ASSIGNMENT-4
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github:https://github.com/vemparalahemasri/NNDL_Assignment4.

1. Add one more hidden layer to autoencoder
2. 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. Repeat the question 2 on the denoisening autoencoder
4. plot loss and accuracy using the history object

```
In [15]:
from keras.layers import Input, Dense
from keras.models import Model

# this is the size of our encoded representations
encoding_dim = 32  # 32 floats -> compression of factor 24.5, assuming the input is 784 floats

# this is our input placeholder
input_img = Input(shape=(784,))
# "encoded" is the encoded representation of the input
encoded = Dense(encoding_dim, activation='relu')(input_img)
# "decoded" is the lossy reconstruction of the input
decoded = Dense(784, activation='sigmoid')(encoded)
# this model maps an input to its reconstruction
autoencoder = Model(input_img, decoded)
# this model maps an input to its encoded representation
autoencoder.compile(optimizer='adadelta', loss='binary_crossentropy', metrics ='accuracy')
from keras.datasets import mnist, fashion_mnist
import numpy as np
(x_train, y_train), (x_test, y_test) = fashion_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:])))

autoencoder.fit(x_train, x_train,
                epochs=5,
                batch_size=256,
                shuffle=True,
                validation_data=(x_test, x_test))
```

```
Epoch 1/5
```

```
Epoch 1/5
235/235 [==============================] - 4s 12ms/step - loss: 0.6937 - accuracy: 0.0036 - val_loss: 0.6936 - val_accuracy:
0.0045
Epoch 2/5
235/235 [==============================] - 3s 12ms/step - loss: 0.6935 - accuracy: 0.0037 - val_loss: 0.6935 - val_accuracy:
0.0046
Epoch 3/5
235/235 [==============================] - 3s 12ms/step - loss: 0.6934 - accuracy: 0.0037 - val_loss: 0.6933 - val_accuracy:
0.0045
Epoch 4/5
235/235 [==============================] - 3s 11ms/step - loss: 0.6933 - accuracy: 0.0037 - val_loss: 0.6932 - val_accuracy:
0.0044
Epoch 5/5
235/235 [==============================] - 3s 11ms/step - loss: 0.6931 - accuracy: 0.0037 - val_loss: 0.6931 - val_accuracy:
0.0044
```

In [14]:

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

# This is the size of our encoded representation
encoding_dim = 32  # 32 floats -> compression of factor 24.5, assuming the input is 784 floats

# This is our input placeholder
input_img = Input(shape=(784,))

# "encoded" is the encoded representation of the input
encoded1 = Dense(128, activation='relu')(input_img)
encoded2 = Dense(encoding_dim, activation='relu')(encoded1)

# "decoded" is the lossy reconstruction of the input
decoded1 = Dense(128, activation='relu')(encoded2)
decoded2 = Dense(784, activation='sigmoid')(decoded1)

# This model maps an input to its reconstruction
autoencoder = Model(input_img, decoded2)

# This model maps an input to its encoded representation
encoder = Model(input_img, encoded2)

# This is our decoder model
encoded_input = Input(shape=(encoding_dim,))
decoder_layer1 = autoencoder.layers[-2]
decoder_layer2 = autoencoder.layers[-1]
decoder = Model(encoded_input, decoder_layer2(decoder_layer1(encoded_input)))

# Compile the model
autoencoder.compile(optimizer='adadelta', loss='binary_crossentropy',metrics ='accuracy')
```

```python
# Load the MNIST dataset
from keras.datasets import mnist, fashion_mnist
import numpy as np
(x_train, y_train), (x_test, y_test) = fashion_mnist.load_data()

# Normalize and flatten the 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 autoencoder
autoencoder.fit(x_train, x_train,
                epochs=5,
                batch_size=256,
                shuffle=True,
                validation_data=(x_test, x_test))
```

```
Epoch 1/5
235/235 [==============================] - 7s 22ms/step - loss: 0.6939 - accuracy: 0.0027 - val_loss: 0.6938 - val_accuracy:
0.0025
Epoch 2/5
235/235 [==============================] - 4s 19ms/step - loss: 0.6938 - accuracy: 0.0028 - val_loss: 0.6937 - val_accuracy:
0.0025
Epoch 3/5
235/235 [==============================] - 4s 17ms/step - loss: 0.6937 - accuracy: 0.0027 - val_loss: 0.6936 - val_accuracy:
0.0026
Epoch 4/5
235/235 [==============================] - 4s 17ms/step - loss: 0.6936 - accuracy: 0.0027 - val_loss: 0.6935 - val_accuracy:
0.0026
Epoch 5/5
```

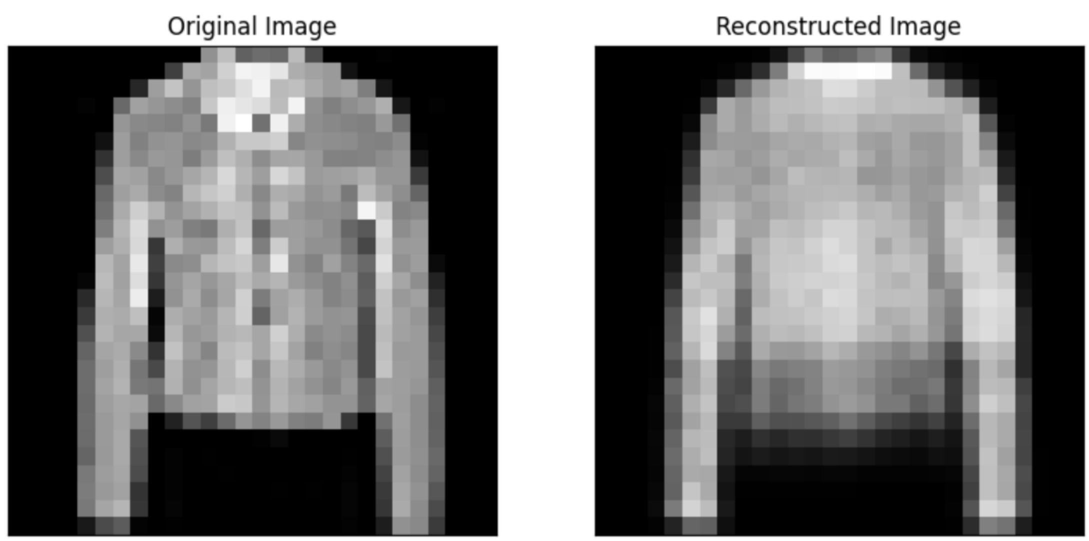
```
235/235 [==============================] - 4s 17ms/step - loss: 0.6935 - accuracy: 0.0027 - val_loss: 0.6934 - val_accuracy:
0.0028
```

t[14]: `<keras.callbacks.History at 0x2b9d7038350>`

[15]:

```python
import matplotlib.pyplot as plt

# Get the reconstructed images for the test set
reconstructed_imgs = autoencoder.predict(x_test)

# Choose a random image from the test set
n = 10  # index of the image to be plotted
plt.figure(figsize=(10, 5))

# Plot the original image
ax = plt.subplot(1, 2, 1)
plt.imshow(x_test[n].reshape(28, 28))
plt.gray()
ax.get_xaxis().set_visible(False)
ax.get_yaxis().set_visible(False)
ax.set_title("Original Image")

# Plot the reconstructed image
ax = plt.subplot(1, 2, 2)
plt.imshow(reconstructed_imgs[n].reshape(28, 28))
plt.gray()
ax.get_xaxis().set_visible(False)
ax.get_yaxis().set_visible(False)
ax.set_title("Reconstructed Image")

plt.show()
```

```
313/313 [==============================] - 1s 3ms/step
```

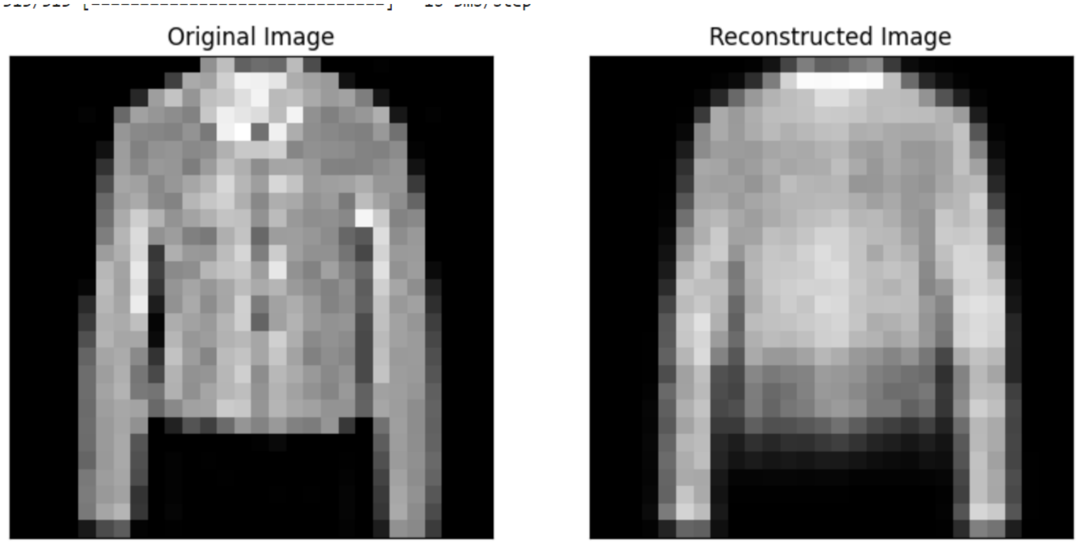


```
from keras.layers import Input, Dense
from keras.models import Model

# this is the size of our encoded representations
encoding_dim = 32  # 32 floats -> compression of factor 24.5, assuming the input is 784 floats

# this is our input placeholder
input_img = Input(shape=(784,))
# "encoded" is the encoded representation of the input
encoded = Dense(encoding_dim, activation='relu')(input_img)
# "decoded" is the lossy reconstruction of the input
decoded = Dense(784, activation='sigmoid')(encoded)
# this model maps an input to its reconstruction
autoencoder = Model(input_img, decoded)
# this model maps an input to its encoded representation
autoencoder.compile(optimizer='adadelta', loss='binary_crossentropy',metrics ='accuracy')
from keras.datasets import fashion_mnist
import numpy as np
(x_train, _), (x_test, _) = fashion_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:])))

#introducing noise
noise_factor = 0.5
x_train_noisy = x_train + noise_factor * np.random.normal(loc=0.0, scale=1.0, size=x_train.shape)
x_test_noisy = x_test + noise_factor * np.random.normal(loc=0.0, scale=1.0, size=x_test.shape)

autoencoder.fit(x_train_noisy, x_train,
                epochs=10,
                batch_size=256,
```

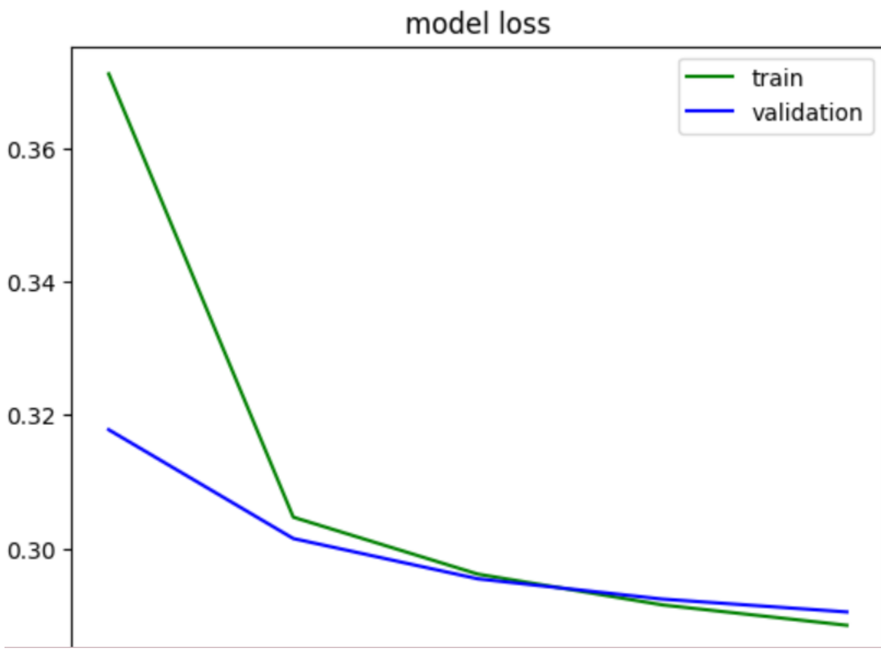
```
                shuffle=True,
                validation_data=(x_test_noisy, x_test_noisy))
```

```
Epoch 1/10
235/235 [==============================] - 4s 14ms/step - loss: 0.6964 - accuracy: 7.8333e-04 - val_loss: 0.6963 - val_accurac
y: 8.0000e-04
Epoch 2/10
235/235 [==============================] - 3s 13ms/step - loss: 0.6962 - accuracy: 8.0000e-04 - val_loss: 0.6961 - val_accurac
y: 8.0000e-04
Epoch 3/10
235/235 [==============================] - 3s 13ms/step - loss: 0.6959 - accuracy: 8.1667e-04 - val_loss: 0.6959 - val_accurac
y: 8.0000e-04
Epoch 4/10
235/235 [==============================] - 3s 11ms/step - loss: 0.6957 - accuracy: 8.6667e-04 - val_loss: 0.6956 - val_accurac
y: 7.0000e-04
Epoch 5/10
235/235 [==============================] - 3s 11ms/step - loss: 0.6955 - accuracy: 8.6667e-04 - val_loss: 0.6954 - val_accurac
y: 7.0000e-04
Epoch 6/10
235/235 [==============================] - 3s 11ms/step - loss: 0.6952 - accuracy: 8.6667e-04 - val_loss: 0.6952 - val_accurac
y: 8.0000e-04
Epoch 7/10
235/235 [==============================] - 3s 11ms/step - loss: 0.6950 - accuracy: 9.0000e-04 - val_loss: 0.6950 - val_accurac
y: 9.0000e-04
Epoch 8/10
235/235 [==============================] - 3s 13ms/step - loss: 0.6948 - accuracy: 8.6667e-04 - val_loss: 0.6948 - val_accurac
y: 0.0011
Epoch 9/10
235/235 [==============================] - 3s 11ms/step - loss: 0.6946 - accuracy: 8.6667e-04 - val_loss: 0.6946 - val_accurac
y: 0.0013
Epoch 10/10
235/235 [==============================] - 3s 11ms/step - loss: 0.6944 - accuracy: 8.3333e-04 - val_loss: 0.6944 - val_accurac
```

```python
import matplotlib.pyplot as plt

# Get the reconstructed images for the test set
reconstructed_imgs = autoencoder.predict(x_test)

# Choose a random image from the test set
n = 10  # index of the image to be plotted
plt.figure(figsize=(10, 5))

# Plot the original image
ax = plt.subplot(1, 2, 1)
plt.imshow(x_test[n].reshape(28, 28))
plt.gray()
ax.get_xaxis().set_visible(False)
ax.get_yaxis().set_visible(False)
ax.set_title("Original Image")

# Plot the reconstructed image
ax = plt.subplot(1, 2, 2)
plt.imshow(reconstructed_imgs[n].reshape(28, 28))
plt.gray()
ax.get_xaxis().set_visible(False)
ax.get_yaxis().set_visible(False)
ax.set_title("Reconstructed Image")

plt.show()
```



```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()
```



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

# this is the size of our encoded representations
encoding_dim = 32  # 32 floats -> compression of factor 24.5, assuming the input is 784 floats

# this is our input placeholder
input_img = Input(shape=(784,))
# "encoded" is the encoded representation of the input
encoded = Dense(encoding_dim, activation='relu')(input_img)
# "decoded" is the lossy reconstruction of the input
decoded = Dense(784, activation='sigmoid')(encoded)
# this model maps an input to its reconstruction
autoencoder = Model(input_img, decoded)
# this model maps an input to its encoded representation
autoencoder.compile(optimizer='adam', loss='binary_crossentropy',metrics ='accuracy')
from keras.datasets import fashion_mnist
import numpy as np
(x_train, _), (x_test, _) = fashion_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:])))

#introducing noise
noise_factor = 0.5
x_train_noisy = x_train + noise_factor * np.random.normal(loc=0.0, scale=1.0, size=x_train.shape)
x_test_noisy = x_test + noise_factor * np.random.normal(loc=0.0, scale=1.0, size=x_test.shape)

autoencoder.fit(x_train_noisy, x_train,
```

```python
                epochs=10,
                batch_size=256,
                shuffle=True,
                validation_data=(x_test_noisy, x_test_noisy))
```

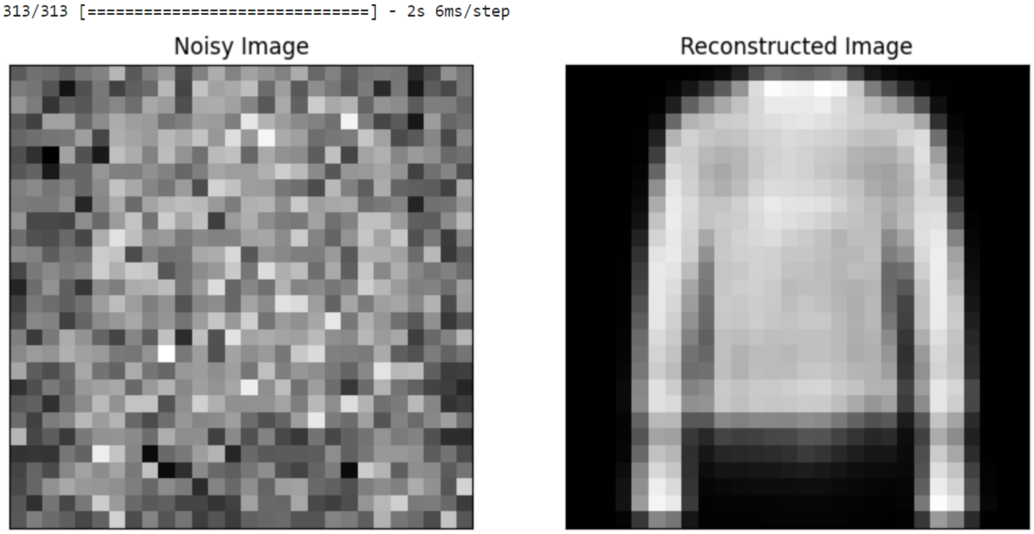
```
Epoch 1/10
235/235 [==============================] - 5s 17ms/step - loss: 0.4241 - accuracy: 0.0060 - val_loss: 0.3411 - val_accuracy:
0.0070
Epoch 2/10
235/235 [==============================] - 3s 12ms/step - loss: 0.3393 - accuracy: 0.0115 - val_loss: 0.3126 - val_accuracy:
0.0065
Epoch 3/10
235/235 [==============================] - 3s 12ms/step - loss: 0.3235 - accuracy: 0.0125 - val_loss: 0.2970 - val_accuracy:
0.0055
Epoch 4/10
235/235 [==============================] - 3s 12ms/step - loss: 0.3151 - accuracy: 0.0124 - val_loss: 0.2870 - val_accuracy:
0.0079
Epoch 5/10
235/235 [==============================] - 4s 17ms/step - loss: 0.3104 - accuracy: 0.0132 - val_loss: 0.2802 - val_accuracy:
0.0090
Epoch 6/10
235/235 [==============================] - 3s 11ms/step - loss: 0.3074 - accuracy: 0.0133 - val_loss: 0.2753 - val_accuracy:
0.0092
Epoch 7/10
235/235 [==============================] - 3s 12ms/step - loss: 0.3053 - accuracy: 0.0139 - val_loss: 0.2718 - val_accuracy:
0.0096
Epoch 8/10
235/235 [==============================] - 3s 12ms/step - loss: 0.3038 - accuracy: 0.0143 - val_loss: 0.2688 - val_accuracy:
0.0098
Epoch 9/10
235/235 [==============================] - 4s 17ms/step - loss: 0.3026 - accuracy: 0.0150 - val_loss: 0.2666 - val_accuracy:
0.0094
Epoch 10/10
```

```python
import matplotlib.pyplot as plt

# Get the reconstructed images for the test set
reconstructed_imgs = autoencoder.predict(x_test_noisy)

# Choose a random image from the test set
n = 10  # index of the image to be plotted
plt.figure(figsize=(10, 5))

# Plot the original noisy image
ax = plt.subplot(1, 2, 1)
plt.imshow(x_test_noisy[n].reshape(28, 28))
plt.gray()
ax.get_xaxis().set_visible(False)
ax.get_yaxis().set_visible(False)
ax.set_title("Noisy Image")

# Plot the reconstructed image
ax = plt.subplot(1, 2, 2)
plt.imshow(reconstructed_imgs[n].reshape(28, 28))
plt.gray()
ax.get_xaxis().set_visible(False)
ax.get_yaxis().set_visible(False)
ax.set_title("Reconstructed Image")

plt.show()
```

```
3/313 [==============================] - 2s 6ms/step
```


```python
ax.get_xaxis().set_visible(False)
ax.get_yaxis().set_visible(False)
ax.set_title("Reconstructed Image")

plt.show()
```

```
313/313 [==============================] - 2s 6ms/step
```

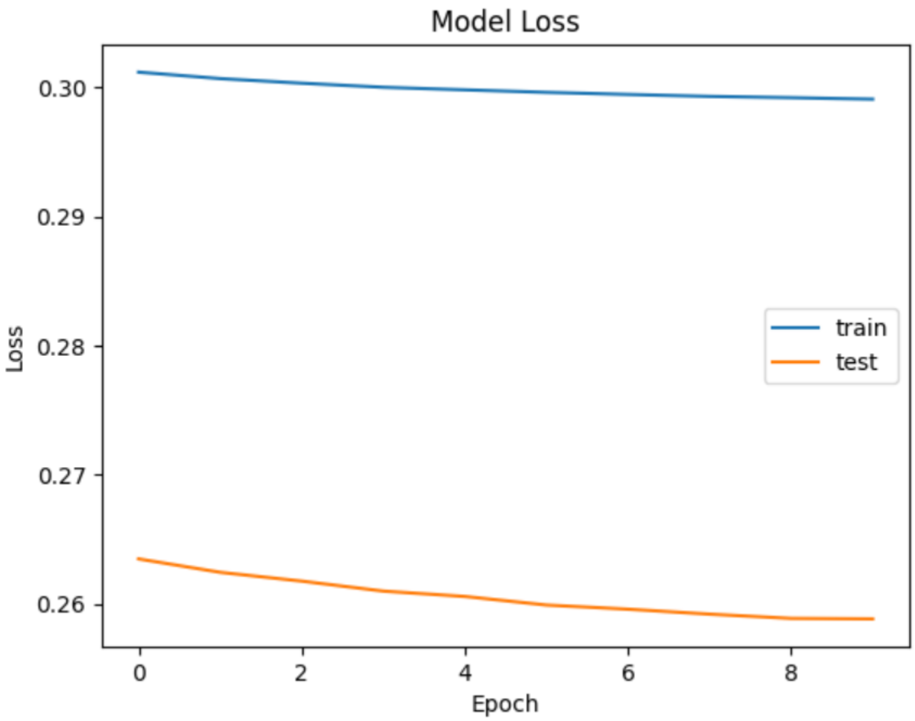



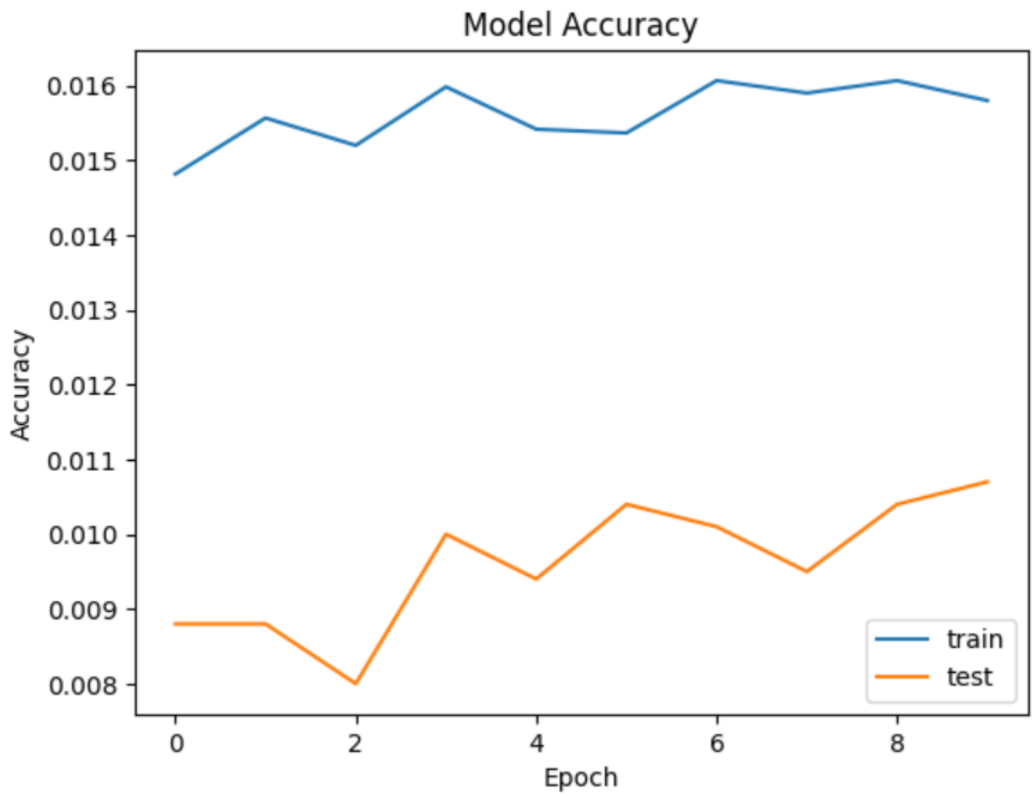
]:

```python
import matplotlib.pyplot as plt

# Train the autoencoder
history = autoencoder.fit(x_train_noisy, x_train,
                epochs=10,
                batch_size=256,
                shuffle=True,
                validation_data=(x_test_noisy, x_test_noisy))

# Plot the loss
plt.plot(history.history['loss'], label='train')
plt.plot(history.history['val_loss'], label='test')
plt.title('Model Loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend()
plt.show()

# Plot the accuracy
plt.plot(history.history['accuracy'], label='train')
plt.plot(history.history['val_accuracy'], label='test')
plt.title('Model Accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend()
plt.show()
```

```
Epoch 1/10
235/235 [==============================] - 3s 14ms/step - loss: 0.3012 - accuracy: 0.0148 - val_loss: 0.2635 - val_accuracy:
0.0088
Epoch 2/10
235/235 [==============================] - 3s 14ms/step - loss: 0.3007 - accuracy: 0.0156 - val_loss: 0.2624 - val_accuracy:
0.0088
Epoch 3/10
235/235 [==============================] - 3s 12ms/step - loss: 0.3003 - accuracy: 0.0152 - val_loss: 0.2617 - val_accuracy:
0.0080
Epoch 4/10
235/235 [==============================] - 3s 12ms/step - loss: 0.3000 - accuracy: 0.0160 - val_loss: 0.2610 - val_accuracy:
0.0100
Epoch 5/10
235/235 [==============================] - 3s 11ms/step - loss: 0.2998 - accuracy: 0.0154 - val_loss: 0.2606 - val_accuracy:
0.0094
Epoch 6/10
235/235 [==============================] - 4s 16ms/step - loss: 0.2996 - accuracy: 0.0154 - val_loss: 0.2599 - val_accuracy:
0.0104
Epoch 7/10
235/235 [==============================] - 3s 12ms/step - loss: 0.2995 - accuracy: 0.0161 - val_loss: 0.2596 - val_accuracy:
0.0101
Epoch 8/10
235/235 [==============================] - 3s 11ms/step - loss: 0.2993 - accuracy: 0.0159 - val_loss: 0.2592 - val_accuracy:
0.0095
Epoch 9/10
```

```
235/235 [==============================] - 3s 15ms/step - loss: 0.2991 - accuracy: 0.0158 - val_loss: 0.
0.0107
```




Model Accuracy
Accuracy
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
Epoch
0
2
4
6
8
train
test