denoising_autoencoder

January 12, 2022

1 18CSC402 - DEEP LEARNING

HANDWRITTEN CHARACTER LANGUAGE : Malayalam

NOISE USED : Salt & Pepper

[ ]:

```
import os
import cv2
import random
import numpy as np
from tensorflow import keras
import matplotlib.pyplot as plt
from skimage.util import random_noise
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import img_to_array
from keras.layers import Conv2D, MaxPooling2D, UpSampling2D, Input
```

[ ]:

```
# reading the images from its location

SIZE = 64
X, X_noisy = [], []
img_path = "/content/drive/MyDrive/MalayalamHandwrittenData/"
for folder in os.listdir(img_path):
  path = img_path+folder+"/"
  files = os.listdir(path)
  for i in range(300):
    filename = files[i]
    img = cv2.imread(path+filename,0)
    img = cv2.resize(img,(SIZE,SIZE))
    img_array = img_to_array(img)
    X.append(img_array)
    noisy_img = random_noise(img, mode="s&p", amount=0.25)
    X_noisy.append(noisy_img)

X_noisy = np.reshape(X_noisy, (len(X_noisy), SIZE, SIZE, 1))
X_noisy = X_noisy.astype('float32') / 255.0
X = np.reshape(X, (len(X), SIZE, SIZE, 1))
X = X.astype('float32') / 255.0
```

```
print("Noisy data shape:", X_noisy.shape)
print("Clean data shape:", X.shape)
```

```
Noisy data shape: (4500, 64, 64, 1)
Clean data shape: (4500, 64, 64, 1)
```

[ ]:

```
# splitting data into train and validation sets

from sklearn.model_selection import train_test_split
X_train, X_valid, y_train, y_valid = train_test_split(X_noisy, X, test_size=0.2)
print(X_train.shape)
print(X_valid.shape)
print(y_train.shape)
print(y_valid.shape)
```

```
(3600, 64, 64, 1)
(900, 64, 64, 1)
(3600, 64, 64, 1)
(900, 64, 64, 1)
```

[ ]:

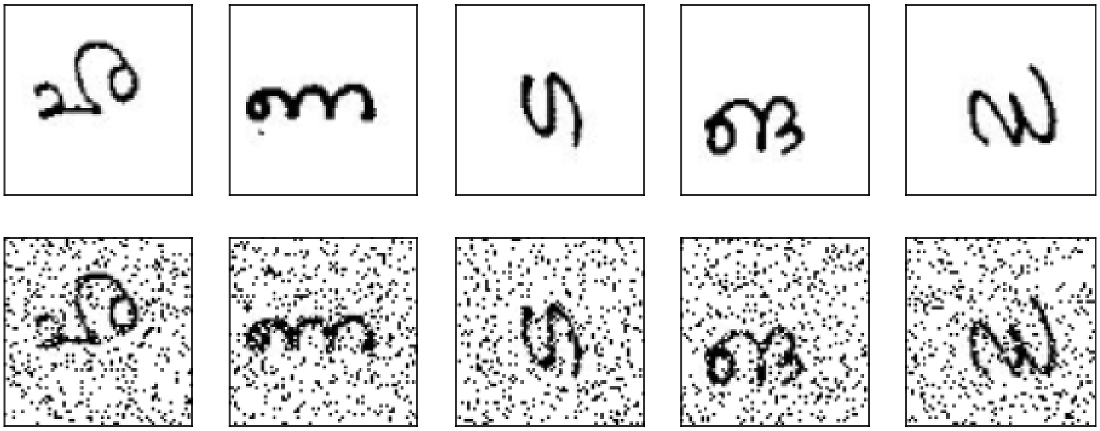
```
# plotting some sample clean and corresponding noisy images

num = [random.randint(0,4500) for i in range(5)]
n = len(num)
plt.figure(figsize=(10, 4))
for i in range(n):

    # Show sample test images
    ax = plt.subplot(2, n, i + 1)
    plt.imshow(X[num[i]].reshape(SIZE, SIZE), cmap="gray")
    ax.get_xaxis().set_visible(False)
    ax.get_yaxis().set_visible(False)

    # Show corresponding output images
    ax = plt.subplot(2, n, i + 1 + n)
    plt.imshow(X_noisy[num[i]].reshape(SIZE, SIZE), cmap="gray")
    ax.get_xaxis().set_visible(False)
    ax.get_yaxis().set_visible(False)

plt.show()
```



[ ]:

```
# ARCHITECTURE : convolutional autoencoder

# Encoder
input = Input(shape=(64, 64, 1)) # 64*64*1
x = Conv2D(64, (3, 3), activation="relu", padding="same")(input) # 64*64*64
x = MaxPooling2D((2, 2), padding="same")(x) # 32*32*64
x = Conv2D(32, (3, 3), activation="relu", padding="same")(x) # 32*32*32
x = MaxPooling2D((2, 2), padding="same")(x) # 16*16*32
x = Conv2D(16, (3, 3), activation="relu", padding="same")(x) # 16*16*16
# encoder model
encoder = keras.Model(input, x)

# Decoder
x = Conv2D(32, (3, 3), activation="relu", padding="same")(x) # 16*16*32
x = UpSampling2D((2, 2))(x) # 32*32*32
x = Conv2D(64, (3, 3), activation="relu", padding="same")(x) # 32*32*64
x = UpSampling2D((2, 2))(x) # 64*64*64
output = Conv2D(1, (3, 3), activation="sigmoid", padding="same")(x) # 64*64*1

# Model
```

```
conv_autoencoder = keras.Model(input, output)
```

[ ]:

```
# Compiling the model

conv_autoencoder.compile(optimizer="adam", loss="mse")
conv_autoencoder.summary()
```

```
Model: "model_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 64, 64, 1)]       0

 conv2d (Conv2D)             (None, 64, 64, 64)        640

 max_pooling2d (MaxPooling2D  (None, 32, 32, 64)       0
 )

 conv2d_1 (Conv2D)           (None, 32, 32, 32)        18464

 max_pooling2d_1 (MaxPooling  (None, 16, 16, 32)       0
 2D)

 conv2d_2 (Conv2D)           (None, 16, 16, 16)        4624

 conv2d_3 (Conv2D)           (None, 16, 16, 32)        4640

 up_sampling2d (UpSampling2D  (None, 32, 32, 32)       0
 )

 conv2d_4 (Conv2D)           (None, 32, 32, 64)        18496

 up_sampling2d_1 (UpSampling  (None, 64, 64, 64)       0
 2D)

 conv2d_5 (Conv2D)           (None, 64, 64, 1)         577

=================================================================
Total params: 47,441
Trainable params: 47,441
Non-trainable params: 0
_________________________________________________________________
```

[ ]:

```
# fitting the model

history = conv_autoencoder.fit(X_train, y_train, validation_data=(X_valid,␣
 ↪y_valid), epochs=50, batch_size=128)
```

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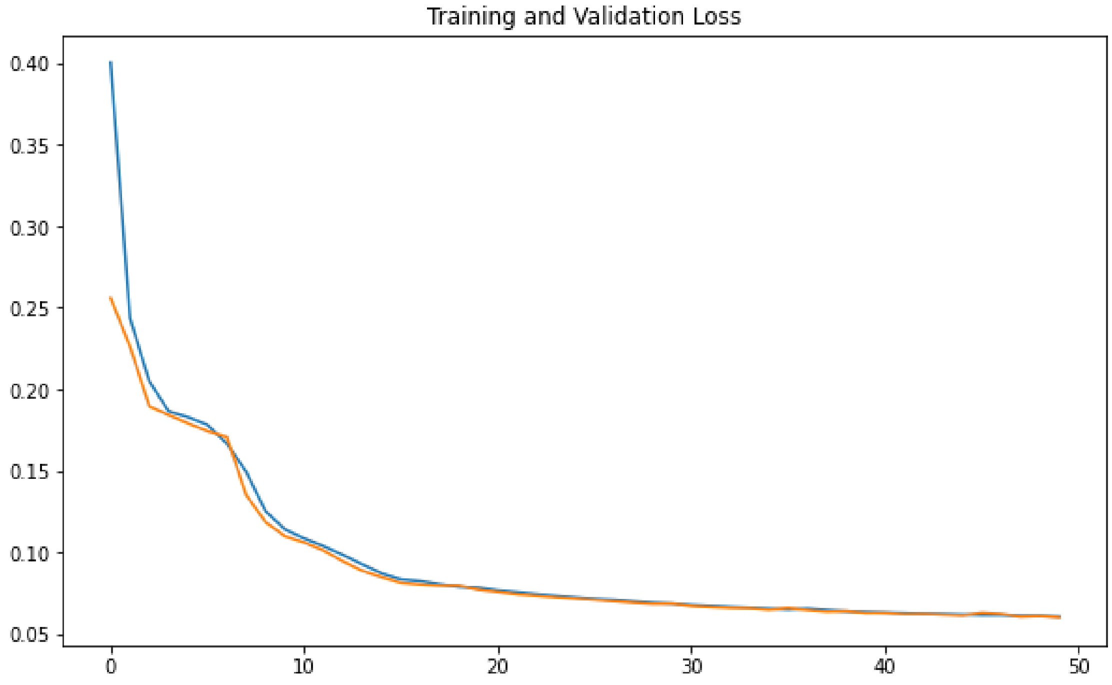
```
# plotting the train and validation loss curves

loss = history.history["loss"]
val_loss = history.history["val_loss"]

plt.figure(figsize=(10,6))
epochs = 50

plt.plot(loss, label='Training Loss')
plt.plot(val_loss, label='Validation Loss')
plt.title('Training and Validation Loss')

plt.show()
```

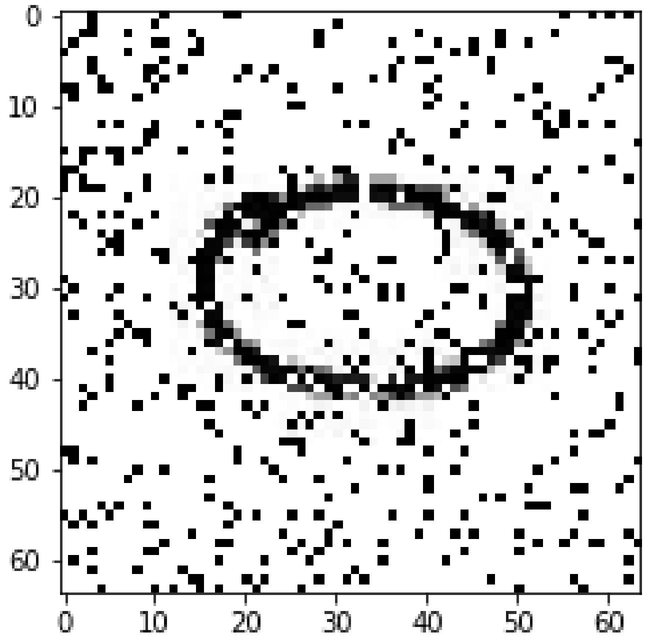


[ ]:

```
# demonstrating the prediction on an image in the validation set
plt.imshow(X_valid[1].reshape(64,64), cmap="gray")
```

[ ]:

```
<matplotlib.image.AxesImage at 0x7fe0f6b5f790>
```



[ ]:
```
# denoised output of the image
output = conv_autoencoder.predict([X_valid[1].reshape(-1,64,64,1)])[0]
plt.imshow(output.reshape(64,64), cmap="gray")
```

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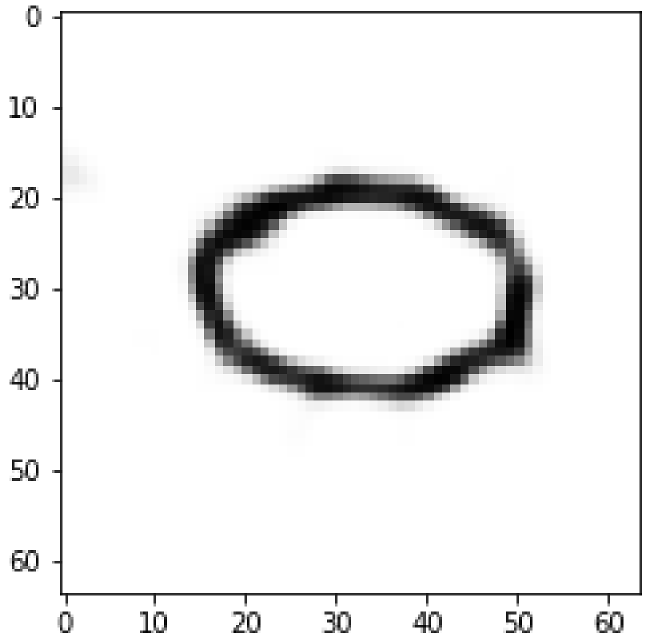
```
<matplotlib.image.AxesImage at 0x7fe0f6aff110>
```



[ ]:

```
# checking the reconstruction power on unseen data

test_img = cv2.imread("/content/drive/MyDrive/MalayalamHandwrittenSubset/
 ↪Malayalam Handwritten Subset/15.jpg",0)
test_img = cv2.resize(test_img,(SIZE,SIZE))
test_noisy_img = random_noise(test_img, mode="s&p", amount=0.25)
test_noisy_img_reshaped = np.reshape(test_noisy_img, (SIZE, SIZE,1))
test_noisy_img_reshaped = test_noisy_img_reshaped.astype('float32') / 255.0
denoised_img = conv_autoencoder.predict([test_noisy_img_reshaped.
 ↪reshape(-1,64,64,1)])[0]
print(denoised_img.shape)
plt.imshow(test_noisy_img, cmap="gray")
```

```
(64, 64, 1)
```

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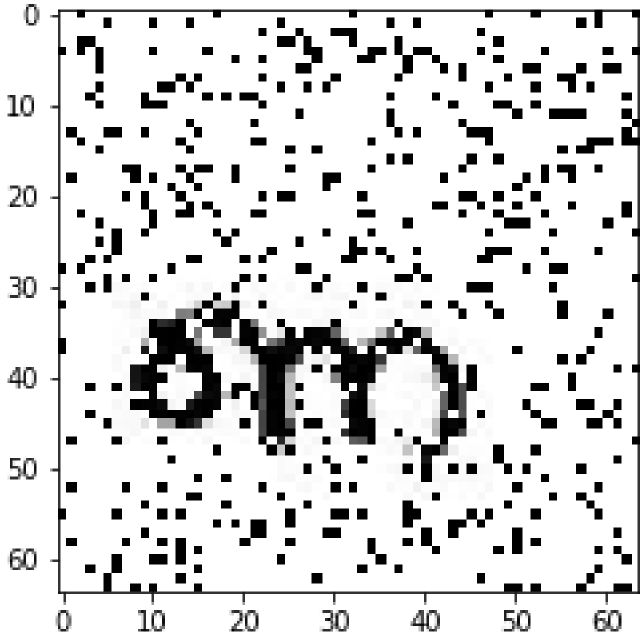
```
<matplotlib.image.AxesImage at 0x7fe16d9d6350>
```

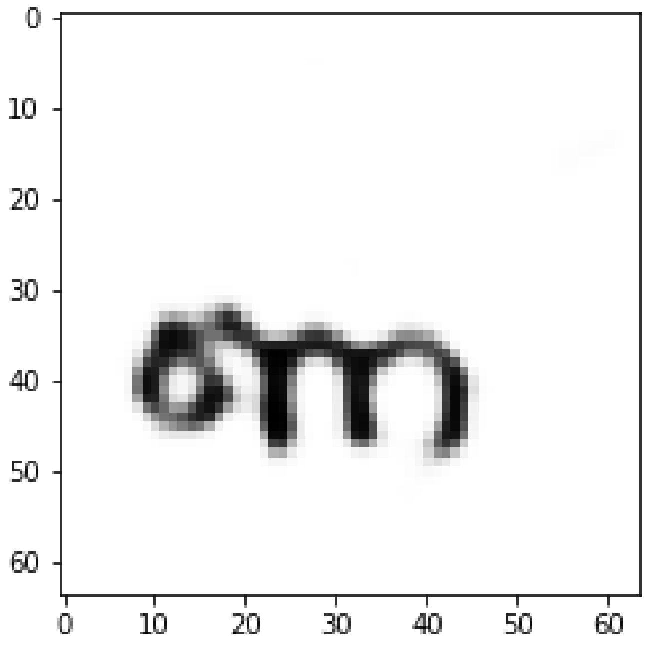


[ ]:

```
plt.imshow(denoised_img.reshape(64,64), cmap="gray")
```

[ ]:

```
<matplotlib.image.AxesImage at 0x7fe16daf9510>
```



PREDICTING ONE SAMPLE FROM EACH OF THE 15 CHARACTERS

```
[ ]: dir_path = "/content/drive/MyDrive/MalayalamHandwrittenSubset/Malayalam␣
      ↪Handwritten Subset/"
     SIZE = 64
     test_clean, test_noisy = [], []
     for filename in os.listdir(dir_path):
         img = cv2.imread(dir_path+filename,0)
         img = cv2.resize(img,(SIZE,SIZE))
         img_array = img_to_array(img)
         test_clean.append(img_array)
         noisy_img = random_noise(img, mode="s&p", amount=0.25)
         test_noisy.append(noisy_img)

     test_noisy = np.reshape(test_noisy, (len(test_noisy), SIZE, SIZE, 1))
     test_noisy = test_noisy.astype('float32') / 255.0
     test_clean = np.reshape(test_clean, (len(test_clean), SIZE, SIZE, 1))
     test_clean = test_clean.astype('float32') / 255.0
     print("Noisy test data shape:", test_noisy.shape)
     print("Clean test data shape:", test_clean.shape)
```

```
Noisy test data shape: (15, 64, 64, 1)
Clean test data shape: (15, 64, 64, 1)
```

```
[ ]: # decoding the noisy images
     test_decoded = conv_autoencoder.predict([test_noisy.reshape(-1,64,64,1)])
```

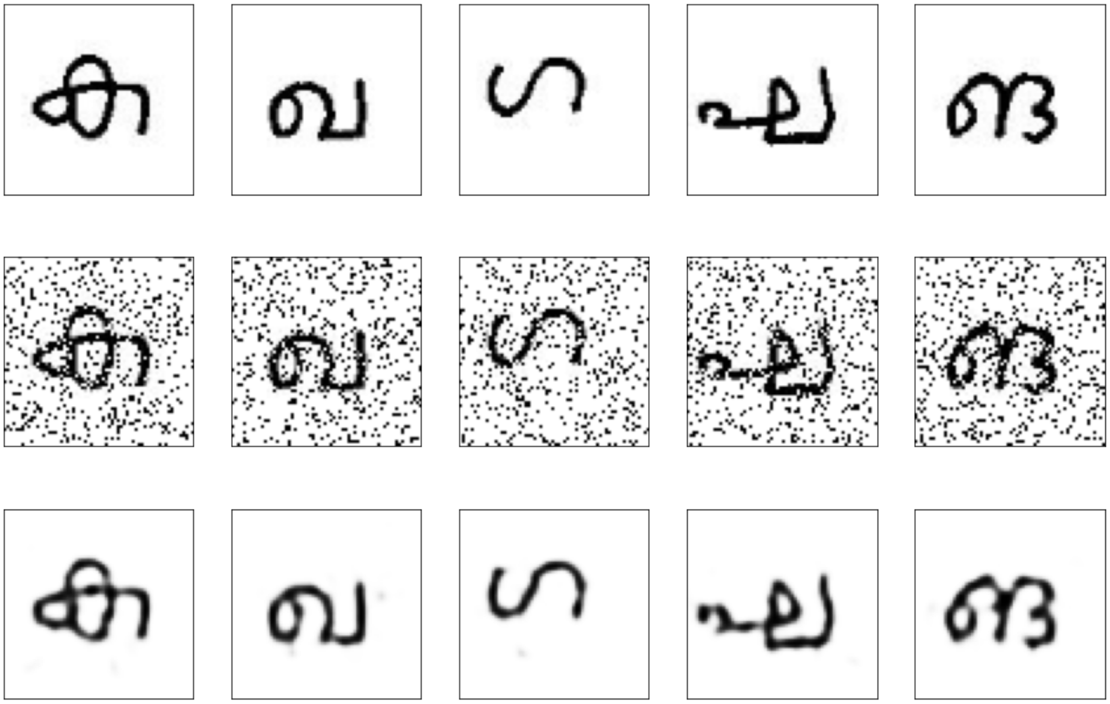
[ ]:

```
# visualisation of adding noise to data and predicting (first 5 characters)

plt.figure(figsize=(15, 10))
for i in range(5):
  # original clean images
  fig = plt.subplot(3,5,i+1)
  plt.imshow(test_clean[i].reshape(64,64), cmap="gray")
  fig.get_xaxis().set_visible(False)
  fig.get_yaxis().set_visible(False)

  # noisy images
  fig = plt.subplot(3,5,i+1+5)
  plt.imshow(test_noisy[i].reshape(64,64), cmap="gray")
  fig.get_xaxis().set_visible(False)
  fig.get_yaxis().set_visible(False)

  # decoded images
  fig = plt.subplot(3,5,i+1+(2*5))
  plt.imshow(test_decoded[i].reshape(64,64), cmap="gray")
  fig.get_xaxis().set_visible(False)
  fig.get_yaxis().set_visible(False)
```



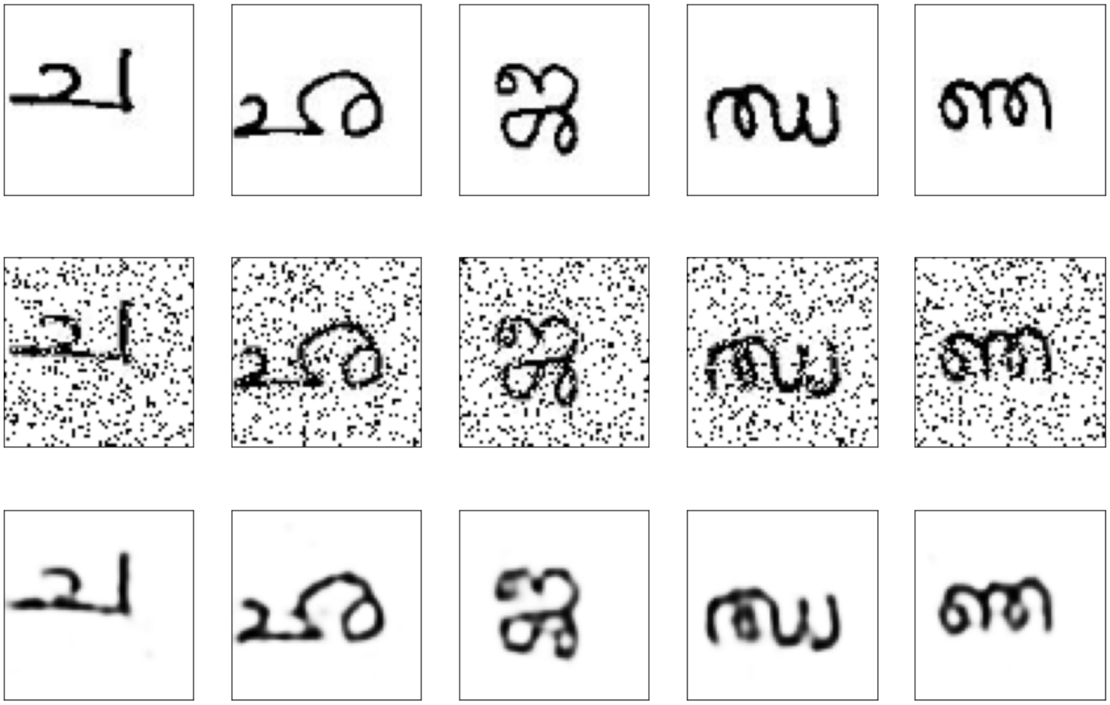
[ ]:

```
# visualisation of adding noise to data and predicting (next 5 characters)
```

```
plt.figure(figsize=(15, 10))
for i in range(5):
  # original clean images
  fig = plt.subplot(3,5,i+1)
  plt.imshow(test_clean[i+5].reshape(64,64), cmap="gray")
  fig.get_xaxis().set_visible(False)
  fig.get_yaxis().set_visible(False)

  # noisy images
  fig = plt.subplot(3,5,i+1+5)
  plt.imshow(test_noisy[i+5].reshape(64,64), cmap="gray")
  fig.get_xaxis().set_visible(False)
  fig.get_yaxis().set_visible(False)

  # decoded images
  fig = plt.subplot(3,5,i+1+(2*5))
  plt.imshow(test_decoded[i+5].reshape(64,64), cmap="gray")
  fig.get_xaxis().set_visible(False)
  fig.get_yaxis().set_visible(False)
```



[ ]:

```
# visualisation of adding noise to data and predicting (last 5 characters)

plt.figure(figsize=(15, 10))
for i in range(5):
    # original clean images
    fig = plt.subplot(3,5,i+1)
    plt.imshow(test_clean[i+10].reshape(64,64), cmap="gray")
    fig.get_xaxis().set_visible(False)
    fig.get_yaxis().set_visible(False)

    # noisy images
    fig = plt.subplot(3,5,i+1+5)
    plt.imshow(test_noisy[i+10].reshape(64,64), cmap="gray")
    fig.get_xaxis().set_visible(False)
    fig.get_yaxis().set_visible(False)

    # decoded images
    fig = plt.subplot(3,5,i+1+(2*5))
    plt.imshow(test_decoded[i+10].reshape(64,64), cmap="gray")
    fig.get_xaxis().set_visible(False)
    fig.get_yaxis().set_visible(False)
```