Spring 2024: CS5720 Neural Networks & Deep Learning - ICP-8 Assignment-8
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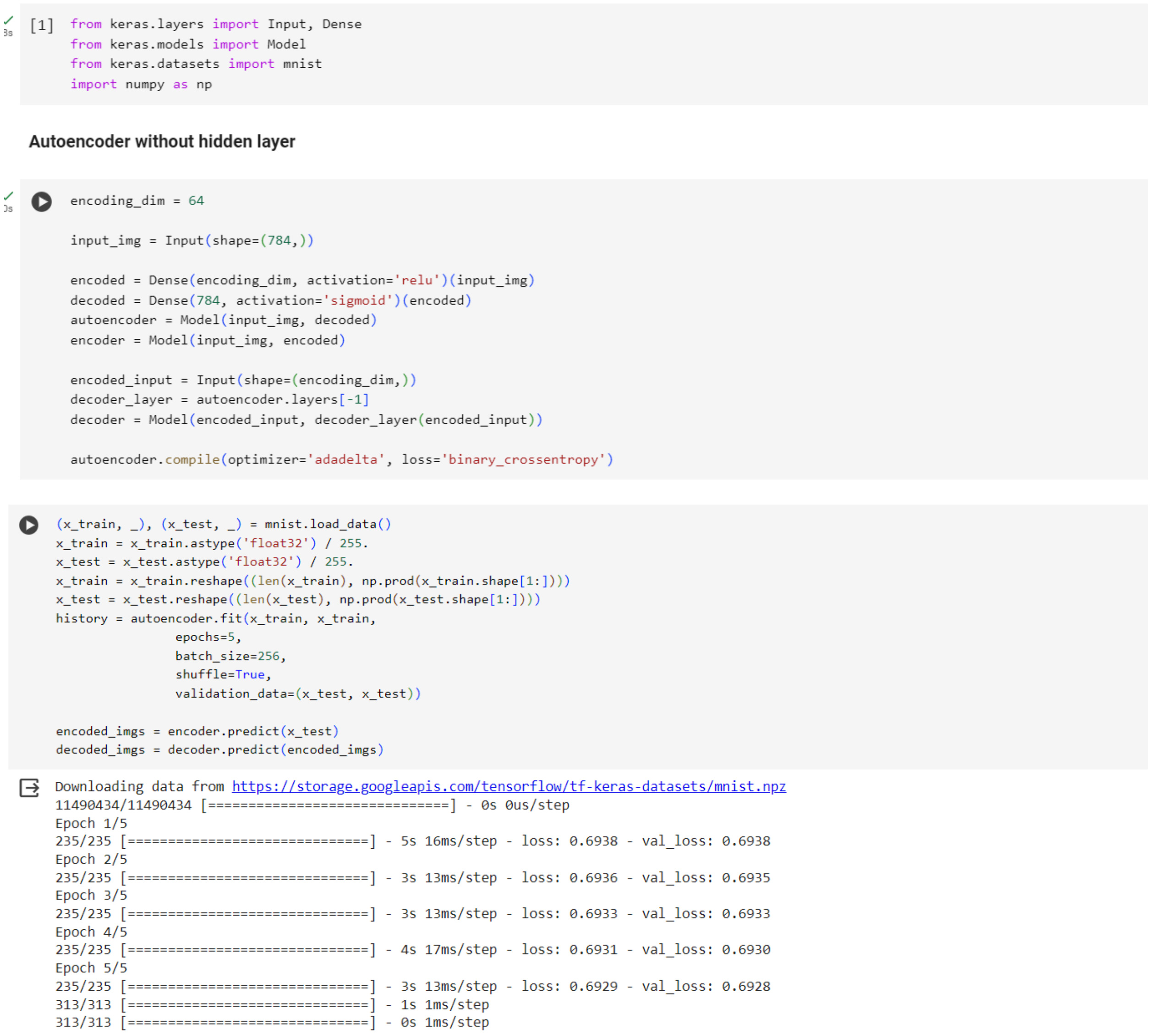
Github Link: https://github.com/VinayGunuguntla/icp8.git

Video Link: NNDL_Assignment_8.mp4



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

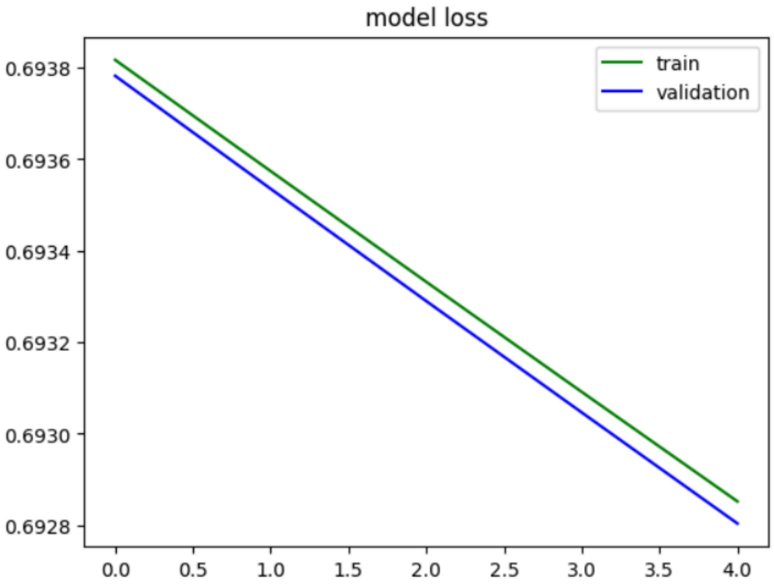
Autoencoder without hidden layer

```
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)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/mnist.npz
11490434/11490434 [==============================] - 0s 0us/step
Epoch 1/5
235/235 [==============================] - 5s 16ms/step - loss: 0.6938 - val_loss: 0.6938
Epoch 2/5
235/235 [==============================] - 3s 13ms/step - loss: 0.6936 - val_loss: 0.6935
Epoch 3/5
235/235 [==============================] - 3s 13ms/step - loss: 0.6933 - val_loss: 0.6933
Epoch 4/5
235/235 [==============================] - 4s 17ms/step - loss: 0.6931 - val_loss: 0.6930
Epoch 5/5
235/235 [==============================] - 3s 13ms/step - loss: 0.6929 - val_loss: 0.6928
313/313 [==============================] - 1s 1ms/step
313/313 [==============================] - 0s 1ms/step
```

```
# 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()
```

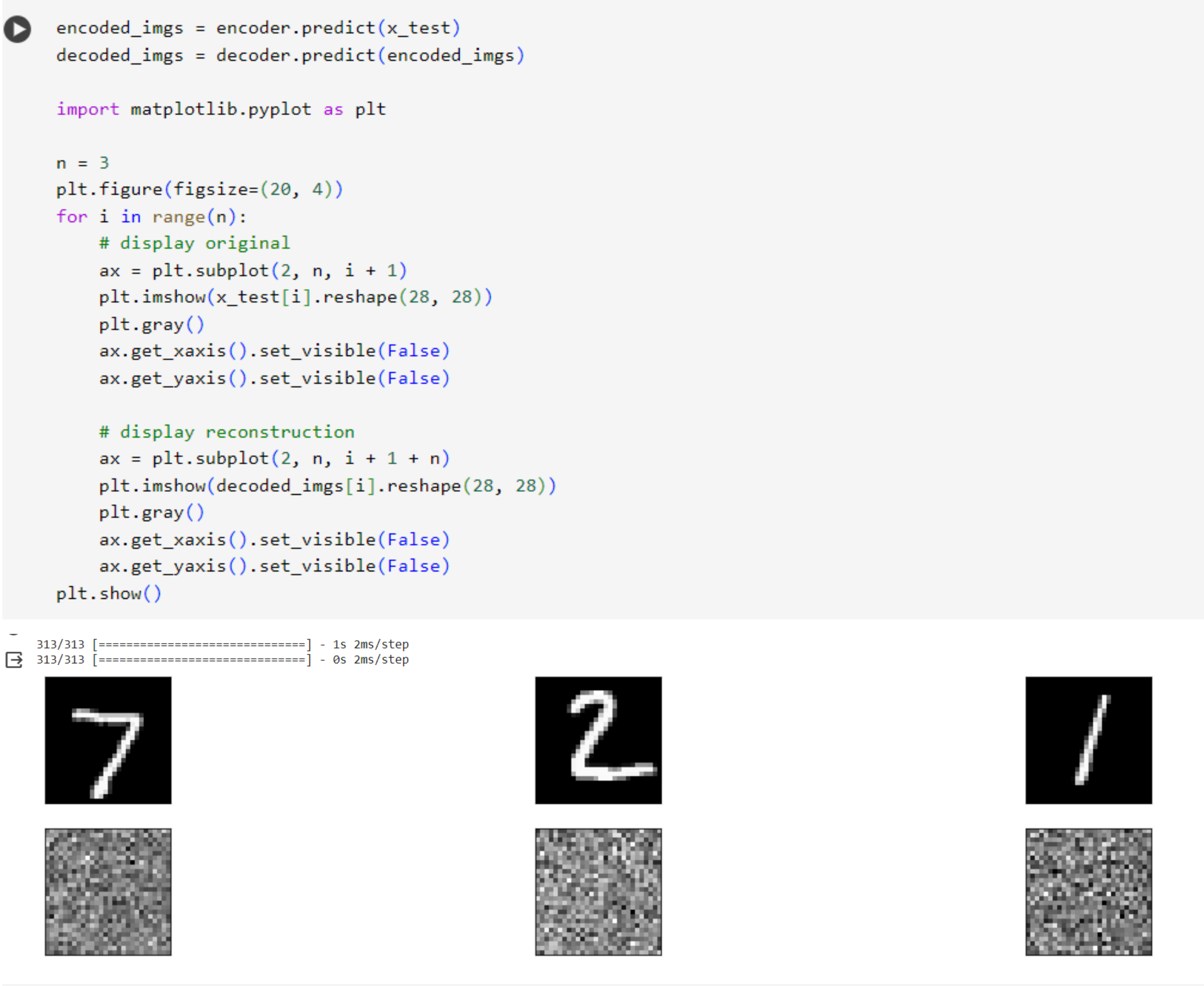


Autoencoder with hidden layer

```
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')
```

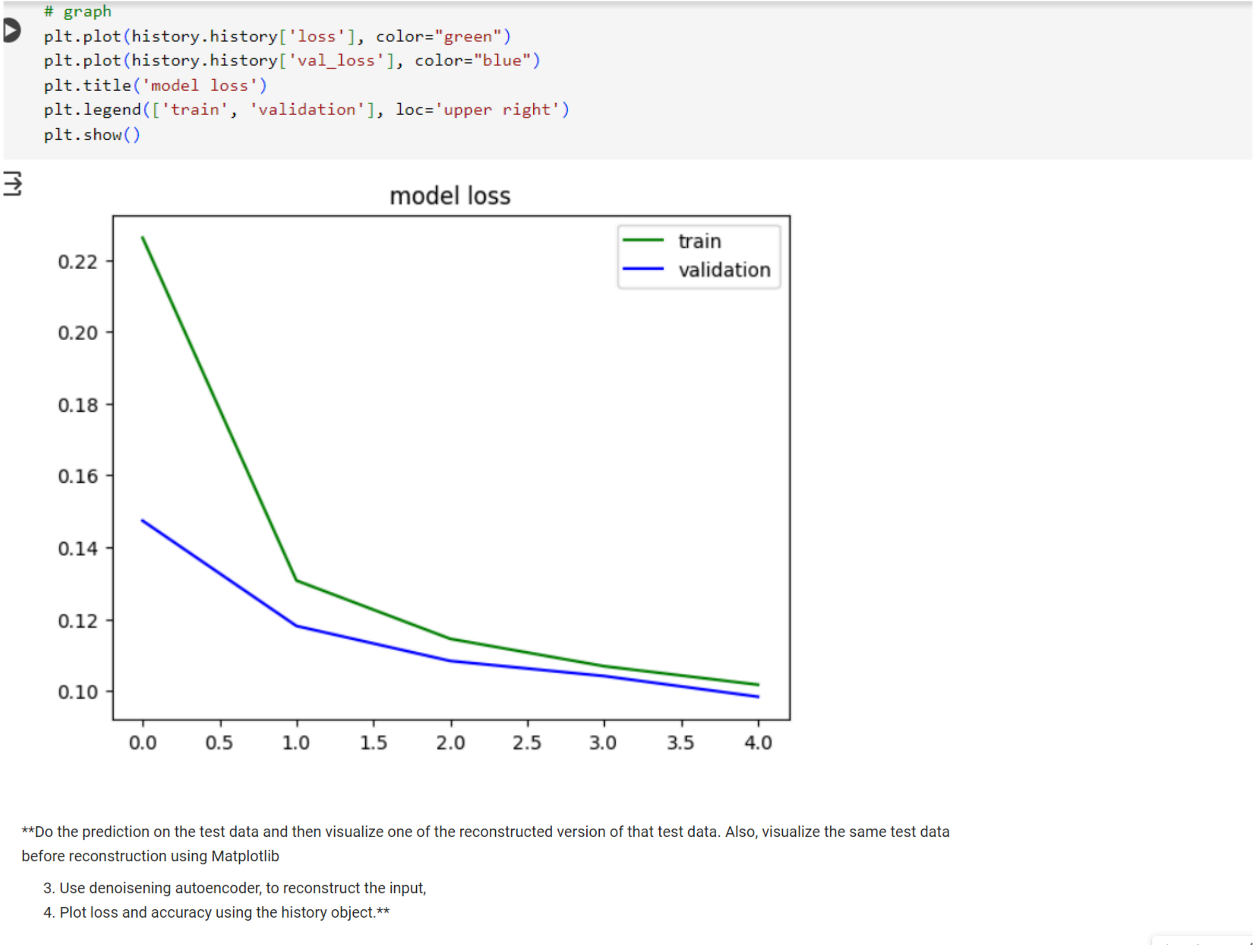
```
[6] (x_train, _), (x_test, _) = mnist.load_data()
    x_train = x_train.astype('float32') / 255.
    x_test = x_test.astype('float32') / 255.
    x_train = x_train.reshape((len(x_train), np.prod(x_train.shape[1:])))
    x_test = x_test.reshape((len(x_test), np.prod(x_test.shape[1:])))
    history = 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 20ms/step - loss: 0.2261 - val_loss: 0.1473
Epoch 2/5
235/235 [==============================] - 4s 15ms/step - loss: 0.1307 - val_loss: 0.1180
Epoch 3/5
235/235 [==============================] - 4s 15ms/step - loss: 0.1145 - val_loss: 0.1083
Epoch 4/5
235/235 [==============================] - 4s 19ms/step - loss: 0.1068 - val_loss: 0.1041
Epoch 5/5
235/235 [==============================] - 4s 16ms/step - loss: 0.1017 - val_loss: 0.0983
```



```
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()
```

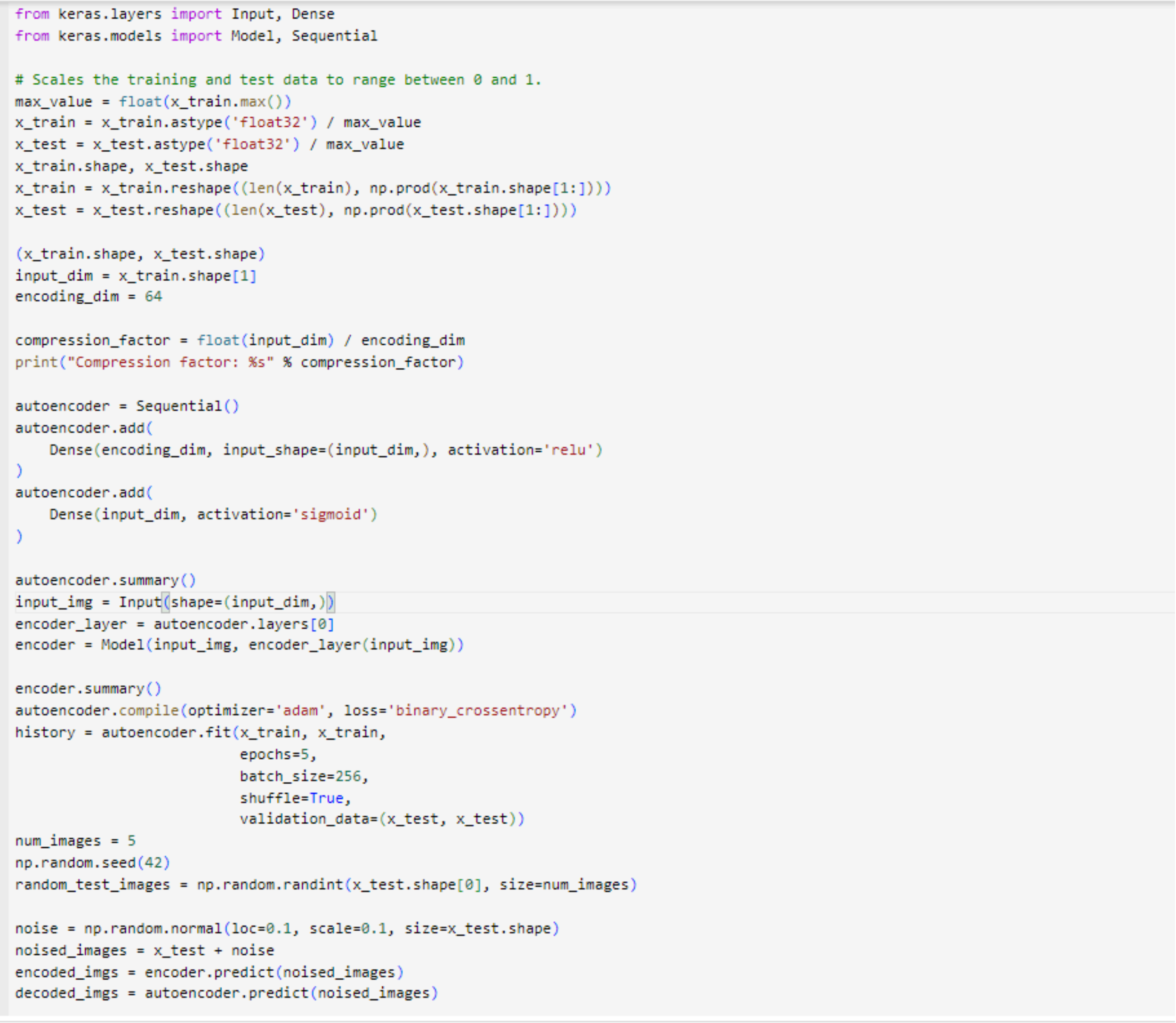
```
313/313 [==============================] - 1s 2ms/step
313/313 [==============================] - 0s 2ms/step
```



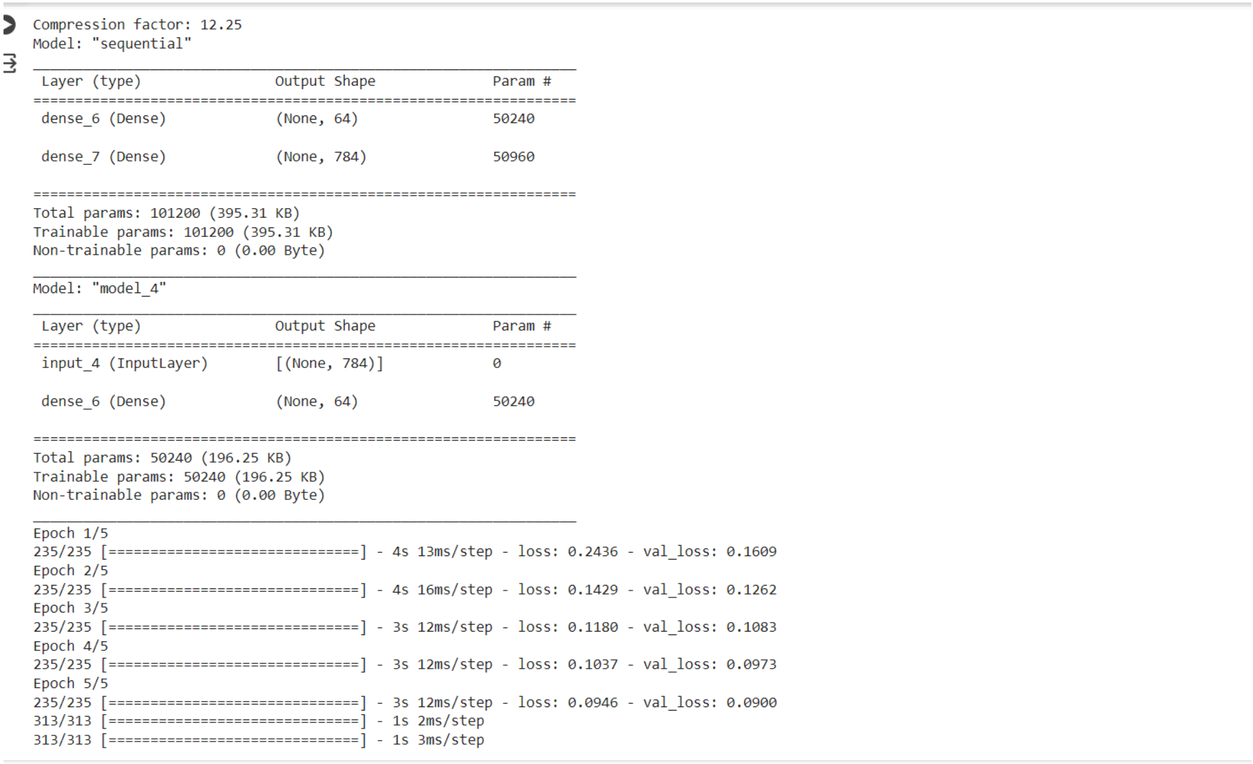
```
# graph
plt.plot(history.history['loss'], color="green")
plt.plot(history.history['val_loss'], color="blue")
plt.title('model loss')
plt.legend(['train', 'validation'], loc='upper right')
plt.show()
```

**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')
)

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)
```



```
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: 101200 (395.31 KB)
Trainable params: 101200 (395.31 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
Model: "model_4"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_4 (InputLayer)        [(None, 784)]             0

 dense_6 (Dense)             (None, 64)                50240

=================================================================
Total params: 50240 (196.25 KB)
Trainable params: 50240 (196.25 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
Epoch 1/5
235/235 [==============================] - 4s 13ms/step - loss: 0.2436 - val_loss: 0.1609
Epoch 2/5
235/235 [==============================] - 4s 16ms/step - loss: 0.1429 - val_loss: 0.1262
Epoch 3/5
235/235 [==============================] - 3s 12ms/step - loss: 0.1180 - val_loss: 0.1083
Epoch 4/5
235/235 [==============================] - 3s 12ms/step - loss: 0.1037 - val_loss: 0.0973
Epoch 5/5
235/235 [==============================] - 3s 12ms/step - loss: 0.0946 - val_loss: 0.0900
313/313 [==============================] - 1s 2ms/step
313/313 [==============================] - 1s 3ms/step
```