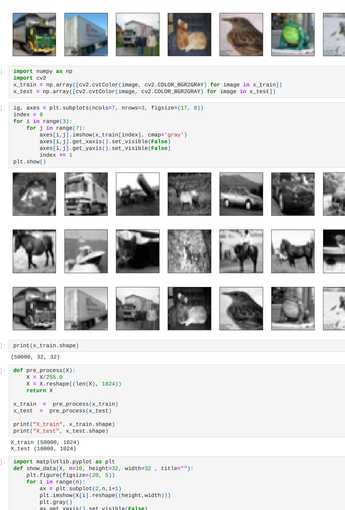
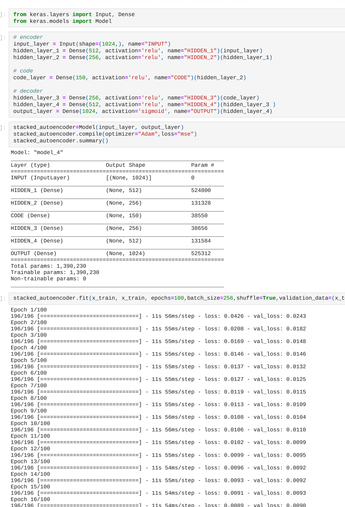
In [1]:
```
from keras.datasets import cifar10
(x_train,_),(x_test,_)=cifar10.load_data()
```
```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170500096/170498071 [==============================] - 2s 0us/step
```

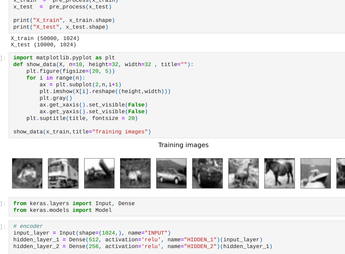
In [7]:
```
import matplotlib.pyplot as plt
fig, axes = plt.subplots(ncols=7, nrows=3, figsize=(17, 8))
index = 0
for i in range(3):
    for j in range(7):
        axes[i,j].imshow(x_train[index])
        axes[i,j].get_xaxis().set_visible(False)
        axes[i,j].get_yaxis().set_visible(False)
        index += 1
plt.show()
```


In [11]:
```
import numpy as np
import cv2
x_train = np.array([cv2.cvtColor(image, cv2.COLOR_BGR2GRAY) for image in x_train])
x_test = np.array([cv2.cvtColor(image, cv2.COLOR_BGR2GRAY) for image in x_test])
```

In [12]:
```
ig, axes = plt.subplots(ncols=7, nrows=3, figsize=(17, 8))
index = 0
for i in range(3):
    for j in range(7):
        axes[i,j].imshow(x_train[index], cmap='gray')
        axes[i,j].get_xaxis().set_visible(False)
        axes[i,j].get_yaxis().set_visible(False)
        index += 1
plt.show()
```


In [13]:
```
print(x_train.shape)
```
```
(50000, 32, 32)
```

In [14]:
```
def pre_process(X):
    X = X/255.0
    X = X.reshape((len(X), 1024))
    return X

x_train = pre_process(x_train)
x_test = pre_process(x_test)

print("X_train", x_train.shape)
print("X_test", x_test.shape)
```
```
X_train (50000, 1024)
X_test (10000, 1024)
```

In [15]:
```
import matplotlib.pyplot as plt
def show_data(X, n=10, height=32, width=32 , title=""):
    plt.figure(figsize=(20, 5))
    for i in range(n):
        ax = plt.subplot(2,n,i+1)
        plt.imshow(X[i].reshape((height,width)))
        plt.gray()
        ax.get_xaxis().set_visible(False)
        ax.get_yaxis().set_visible(False)
    plt.suptitle(title, fontsize = 20)

show_data(x_train,title="Training images")
```


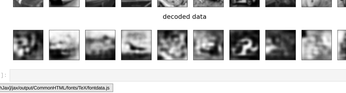
In [16]:
```
from keras.layers import Input, Dense
from keras.models import Model
```

In [30]:
```
# encoder
input_layer = Input(shape=(1024,), name="INPUT")
hidden_layer_1 = Dense(512, activation='relu', name="HIDDEN_1")(input_layer)
hidden_layer_2 = Dense(256, activation='relu', name="HIDDEN_2")(hidden_layer_1)

# code
code_layer = Dense(150, activation='relu', name="CODE")(hidden_layer_2)

# decoder
hidden_layer_3 = Dense(256, activation='relu', name="HIDDEN_3")(code_layer)
hidden_layer_4 = Dense(512, activation='relu', name="HIDDEN_4")(hidden_layer_3 )
output_layer = Dense(1024, activation='sigmoid', name="OUTPUT")(hidden_layer_4)
```

In [31]:
```
stacked_autoencoder=Model(input_layer, output_layer)
stacked_autoencoder.compile(optimizer="Adam", loss="mse")
stacked_autoencoder.summary()
```
```
Model: "model_4"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
INPUT (InputLayer)           [(None, 1024)]            0
_________________________________________________________________
HIDDEN_1 (Dense)             (None, 512)               524800
_________________________________________________________________
HIDDEN_2 (Dense)             (None, 256)               131328
_________________________________________________________________
CODE (Dense)                 (None, 150)               38550
_________________________________________________________________
HIDDEN_3 (Dense)             (None, 256)               38656
_________________________________________________________________
HIDDEN_4 (Dense)             (None, 512)               131584
_________________________________________________________________
OUTPUT (Dense)               (None, 1024)              525312
=================================================================
Total params: 1,390,230
Trainable params: 1,390,230
Non-trainable params: 0
_________________________________________________________________
```

In [32]:
```
stacked_autoencoder.fit(x_train, x_train, epochs=100,batch_size=256,shuffle=True,validation_data=(x_test, x_test))
```
```
Epoch 1/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0426 - val_loss: 0.0243
Epoch 2/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0208 - val_loss: 0.0182
Epoch 3/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0169 - val_loss: 0.0148
Epoch 4/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0146 - val_loss: 0.0146
Epoch 5/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0137 - val_loss: 0.0132
Epoch 6/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0127 - val_loss: 0.0125
Epoch 7/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0119 - val_loss: 0.0115
Epoch 8/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0113 - val_loss: 0.0109
Epoch 9/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0108 - val_loss: 0.0104
Epoch 10/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0106 - val_loss: 0.0110
Epoch 11/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0102 - val_loss: 0.0099
Epoch 12/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0099 - val_loss: 0.0095
Epoch 13/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0096 - val_loss: 0.0092
Epoch 14/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0093 - val_loss: 0.0092
Epoch 15/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0091 - val_loss: 0.0093
Epoch 16/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0089 - val_loss: 0.0090
Epoch 17/100
196/196 [==============================] - 10s 53ms/step - loss: 0.0089 - val_loss: 0.0087
Epoch 18/100
196/196 [==============================] - 10s 53ms/step - loss: 0.0086 - val_loss: 0.0089
Epoch 19/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0085 - val_loss: 0.0085
Epoch 20/100
196/196 [==============================] - 10s 53ms/step - loss: 0.0083 - val_loss: 0.0090
Epoch 21/100
196/196 [==============================] - 10s 54ms/step - loss: 0.0083 - val_loss: 0.0085
Epoch 22/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0081 - val_loss: 0.0080
Epoch 23/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0080 - val_loss: 0.0078
Epoch 24/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0078 - val_loss: 0.0079
Epoch 25/100
196/196 [==============================] - 10s 53ms/step - loss: 0.0077 - val_loss: 0.0076
Epoch 26/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0078 - val_loss: 0.0076
Epoch 27/100
196/196 [==============================] - 10s 53ms/step - loss: 0.0075 - val_loss: 0.0074
Epoch 28/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0073 - val_loss: 0.0073
Epoch 29/100
196/196 [==============================] - 10s 53ms/step - loss: 0.0073 - val_loss: 0.0072
Epoch 30/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0073 - val_loss: 0.0075
Epoch 31/100
196/196 [==============================] - 10s 53ms/step - loss: 0.0072 - val_loss: 0.0077
Epoch 32/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0072 - val_loss: 0.0070
Epoch 33/100
196/196 [==============================] - 10s 53ms/step - loss: 0.0071 - val_loss: 0.0071
Epoch 34/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0071 - val_loss: 0.0069
Epoch 35/100
196/196 [==============================] - 10s 53ms/step - loss: 0.0072 - val_loss: 0.0069
Epoch 36/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0069 - val_loss: 0.0069
Epoch 37/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0069 - val_loss: 0.0069
Epoch 38/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0069 - val_loss: 0.0067
Epoch 39/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0068 - val_loss: 0.0072
Epoch 40/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0068 - val_loss: 0.0069
Epoch 41/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0067 - val_loss: 0.0072
Epoch 42/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0068 - val_loss: 0.0067
Epoch 43/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0067 - val_loss: 0.0069
Epoch 44/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0067 - val_loss: 0.0067
Epoch 45/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0066 - val_loss: 0.0068
Epoch 46/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0066 - val_loss: 0.0067
Epoch 47/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0066 - val_loss: 0.0066
Epoch 48/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0065 - val_loss: 0.0066
Epoch 49/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0064 - val_loss: 0.0064
Epoch 50/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0064 - val_loss: 0.0065
Epoch 51/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0063 - val_loss: 0.0064
Epoch 52/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0064 - val_loss: 0.0067
Epoch 53/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0063 - val_loss: 0.0066
Epoch 54/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0063 - val_loss: 0.0062
Epoch 55/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0063 - val_loss: 0.0063
Epoch 56/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0063 - val_loss: 0.0062
Epoch 57/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0062 - val_loss: 0.0062
Epoch 58/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0062 - val_loss: 0.0062
Epoch 59/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0062 - val_loss: 0.0068
Epoch 60/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0062 - val_loss: 0.0063
Epoch 61/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0062 - val_loss: 0.0062
Epoch 62/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0061 - val_loss: 0.0063
Epoch 63/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0061 - val_loss: 0.0061
Epoch 64/100
196/196 [==============================] - 11s 54ms/step - loss: 0.0061 - val_loss: 0.0060
Epoch 65/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0061 - val_loss: 0.0060
Epoch 66/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0060 - val_loss: 0.0065
Epoch 67/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0060 - val_loss: 0.0059
Epoch 68/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0060 - val_loss: 0.0059
Epoch 69/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0060 - val_loss: 0.0058
Epoch 70/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0059 - val_loss: 0.0062
Epoch 71/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0060 - val_loss: 0.0060
Epoch 72/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0059 - val_loss: 0.0061
Epoch 73/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0061 - val_loss: 0.0059
Epoch 74/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0060 - val_loss: 0.0061
Epoch 75/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0059 - val_loss: 0.0059
Epoch 76/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0059 - val_loss: 0.0060
Epoch 77/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0059 - val_loss: 0.0060
Epoch 78/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0058 - val_loss: 0.0058
Epoch 79/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0059 - val_loss: 0.0058
Epoch 80/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0059 - val_loss: 0.0059
Epoch 81/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0059 - val_loss: 0.0061
Epoch 82/100
196/196 [==============================] - 11s 57ms/step - loss: 0.0058 - val_loss: 0.0057
Epoch 83/100
196/196 [==============================] - 11s 57ms/step - loss: 0.0058 - val_loss: 0.0061
Epoch 84/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0058 - val_loss: 0.0057
Epoch 85/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0057 - val_loss: 0.0058
Epoch 86/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0057 - val_loss: 0.0057
Epoch 87/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0057 - val_loss: 0.0060
Epoch 88/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0057 - val_loss: 0.0058
Epoch 89/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0057 - val_loss: 0.0059
Epoch 90/100
196/196 [==============================] - 11s 56ms/step - loss: 0.0057 - val_loss: 0.0056
Epoch 91/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0057 - val_loss: 0.0057
Epoch 92/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0056 - val_loss: 0.0057
Epoch 93/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0056 - val_loss: 0.0056
Epoch 94/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0056 - val_loss: 0.0056
Epoch 95/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0056 - val_loss: 0.0056
Epoch 96/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0056 - val_loss: 0.0056
Epoch 97/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0055 - val_loss: 0.0057
Epoch 98/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0056 - val_loss: 0.0056
Epoch 99/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0056 - val_loss: 0.0055
Epoch 100/100
196/196 [==============================] - 11s 55ms/step - loss: 0.0056 - val_loss: 0.0056
```
Out[32]:
```
<tensorflow.python.keras.callbacks.History at 0x7fc2f0037828>
```

In [33]:
```
decoded_data = stacked_autoencoder.predict(x_test)
```

In [34]:
```
show_data(x_test, title="original data")
show_data(decoded_data, title="decoded data")
```


In [ ]:
```
```