activation='sigmoid')
)
```



```python
autoencoder.summary()
input_img = Input(shape=(input_dim,))
encoder_layer = autoencoder.layers[0]
encoder = Model(input_img, encoder_layer(input_img))

encoder.summary()
autoencoder.compile(optimizer='adam', loss='binary_crossentropy')
history = autoencoder.fit(x_train, x_train,
                          epochs=5,
                          batch_size=256,
                          shuffle=True,
                          validation_data=(x_test, x_test))
num_images = 5
np.random.seed(42)
random_test_images = np.random.randint(x_test.shape[0], size=num_images)

noise = np.random.normal(loc=0.1, scale=0.1, size=x_test.shape)
noised_images = x_test + noise
encoded_imgs = encoder.predict(noised_images)
decoded_imgs = autoencoder.predict(noised_images)
```



```
···  Output exceeds the size limit. Open the full output data in a text editor
     Compression factor: 12.25
     Model: "sequential"
     _________________________________________________________________
      Layer (type)                Output Shape              Param #
     =================================================================
      dense_6 (Dense)             (None, 64)                50240

      dense_7 (Dense)             (None, 784)               50960

     =================================================================
     Total params: 101,200
     Trainable params: 101,200
     Non-trainable params: 0
     _________________________________________________________________
     Model: "model_4"
     _________________________________________________________________
      Layer (type)                Output Shape              Param #
     =================================================================
      input_4 (InputLayer)        [(None, 784)]             0

      dense_6 (Dense)             (None, 64)                50240

     =================================================================
     Total params: 50,240
     Trainable params: 50,240
     ...
     Epoch 5/5
     235/235 [==============================] - 3s 13ms/step - loss: 0.0957 - val_loss: 0.0908
     313/313 [==============================] - 1s 1ms/step
     313/313 [==============================] - 1s 2ms/step
```