In [1]:
```
import numpy as np
import tensorflow as tf
import matplotlib.pyplot as plt
from tensorflow.keras import layers
from tensorflow.keras.datasets import mnist
from tensorflow.keras.models import Model
import keras
from keras import layers
```

In [2]:
```
(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:])))
```

In [3]:
```
encoding_dim = 32
input_img = keras.Input(shape=(784,))
encoded = layers.Dense(encoding_dim, activation='relu')(input_img)
decoded = layers.Dense(784, activation='sigmoid')(encoded)
autoencoder = keras.Model(input_img, decoded)
```

In [4]:
```
encoder = keras.Model(input_img, encoded)
encoded_input = keras.Input(shape=(encoding_dim,))

decoder_layer = autoencoder.layers[-1]
decoder = keras.Model(encoded_input, decoder_layer(encoded_input))

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

In [5]:
```
autoencoder.fit(x_train, x_train,
                epochs=50,
                batch_size=256,
                shuffle=True,
                validation_data=(x_test, x_test))
```

```
Epoch 1/50
235/235 [==============================] - 2s 5ms/step - loss: 0.2745 - val_loss:
0.1851
Epoch 2/50
235/235 [==============================] - 1s 4ms/step - loss: 0.1674 - val_loss:
0.1511
Epoch 3/50
235/235 [==============================] - 1s 4ms/step - loss: 0.1422 - val_loss:
0.1324
Epoch 4/50
235/235 [==============================] - 1s 5ms/step - loss: 0.1277 - val_loss:
0.1212
Epoch 5/50
235/235 [==============================] - 1s 4ms/step - loss: 0.1185 - val_loss:
0.1133
Epoch 6/50
235/235 [==============================] - 1s 4ms/step - loss: 0.1117 - val_loss:
0.1075
Epoch 7/50
235/235 [==============================] - 1s 4ms/step - loss: 0.1065 - val_loss:
0.1029
Epoch 8/50
235/235 [==============================] - 1s 4ms/step - loss: 0.1026 - val_loss:
0.0997
Epoch 9/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0997 - val_loss:
0.0974
Epoch 10/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0977 - val_loss:
0.0956
Epoch 11/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0964 - val_loss:
0.0946
Epoch 12/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0955 - val_loss:
0.0939
Epoch 13/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0949 - val_loss:
0.0935
Epoch 14/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0946 - val_loss:
0.0931
Epoch 15/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0943 - val_loss:
0.0929
Epoch 16/50
235/235 [==============================] - 1s 5ms/step - loss: 0.0941 - val_loss:
0.0927
Epoch 17/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0939 - val_loss:
0.0926
Epoch 18/50
235/235 [==============================] - 1s 5ms/step - loss: 0.0937 - val_loss:
0.0925
Epoch 19/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0936 - val_loss:
0.0924
Epoch 20/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0935 - val_loss:
0.0922
Epoch 21/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0934 - val_loss:
0.0922
Epoch 22/50
```

```
235/235 [==============================] - 1s 4ms/step - loss: 0.0933 - val_loss:
0.0922
Epoch 23/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0933 - val_loss:
0.0920
Epoch 24/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0932 - val_loss:
0.0920
Epoch 25/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0932 - val_loss:
0.0920
Epoch 26/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0931 - val_loss:
0.0919
Epoch 27/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0931 - val_loss:
0.0919
Epoch 28/50
235/235 [==============================] - 1s 4ms/step - loss: 0.0930 - val_loss:
0.0918
Epoch 29/50
235/235 [==============================] - 1s 5ms/step - loss: 0.0930 - val_loss:
0.0919
Epoch 30/50
235/235 [==============================] - 1s 6ms/step - loss: 0.0930 - val_loss:
0.0917
Epoch 31/50
235/235 [==============================] - 1s 6ms/step - loss: 0.0929 - val_loss:
0.0918
Epoch 32/50
235/235 [==============================] - 2s 6ms/step - loss: 0.0929 - val_loss:
0.0918
Epoch 33/50
235/235 [==============================] - 1s 6ms/step - loss: 0.0929 - val_loss:
0.0917
Epoch 34/50
235/235 [==============================] - 1s 5ms/step - loss: 0.0928 - val_loss:
0.0917
Epoch 35/50
235/235 [==============================] - 1s 6ms/step - loss: 0.0928 - val_loss:
0.0917
Epoch 36/50
235/235 [==============================] - 1s 6ms/step - loss: 0.0928 - val_loss:
0.0917
Epoch 37/50
235/235 [==============================] - 1s 5ms/step - loss: 0.0928 - val_loss:
0.0917
Epoch 38/50
235/235 [==============================] - 1s 6ms/step - loss: 0.0928 - val_loss:
0.0916
Epoch 39/50
235/235 [==============================] - 1s 5ms/step - loss: 0.0927 - val_loss:
0.0917
Epoch 40/50
235/235 [==============================] - 1s 6ms/step - loss: 0.0927 - val_loss:
0.0916
Epoch 41/50
235/235 [==============================] - 1s 6ms/step - loss: 0.0927 - val_loss:
0.0917
Epoch 42/50
235/235 [==============================] - 1s 5ms/step - loss: 0.0927 - val_loss:
0.0917
Epoch 43/50
235/235 [==============================] - 1s 5ms/step - loss: 0.0927 - val_loss:
```

```
0.0917
Epoch 44/50
235/235 [==============================] - 1s 6ms/step - loss: 0.0927 - val_loss:
0.0916
Epoch 45/50
235/235 [==============================] - 1s 6ms/step - loss: 0.0927 - val_loss:
0.0916
Epoch 46/50
235/235 [==============================] - 1s 5ms/step - loss: 0.0926 - val_loss:
0.0915
Epoch 47/50
235/235 [==============================] - 1s 5ms/step - loss: 0.0926 - val_loss:
0.0916
Epoch 48/50
235/235 [==============================] - 1s 5ms/step - loss: 0.0926 - val_loss:
0.0916
Epoch 49/50
235/235 [==============================] - 1s 6ms/step - loss: 0.0926 - val_loss:
0.0915
Epoch 50/50
235/235 [==============================] - 1s 6ms/step - loss: 0.0926 - val_loss:
0.0915
```

Out[5]:
```
<keras.callbacks.History at 0x207dfaf9e20>
```

In [6]:
```
encoded_imgs = encoder.predict(x_test)
decoded_imgs = decoder.predict(encoded_imgs)
```

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

In [7]:
```
n = 7
plt.figure(figsize=(20, 4))
for i in range(n):
    #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)

    #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()
```