In [2]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
drive.mount("/content/drive", force_remount=True).
```

In [0]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.decomposition import PCA
from sklearn.preprocessing import StandardScaler
from PIL import Image
from os import listdir
```

In [0]:
```
images = []
images_original = []

for file in sorted(listdir("/content/drive/My Drive/Celeba/train")): # open th
e individual images from the folder, unravel
                                                # and append to a list
        if file[0] == "0":
            im = Image.open("/content/drive/My Drive/Celeba/train/"+str(file))
            img = im.resize((64,64))
            img = np.asarray(img)
            images.append(img)
            im = np.asarray(im)
            images_original.append(im)
```

In [0]:
```
images_array = np.asarray(images)
```

In [6]:
```
images_array.shape
```

Out[6]:
```
(1000, 64, 64, 3)
```

In [0]:
```
images_test = []
images_original_test = []

for file in sorted(listdir("/content/drive/My Drive/Celeba/test")): # open the
individual images from the folder, unravel
                                                # and append to a list
        if file[0] == "0":
            im = Image.open("/content/drive/My Drive/Celeba/test/"+str(file))
            img = im.resize((64,64))
            img = np.asarray(img)
            images_test.append(img)
            im = np.asarray(im)
            images_original_test.append(im)
```

In [0]:
```
x_test = np.asarray(images_test)/255
```

In [9]:
```
import keras
from keras import layers
from keras import backend as K
from keras.models import Model
import numpy as np

img_shape = (64, 64, 3)
batch_size = 16
latent_dim = 100

input_img = keras.Input(shape=img_shape)

x = layers.Conv2D(32, 4, strides=(2,2), padding="SAME", activation='relu')(inp
ut_img)
x = layers.Conv2D(32, 4, strides=(2,2), padding="SAME", activation='relu')(x)
x = layers.Conv2D(64, 4, strides=(2,2), padding="SAME", activation='relu')(x)
x = layers.Conv2D(64, 4, strides=(2,2), padding="SAME", activation='relu')(x)
x = layers.Conv2D(256, 4, padding="VALID", activation='relu')(x)


shape_before_flattening = K.int_shape(x)

x = layers.Flatten()(x)

z_mean = layers.Dense(latent_dim)(x)
z_log_var = layers.Dense(latent_dim)(x)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/
tensorflow_backend.py:66: The name tf.get_default_graph is deprecated. Please
use tf.compat.v1.get_default_graph instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/
tensorflow_backend.py:541: The name tf.placeholder is deprecated. Please use
tf.compat.v1.placeholder instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/
tensorflow_backend.py:4432: The name tf.random_uniform is deprecated. Please
use tf.random.uniform instead.
```

In [10]:
```
def sampling(args):
    z_mean, z_log_var = args
    epsilon = K.random_normal(shape=(K.shape(z_mean)[0], latent_dim),
                              mean=0, stddev= 0.01)
    return z_mean + K.exp(z_log_var) * epsilon

z = layers.Lambda(sampling)([z_mean, z_log_var])
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/
tensorflow_backend.py:4409: The name tf.random_normal is deprecated. Please u
se tf.random.normal instead.
```

In [0]:
```
encoder = Model(input_img, z)
```

In [0]:
```
decoder_input = layers.Input(K.int_shape(z)[1:])

x = layers.Dense(np.prod(shape_before_flattening[1:]),activation='relu')(decod
er_input)

x = layers.Reshape(shape_before_flattening[1:])(x)
x = layers.Conv2DTranspose(256, 4, padding="VALID", activation='relu')(x)
x = layers.Conv2DTranspose(64, 4, strides=(2,2), padding="SAME", activation='r
elu')(x)
x = layers.Conv2DTranspose(64, 4, strides=(2,2), padding="SAME", activation='r
elu')(x)
x = layers.Conv2DTranspose(32, 4, strides=(2,2), padding="SAME", activation='r
elu')(x)

x = layers.Conv2DTranspose(3, 4, strides=(2,2), padding="SAME")(x)

decoder = Model(decoder_input, x)

z_decoded = decoder(z)
output = z_decoded
```

In [0]:
```
import tensorflow as tf

class CustomVariationalLayer(keras.layers.Layer):

    def vae_loss(self, x, z_decoded):
        x = K.flatten(x)
        z_decoded = K.flatten(z_decoded)
        xent_loss = loss = tf.reduce_mean(tf.reduce_sum(tf.squared_difference(
x, z_decoded)))

        kl_loss = -0.5 * K.mean(
            1 + z_log_var - K.square(z_mean) - K.exp(z_log_var), axis=-1)
        return K.mean(xent_loss + kl_loss)

    def call(self, inputs):
        x = inputs[0]
        z_decoded = inputs[1]
        loss = self.vae_loss(x, z_decoded)
        self.add_loss(loss, inputs=inputs)
        return x

y = CustomVariationalLayer()([input_img, z_decoded])
```

In [15]:
```
from keras import optimizers

vae = Model(input_img, y)
vae.compile(optimizer= optimizers.RMSprop(lr = 0.00001), loss= None)
vae.summary()

#(x_train, _), (x_test, y_test) = mnist.load_data()

x_train = (images_array) / 255

#x_train = x_train.astype('float32') / 255.
#x_train = x_train.reshape(x_train.shape + (1,))
#x_test = x_test.astype('float32') / 255.
#x_test = x_test.reshape(x_test.shape + (1,))

vae.fit(x=x_train, y=None,
        epochs= 550,
        shuffle = False,
        batch_size=batch_size,
        validation_data=(x_test, None)
        )
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/optimize
rs.py:793: The name tf.train.Optimizer is deprecated. Please use tf.compat.v
1.train.Optimizer instead.

Model: "model_3"
__________________________________________________________________________
_____________________
Layer (type)                 Output Shape              Param #     Connected to
==========================================================================
=====================
input_1 (InputLayer)         (None, 64, 64, 3)         0
__________________________________________________________________________
_____________________
conv2d_1 (Conv2D)            (None, 32, 32, 32)        1568        input_1[0]
[0]
__________________________________________________________________________
_____________________
conv2d_2 (Conv2D)            (None, 16, 16, 32)        16416       conv2d_1[0]
[0]
__________________________________________________________________________
_____________________
conv2d_3 (Conv2D)            (None, 8, 8, 64)          32832       conv2d_2[0]
[0]
__________________________________________________________________________
_____________________
conv2d_4 (Conv2D)            (None, 4, 4, 64)          65600       conv2d_3[0]
[0]
__________________________________________________________________________
_____________________
conv2d_5 (Conv2D)            (None, 1, 1, 256)         262400      conv2d_4[0]
[0]
__________________________________________________________________________
_____________________
flatten_1 (Flatten)          (None, 256)               0           conv2d_5[0]
[0]
__________________________________________________________________________
_____________________
dense_1 (Dense)              (None, 100)               25700       flatten_1[0]
[0]
__________________________________________________________________________
_____________________
dense_2 (Dense)              (None, 100)               25700       flatten_1[0]
[0]
__________________________________________________________________________
_____________________
lambda_1 (Lambda)            (None, 100)               0           dense_1[0]
[0]
                                                                   dense_2[0]
[0]
__________________________________________________________________________
_____________________
model_2 (Model)              (None, 64, 64, 3)         1436835     lambda_1[0]
[0]
__________________________________________________________________________
_____________________
custom_variational_layer_2 (Cus [(None, 64, 64, 3),  0           input_1[0]
[0]
```

```
                                                                 model_2[1]
[0]
==================================================================================
====================
Total params: 1,867,051
Trainable params: 1,867,051
Non-trainable params: 0
__________________________________________________________________________________
_____________________
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/
tensorflow_backend.py:1033: The name tf.assign_add is deprecated. Please use
tf.compat.v1.assign_add instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/
tensorflow_backend.py:1020: The name tf.assign is deprecated. Please use tf.c
ompat.v1.assign instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/
tensorflow_backend.py:3005: The name tf.Session is deprecated. Please use tf.
compat.v1.Session instead.

Train on 1000 samples, validate on 500 samples
Epoch 1/550
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/
tensorflow_backend.py:190: The name tf.get_default_session is deprecated. Ple
ase use tf.compat.v1.get_default_session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/
tensorflow_backend.py:197: The name tf.ConfigProto is deprecated. Please use
tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/
tensorflow_backend.py:207: The name tf.global_variables is deprecated. Please
use tf.compat.v1.global_variables instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/
tensorflow_backend.py:216: The name tf.is_variable_initialized is deprecated.
Please use tf.compat.v1.is_variable_initialized instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/
tensorflow_backend.py:223: The name tf.variables_initializer is deprecated. P
lease use tf.compat.v1.variables_initializer instead.

1000/1000 [==============================] - 16s 16ms/step - loss: 56260.0913
- val_loss: 56056.9771
Epoch 2/550
1000/1000 [==============================] - 16s 16ms/step - loss: 55928.6479
- val_loss: 55365.4572
Epoch 3/550
1000/1000 [==============================] - 16s 16ms/step - loss: 53621.1174
- val_loss: 49951.3627
Epoch 4/550
1000/1000 [==============================] - 16s 16ms/step - loss: 44719.6076
- val_loss: 40438.3056
Epoch 5/550
1000/1000 [==============================] - 16s 16ms/step - loss: 38065.3163
- val_loss: 35384.7317
```

```
Epoch 6/550
1000/1000 [==============================] - 15s 15ms/step - loss: 33149.8047
- val_loss: 30705.7588
Epoch 7/550
1000/1000 [==============================] - 15s 15ms/step - loss: 28655.1144
- val_loss: 26479.7081
Epoch 8/550
1000/1000 [==============================] - 15s 15ms/step - loss: 24618.8236
- val_loss: 22696.3202
Epoch 9/550
1000/1000 [==============================] - 16s 16ms/step - loss: 21113.3775
- val_loss: 19577.3270
Epoch 10/550
1000/1000 [==============================] - 15s 15ms/step - loss: 18400.8848
- val_loss: 17351.0133
Epoch 11/550
1000/1000 [==============================] - 16s 16ms/step - loss: 16571.9505
- val_loss: 15926.7934
Epoch 12/550
1000/1000 [==============================] - 15s 15ms/step - loss: 15406.2569
- val_loss: 15002.3250
Epoch 13/550
1000/1000 [==============================] - 16s 16ms/step - loss: 14613.3445
- val_loss: 14329.9404
Epoch 14/550
1000/1000 [==============================] - 15s 15ms/step - loss: 13996.7724
- val_loss: 13762.5695
Epoch 15/550
1000/1000 [==============================] - 15s 15ms/step - loss: 13435.9511
- val_loss: 13204.8606
Epoch 16/550
1000/1000 [==============================] - 15s 15ms/step - loss: 12863.3738
- val_loss: 12614.2969
Epoch 17/550
1000/1000 [==============================] - 16s 16ms/step - loss: 12244.7689
- val_loss: 11976.8693
Epoch 18/550
1000/1000 [==============================] - 15s 15ms/step - loss: 11614.2955
- val_loss: 11387.2069
Epoch 19/550
1000/1000 [==============================] - 16s 16ms/step - loss: 11101.4868
- val_loss: 10976.1312
Epoch 20/550
1000/1000 [==============================] - 15s 15ms/step - loss: 10760.1002
- val_loss: 10696.1301
Epoch 21/550
1000/1000 [==============================] - 15s 15ms/step - loss: 10494.1972
- val_loss: 10443.7376
Epoch 22/550
1000/1000 [==============================] - 16s 16ms/step - loss: 10238.6512
- val_loss: 10196.6616
Epoch 23/550
1000/1000 [==============================] - 15s 15ms/step - loss: 9990.1050
- val_loss: 9954.5893
Epoch 24/550
1000/1000 [==============================] - 16s 16ms/step - loss: 9751.4246
- val_loss: 9733.7464
```

```
Epoch 25/550
1000/1000 [==============================] - 16s 16ms/step - loss: 9545.1374
- val_loss: 9555.5239
Epoch 26/550
1000/1000 [==============================] - 16s 16ms/step - loss: 9370.7343
- val_loss: 9401.3677
Epoch 27/550
1000/1000 [==============================] - 16s 16ms/step - loss: 9219.0306
- val_loss: 9264.6719
Epoch 28/550
1000/1000 [==============================] - 16s 16ms/step - loss: 9074.5288
- val_loss: 9129.4449
Epoch 29/550
1000/1000 [==============================] - 16s 16ms/step - loss: 8931.4939
- val_loss: 9002.1991
Epoch 30/550
1000/1000 [==============================] - 15s 15ms/step - loss: 8793.2331
- val_loss: 8877.7502
Epoch 31/550
1000/1000 [==============================] - 16s 16ms/step - loss: 8663.9618
- val_loss: 8765.6348
Epoch 32/550
1000/1000 [==============================] - 16s 16ms/step - loss: 8547.6590
- val_loss: 8665.4081
Epoch 33/550
1000/1000 [==============================] - 15s 15ms/step - loss: 8447.8054
- val_loss: 8580.4335
Epoch 34/550
1000/1000 [==============================] - 16s 16ms/step - loss: 8359.9484
- val_loss: 8501.3195
Epoch 35/550
1000/1000 [==============================] - 16s 16ms/step - loss: 8274.7450
- val_loss: 8418.9744
Epoch 36/550
1000/1000 [==============================] - 16s 16ms/step - loss: 8190.0336
- val_loss: 8335.2663
Epoch 37/550
1000/1000 [==============================] - 16s 16ms/step - loss: 8102.8381
- val_loss: 8245.9722
Epoch 38/550
1000/1000 [==============================] - 16s 16ms/step - loss: 8006.8151
- val_loss: 8147.0850
Epoch 39/550
1000/1000 [==============================] - 16s 16ms/step - loss: 7903.5262
- val_loss: 8040.3579
Epoch 40/550
1000/1000 [==============================] - 16s 16ms/step - loss: 7794.7683
- val_loss: 7926.8120
Epoch 41/550
1000/1000 [==============================] - 16s 16ms/step - loss: 7681.4655
- val_loss: 7811.3916
Epoch 42/550
1000/1000 [==============================] - 16s 16ms/step - loss: 7569.9057
- val_loss: 7697.7847
Epoch 43/550
1000/1000 [==============================] - 16s 16ms/step - loss: 7463.6715
- val_loss: 7592.5431
```

```
Epoch 44/550
1000/1000 [==============================] - 16s 16ms/step - loss: 7367.6926
- val_loss: 7500.8230
Epoch 45/550
1000/1000 [==============================] - 16s 16ms/step - loss: 7283.6129
- val_loss: 7423.3750
Epoch 46/550
1000/1000 [==============================] - 16s 16ms/step - loss: 7209.6657
- val_loss: 7355.8206
Epoch 47/550
1000/1000 [==============================] - 17s 17ms/step - loss: 7143.8794
- val_loss: 7295.0914
Epoch 48/550
1000/1000 [==============================] - 16s 16ms/step - loss: 7083.9140
- val_loss: 7237.7816
Epoch 49/550
1000/1000 [==============================] - 16s 16ms/step - loss: 7027.8893
- val_loss: 7184.8103
Epoch 50/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6974.4617
- val_loss: 7133.6578
Epoch 51/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6922.0299
- val_loss: 7083.5673
Epoch 52/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6869.0141
- val_loss: 7032.3704
Epoch 53/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6818.0384
- val_loss: 6983.4870
Epoch 54/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6767.4005
- val_loss: 6935.1865
Epoch 55/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6718.3595
- val_loss: 6890.0467
Epoch 56/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6673.7487
- val_loss: 6849.1148
Epoch 57/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6631.9645
- val_loss: 6810.9464
Epoch 58/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6593.5574
- val_loss: 6776.1748
Epoch 59/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6557.4790
- val_loss: 6743.6208
Epoch 60/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6522.8352
- val_loss: 6711.7261
Epoch 61/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6489.7197
- val_loss: 6681.5145
Epoch 62/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6457.0537
- val_loss: 6651.5889
```

```
Epoch 63/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6425.2344
- val_loss: 6622.3158
Epoch 64/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6394.2554
- val_loss: 6593.2134
Epoch 65/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6363.4460
- val_loss: 6563.4112
Epoch 66/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6332.8116
- val_loss: 6534.5944
Epoch 67/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6303.1930
- val_loss: 6507.5163
Epoch 68/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6274.3790
- val_loss: 6479.7130
Epoch 69/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6246.6838
- val_loss: 6452.2559
Epoch 70/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6218.8406
- val_loss: 6425.7680
Epoch 71/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6191.0767
- val_loss: 6398.2073
Epoch 72/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6164.4652
- val_loss: 6371.1880
Epoch 73/550
1000/1000 [==============================] - 16s 16ms/step - loss: 6136.8274
- val_loss: 6344.4666
Epoch 74/550
1000/1000 [==============================] - 15s 15ms/step - loss: 6108.9498
- val_loss: 6316.6652
Epoch 75/550
1000/1000 [==============================] - 15s 15ms/step - loss: 6080.3715
- val_loss: 6288.2341
Epoch 76/550
1000/1000 [==============================] - 15s 15ms/step - loss: 6051.8139
- val_loss: 6258.9661
Epoch 77/550
1000/1000 [==============================] - 15s 15ms/step - loss: 6022.4874
- val_loss: 6229.2027
Epoch 78/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5992.7168
- val_loss: 6198.6136
Epoch 79/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5963.3489
- val_loss: 6166.1005
Epoch 80/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5931.8818
- val_loss: 6134.7750
Epoch 81/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5900.9161
- val_loss: 6102.1877
```

```
Epoch 82/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5869.7213
- val_loss: 6071.0823
Epoch 83/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5838.5893
- val_loss: 6039.0055
Epoch 84/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5808.5069
- val_loss: 6008.9599
Epoch 85/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5779.3934
- val_loss: 5978.9579
Epoch 86/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5750.3368
- val_loss: 5951.4840
Epoch 87/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5722.9394
- val_loss: 5924.1898
Epoch 88/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5696.7443
- val_loss: 5898.6155
Epoch 89/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5672.0161
- val_loss: 5875.0998
Epoch 90/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5648.4790
- val_loss: 5852.8411
Epoch 91/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5625.4377
- val_loss: 5831.3327
Epoch 92/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5603.7772
- val_loss: 5810.5866
Epoch 93/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5582.6633
- val_loss: 5791.6661
Epoch 94/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5562.1208
- val_loss: 5772.5834
Epoch 95/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5542.1285
- val_loss: 5754.3235
Epoch 96/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5523.8783
- val_loss: 5735.4147
Epoch 97/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5502.5412
- val_loss: 5719.1741
Epoch 98/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5484.1353
- val_loss: 5701.3423
Epoch 99/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5464.2861
- val_loss: 5684.4054
Epoch 100/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5446.7920
- val_loss: 5666.6803
```

```
Epoch 101/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5426.1511
- val_loss: 5650.7088
Epoch 102/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5408.8584
- val_loss: 5633.0403
Epoch 103/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5389.0198
- val_loss: 5616.2620
Epoch 104/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5371.3401
- val_loss: 5599.9850
Epoch 105/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5351.1029
- val_loss: 5582.7017
Epoch 106/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5334.9330
- val_loss: 5566.4820
Epoch 107/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5314.5400
- val_loss: 5550.2961
Epoch 108/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5298.6009
- val_loss: 5533.5956
Epoch 109/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5279.2437
- val_loss: 5518.1704
Epoch 110/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5263.8870
- val_loss: 5502.0072
Epoch 111/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5244.9821
- val_loss: 5486.7268
Epoch 112/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5230.4583
- val_loss: 5471.0197
Epoch 113/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5212.8003
- val_loss: 5457.1629
Epoch 114/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5196.1022
- val_loss: 5443.1605
Epoch 115/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5182.4960
- val_loss: 5429.1474
Epoch 116/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5167.1185
- val_loss: 5415.6239
Epoch 117/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5152.4476
- val_loss: 5402.5245
Epoch 118/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5138.0093
- val_loss: 5389.2372
Epoch 119/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5123.7013
- val_loss: 5376.7559
```

```
Epoch 120/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5109.8221
- val_loss: 5363.8465
Epoch 121/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5096.4729
- val_loss: 5351.8571
Epoch 122/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5083.2920
- val_loss: 5340.1545
Epoch 123/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5070.1448
- val_loss: 5327.9640
Epoch 124/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5057.5085
- val_loss: 5316.9291
Epoch 125/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5044.8909
- val_loss: 5305.7874
Epoch 126/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5032.6832
- val_loss: 5294.6292
Epoch 127/550
1000/1000 [==============================] - 16s 16ms/step - loss: 5020.4912
- val_loss: 5283.6331
Epoch 128/550
1000/1000 [==============================] - 15s 15ms/step - loss: 5008.9544
- val_loss: 5273.0336
Epoch 129/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4997.2959
- val_loss: 5262.8198
Epoch 130/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4986.0522
- val_loss: 5253.0991
Epoch 131/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4974.8221
- val_loss: 5242.8526
Epoch 132/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4963.7767
- val_loss: 5232.7654
Epoch 133/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4952.7604
- val_loss: 5223.4018
Epoch 134/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4942.2191
- val_loss: 5213.2914
Epoch 135/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4931.6556
- val_loss: 5204.4251
Epoch 136/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4921.4095
- val_loss: 5195.1661
Epoch 137/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4910.8077
- val_loss: 5186.4815
Epoch 138/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4901.0464
- val_loss: 5177.3664
```

```
Epoch 139/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4890.9142
- val_loss: 5168.3998
Epoch 140/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4880.9153
- val_loss: 5159.5538
Epoch 141/550
1000/1000 [==============================] - 17s 17ms/step - loss: 4871.5441
- val_loss: 5150.8206
Epoch 142/550
1000/1000 [==============================] - 17s 17ms/step - loss: 4861.1206
- val_loss: 5141.9402
Epoch 143/550
1000/1000 [==============================] - 17s 17ms/step - loss: 4851.9010
- val_loss: 5133.4530
Epoch 144/550
1000/1000 [==============================] - 17s 17ms/step - loss: 4842.0333
- val_loss: 5124.9747
Epoch 145/550
1000/1000 [==============================] - 17s 17ms/step - loss: 4832.6557
- val_loss: 5116.6211
Epoch 146/550
1000/1000 [==============================] - 17s 17ms/step - loss: 4823.2215
- val_loss: 5108.8158
Epoch 147/550
1000/1000 [==============================] - 17s 17ms/step - loss: 4813.7763
- val_loss: 5098.5758
Epoch 148/550
1000/1000 [==============================] - 17s 17ms/step - loss: 4808.8610
- val_loss: 5089.5599
Epoch 149/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4799.1652
- val_loss: 5081.9522
Epoch 150/550
1000/1000 [==============================] - 17s 17ms/step - loss: 4789.4842
- val_loss: 5074.2999
Epoch 151/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4781.1671
- val_loss: 5066.4183
Epoch 152/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4772.6721
- val_loss: 5059.1977
Epoch 153/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4763.8385
- val_loss: 5051.6361
Epoch 154/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4755.5694
- val_loss: 5043.8907
Epoch 155/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4746.8211
- val_loss: 5037.5441
Epoch 156/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4735.0732
- val_loss: 5048.8512
Epoch 157/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4730.7736
- val_loss: 5025.4156
```

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Epoch 158/550
1000/1000 [==============================] - 17s 17ms/step - loss: 4724.1632
- val_loss: 5015.8212
Epoch 159/550
1000/1000 [==============================] - 18s 18ms/step - loss: 4714.1083
- val_loss: 5008.9728
Epoch 160/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4706.3105
- val_loss: 5002.1747
Epoch 161/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4698.3317
- val_loss: 4996.0215
Epoch 162/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4689.4002
- val_loss: 4990.5569
Epoch 163/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4683.4915
- val_loss: 4983.6598
Epoch 164/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4675.6688
- val_loss: 4977.1322
Epoch 165/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4668.3502
- val_loss: 4970.4454
Epoch 166/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4659.9987
- val_loss: 4964.2522
Epoch 167/550
1000/1000 [==============================] - 17s 17ms/step - loss: 4652.6605
- val_loss: 4958.0105
Epoch 168/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4644.8626
- val_loss: 4951.4908
Epoch 169/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4637.2822
- val_loss: 4944.9853
Epoch 170/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4629.6181
- val_loss: 4938.8814
Epoch 171/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4622.0196
- val_loss: 4932.7616
Epoch 172/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4614.9007
- val_loss: 4926.0862
Epoch 173/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4607.1403
- val_loss: 4920.1982
Epoch 174/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4599.8397
- val_loss: 4914.1709
Epoch 175/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4592.3686
- val_loss: 4907.6740
Epoch 176/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4585.0681
- val_loss: 4902.0115
```

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Epoch 177/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4577.8324
- val_loss: 4895.1833
Epoch 178/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4570.3543
- val_loss: 4889.5286
Epoch 179/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4563.1401
- val_loss: 4883.1779
Epoch 180/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4556.0060
- val_loss: 4877.3021
Epoch 181/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4552.2078
- val_loss: 4868.6088
Epoch 182/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4542.0916
- val_loss: 4865.5568
Epoch 183/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4532.9999
- val_loss: 4859.4263
Epoch 184/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4531.6256
- val_loss: 4851.7322
Epoch 185/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4521.1550
- val_loss: 4847.2635
Epoch 186/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4513.5173
- val_loss: 4840.7383
Epoch 187/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4502.9237
- val_loss: 4840.1292
Epoch 188/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4505.1286
- val_loss: 4826.8320
Epoch 189/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4492.4470
- val_loss: 4823.5140
Epoch 190/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4486.1147
- val_loss: 4817.0836
Epoch 191/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4479.2600
- val_loss: 4811.0562
Epoch 192/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4472.8251
- val_loss: 4805.1088
Epoch 193/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4466.9732
- val_loss: 4800.7700
Epoch 194/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4459.2114
- val_loss: 4793.9389
Epoch 195/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4453.4334
- val_loss: 4788.5771
```

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Epoch 196/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4445.5652
- val_loss: 4782.6128
Epoch 197/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4439.5049
- val_loss: 4776.9293
Epoch 198/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4432.9933
- val_loss: 4770.6428
Epoch 199/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4426.7583
- val_loss: 4765.8126
Epoch 200/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4422.4404
- val_loss: 4757.5625
Epoch 201/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4412.4311
- val_loss: 4754.9506
Epoch 202/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4403.8875
- val_loss: 4751.4511
Epoch 203/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4406.9948
- val_loss: 4741.1760
Epoch 204/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4392.6028
- val_loss: 4737.8823
Epoch 205/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4388.5036
- val_loss: 4732.6198
Epoch 206/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4381.6833
- val_loss: 4728.0573
Epoch 207/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4379.5299
- val_loss: 4718.9240
Epoch 208/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4368.2128
- val_loss: 4717.0875
Epoch 209/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4363.9258
- val_loss: 4711.2250
Epoch 210/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4357.1353
- val_loss: 4707.0447
Epoch 211/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4353.1316
- val_loss: 4700.2749
Epoch 212/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4345.7775
- val_loss: 4697.2161
Epoch 213/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4341.2020
- val_loss: 4690.0946
Epoch 214/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4333.7942
- val_loss: 4686.9356
```

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Epoch 215/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4331.7553
- val_loss: 4678.1024
Epoch 216/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4321.4405
- val_loss: 4676.7289
Epoch 217/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4319.0569
- val_loss: 4667.9816
Epoch 218/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4305.8626
- val_loss: 4669.6781
Epoch 219/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4310.7935
- val_loss: 4658.4187
Epoch 220/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4297.1367
- val_loss: 4655.4612
Epoch 221/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4293.5962
- val_loss: 4651.8785
Epoch 222/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4289.1540
- val_loss: 4645.4359
Epoch 223/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4282.3485
- val_loss: 4642.5767
Epoch 224/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4280.4487
- val_loss: 4634.2286
Epoch 225/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4270.7788
- val_loss: 4633.0197
Epoch 226/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4265.8102
- val_loss: 4628.1060
Epoch 227/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4264.0498
- val_loss: 4620.9053
Epoch 228/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4254.5093
- val_loss: 4618.5038
Epoch 229/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4249.9177
- val_loss: 4613.7176
Epoch 230/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4245.1610
- val_loss: 4610.0434
Epoch 231/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4244.2851
- val_loss: 4602.4705
Epoch 232/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4232.0226
- val_loss: 4599.3086
Epoch 233/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4228.7447
- val_loss: 4597.1103
```

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Epoch 234/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4228.2975
- val_loss: 4589.2840
Epoch 235/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4216.0319
- val_loss: 4586.6269
Epoch 236/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4213.1325
- val_loss: 4583.4743
Epoch 237/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4212.8346
- val_loss: 4576.4009
Epoch 238/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4200.4027
- val_loss: 4573.8171
Epoch 239/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4197.5826
- val_loss: 4569.7414
Epoch 240/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4192.1725
- val_loss: 4567.0882
Epoch 241/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4192.4083
- val_loss: 4559.0431
Epoch 242/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4179.6175
- val_loss: 4557.9832
Epoch 243/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4182.8719
- val_loss: 4551.3168
Epoch 244/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4170.2788
- val_loss: 4548.7641
Epoch 245/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4168.0935
- val_loss: 4546.0141
Epoch 246/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4166.0894
- val_loss: 4539.0650
Epoch 247/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4156.4858
- val_loss: 4537.3190
Epoch 248/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4158.3607
- val_loss: 4530.7002
Epoch 249/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4146.2620
- val_loss: 4528.9409
Epoch 250/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4143.7275
- val_loss: 4524.9582
Epoch 251/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4142.5904
- val_loss: 4518.9773
Epoch 252/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4131.6524
- val_loss: 4517.3776
```

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Epoch 253/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4129.0035
- val_loss: 4514.3206
Epoch 254/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4127.8170
- val_loss: 4507.0144
Epoch 255/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4117.9061
- val_loss: 4507.0574
Epoch 256/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4114.2442
- val_loss: 4501.7795
Epoch 257/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4111.4734
- val_loss: 4498.2417
Epoch 258/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4110.5362
- val_loss: 4491.7469
Epoch 259/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4099.3037
- val_loss: 4490.1637
Epoch 260/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4101.9915
- val_loss: 4484.2469
Epoch 261/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4090.3736
- val_loss: 4483.3808
Epoch 262/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4086.0896
- val_loss: 4495.8447
Epoch 263/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4084.6163
- val_loss: 4476.1431
Epoch 264/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4079.7308
- val_loss: 4471.2334
Epoch 265/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4078.3391
- val_loss: 4466.5500
Epoch 266/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4067.3440
- val_loss: 4468.7685
Epoch 267/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4064.6855
- val_loss: 4461.4638
Epoch 268/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4061.7155
- val_loss: 4457.2892
Epoch 269/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4061.2191
- val_loss: 4453.5168
Epoch 270/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4049.2696
- val_loss: 4450.1133
Epoch 271/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4047.3486
- val_loss: 4447.3859
```

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Epoch 272/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4048.2975
- val_loss: 4442.6194
Epoch 273/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4040.0799
- val_loss: 4437.7210
Epoch 274/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4036.1085
- val_loss: 4435.9216
Epoch 275/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4028.0630
- val_loss: 4432.8157
Epoch 276/550
1000/1000 [==============================] - 15s 15ms/step - loss: 4026.9172
- val_loss: 4430.3507
Epoch 277/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4027.7524
- val_loss: 4426.8584
Epoch 278/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4016.2178
- val_loss: 4423.0250
Epoch 279/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4017.6060
- val_loss: 4418.0781
Epoch 280/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4010.5010
- val_loss: 4415.7871
Epoch 281/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4002.7550
- val_loss: 4413.1165
Epoch 282/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4000.8382
- val_loss: 4409.8004
Epoch 283/550
1000/1000 [==============================] - 16s 16ms/step - loss: 4000.5122
- val_loss: 4405.5266
Epoch 284/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3991.0658
- val_loss: 4405.2879
Epoch 285/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3988.4426
- val_loss: 4402.9817
Epoch 286/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3988.9448
- val_loss: 4395.3536
Epoch 287/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3978.4480
- val_loss: 4393.6762
Epoch 288/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3978.3841
- val_loss: 4390.3222
Epoch 289/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3973.4848
- val_loss: 4386.8153
Epoch 290/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3967.7050
- val_loss: 4383.7082
```

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Epoch 291/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3964.7356
- val_loss: 4381.6748
Epoch 292/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3957.8324
- val_loss: 4378.2004
Epoch 293/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3956.7725
- val_loss: 4378.7680
Epoch 294/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3954.9691
- val_loss: 4372.2325
Epoch 295/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3949.0118
- val_loss: 4368.0365
Epoch 296/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3942.2262
- val_loss: 4366.3423
Epoch 297/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3940.2587
- val_loss: 4363.9340
Epoch 298/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3940.3563
- val_loss: 4360.9212
Epoch 299/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3930.1456
- val_loss: 4357.8588
Epoch 300/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3927.8968
- val_loss: 4354.6337
Epoch 301/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3929.1078
- val_loss: 4353.5015
Epoch 302/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3921.4393
- val_loss: 4348.3171
Epoch 303/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3914.2405
- val_loss: 4347.3846
Epoch 304/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3914.4375
- val_loss: 4341.0557
Epoch 305/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3909.4866
- val_loss: 4339.2569
Epoch 306/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3904.3299
- val_loss: 4342.9976
Epoch 307/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3900.9768
- val_loss: 4336.0058
Epoch 308/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3898.1762
- val_loss: 4332.6428
Epoch 309/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3893.2191
- val_loss: 4333.7568
```

```
Epoch 310/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3889.3933
- val_loss: 4330.6586
Epoch 311/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3890.7864
- val_loss: 4323.2664
Epoch 312/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3883.5061
- val_loss: 4322.1588
Epoch 313/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3881.8287
- val_loss: 4320.6087
Epoch 314/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3873.1953
- val_loss: 4317.1963
Epoch 315/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3871.0474
- val_loss: 4315.4754
Epoch 316/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3870.7878
- val_loss: 4310.0198
Epoch 317/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3861.3435
- val_loss: 4308.9641
Epoch 318/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3864.2987
- val_loss: 4308.1120
Epoch 319/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3858.4365
- val_loss: 4307.0157
Epoch 320/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3850.6520
- val_loss: 4304.0770
Epoch 321/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3848.7286
- val_loss: 4299.4981
Epoch 322/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3848.5444
- val_loss: 4295.0494
Epoch 323/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3844.0874
- val_loss: 4293.0378
Epoch 324/550
1000/1000 [==============================] - 17s 17ms/step - loss: 3839.0475
- val_loss: 4291.6522
Epoch 325/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3834.1118
- val_loss: 4291.5701
Epoch 326/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3830.6181
- val_loss: 4288.5122
Epoch 327/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3831.3142
- val_loss: 4284.1012
Epoch 328/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3826.8877
- val_loss: 4281.9853
```

```
Epoch 329/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3819.2024
- val_loss: 4281.7480
Epoch 330/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3821.1280
- val_loss: 4277.1526
Epoch 331/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3816.0237
- val_loss: 4279.5723
Epoch 332/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3811.0087
- val_loss: 4276.7436
Epoch 333/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3805.5705
- val_loss: 4273.9767
Epoch 334/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3808.4931
- val_loss: 4268.0033
Epoch 335/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3799.5539
- val_loss: 4267.6933
Epoch 336/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3796.9442
- val_loss: 4265.3404
Epoch 337/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3798.1174
- val_loss: 4259.8126
Epoch 338/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3790.1315
- val_loss: 4258.2654
Epoch 339/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3786.9227
- val_loss: 4258.1096
Epoch 340/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3782.9162
- val_loss: 4258.5567
Epoch 341/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3783.9479
- val_loss: 4253.7038
Epoch 342/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3780.0294
- val_loss: 4251.7231
Epoch 343/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3775.2153
- val_loss: 4248.5040
Epoch 344/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3768.9368
- val_loss: 4248.7352
Epoch 345/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3770.8133
- val_loss: 4243.2898
Epoch 346/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3764.1156
- val_loss: 4242.7812
Epoch 347/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3760.5866
- val_loss: 4243.6271
```

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Epoch 348/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3757.6882
- val_loss: 4242.8860
Epoch 349/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3756.3060
- val_loss: 4240.3198
Epoch 350/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3750.6461
- val_loss: 4240.4292
Epoch 351/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3747.9210
- val_loss: 4235.9243
Epoch 352/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3750.6035
- val_loss: 4230.9428
Epoch 353/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3740.3422
- val_loss: 4234.3326
Epoch 354/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3739.4803
- val_loss: 4237.0733
Epoch 355/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3734.0186
- val_loss: 4229.6077
Epoch 356/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3738.9235
- val_loss: 4225.4715
Epoch 357/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3725.5710
- val_loss: 4228.7885
Epoch 358/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3733.6334
- val_loss: 4219.4805
Epoch 359/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3726.0728
- val_loss: 4221.8334
Epoch 360/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3720.6028
- val_loss: 4219.7210
Epoch 361/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3720.0462
- val_loss: 4217.1397
Epoch 362/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3716.1221
- val_loss: 4216.7545
Epoch 363/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3711.7416
- val_loss: 4227.3571
Epoch 364/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3710.7032
- val_loss: 4214.2798
Epoch 365/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3707.3638
- val_loss: 4210.7085
Epoch 366/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3702.9686
- val_loss: 4208.6718
```

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Epoch 367/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3702.7097
- val_loss: 4209.1691
Epoch 368/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3698.1269
- val_loss: 4202.2917
Epoch 369/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3694.9125
- val_loss: 4201.6740
Epoch 370/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3691.4910
- val_loss: 4208.3545
Epoch 371/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3689.0988
- val_loss: 4201.6415
Epoch 372/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3685.5000
- val_loss: 4198.7267
Epoch 373/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3682.4224
- val_loss: 4202.1757
Epoch 374/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3683.8181
- val_loss: 4195.7346
Epoch 375/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3676.5276
- val_loss: 4195.2903
Epoch 376/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3674.6875
- val_loss: 4191.6786
Epoch 377/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3671.5611
- val_loss: 4196.0978
Epoch 378/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3671.1038
- val_loss: 4189.6203
Epoch 379/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3663.5266
- val_loss: 4189.2577
Epoch 380/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3662.0370
- val_loss: 4192.9042
Epoch 381/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3663.5111
- val_loss: 4183.4973
Epoch 382/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3658.2730
 - val_loss: 4184.3057
Epoch 383/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3652.8569
 - val_loss: 4181.4763
Epoch 384/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3650.9976
 - val_loss: 4181.5317
Epoch 385/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3648.6247
 - val_loss: 4179.7468
```

```
Epoch 386/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3649.8225
 - val_loss: 4175.4060
Epoch 387/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3643.4656
 - val_loss: 4177.0475
Epoch 388/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3639.6817
 - val_loss: 4176.6985
Epoch 389/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3637.0843
 - val_loss: 4187.4209
Epoch 390/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3633.9310
 - val_loss: 4179.4983
Epoch 391/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3633.6506
 - val_loss: 4170.1860
Epoch 392/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3630.8636
 - val_loss: 4172.7863
Epoch 393/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3626.9011
 - val_loss: 4169.4713
Epoch 394/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3624.3716
 - val_loss: 4163.9119
Epoch 395/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3621.8789
 - val_loss: 4162.5953
Epoch 396/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3617.0228
 - val_loss: 4165.0498
Epoch 397/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3614.7031
 - val_loss: 4163.3548
Epoch 398/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3614.4987
 - val_loss: 4159.2436
Epoch 399/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3611.1659
 - val_loss: 4157.0617
Epoch 400/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3605.7124
 - val_loss: 4160.6677
Epoch 401/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3606.9790
 - val_loss: 4163.1794
Epoch 402/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3601.4942
 - val_loss: 4154.1029
Epoch 403/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3597.8712
 - val_loss: 4155.8808
Epoch 404/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3598.5247
 - val_loss: 4161.6193
```

```
Epoch 405/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3592.9971
 - val_loss: 4150.7910
Epoch 406/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3591.9477
 - val_loss: 4154.9185
Epoch 407/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3587.6511
 - val_loss: 4153.8480
Epoch 408/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3585.7540
 - val_loss: 4148.2435
Epoch 409/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3587.0590
 - val_loss: 4151.4166
Epoch 410/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3580.3981
 - val_loss: 4145.5203
Epoch 411/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3577.4957
 - val_loss: 4144.6619
Epoch 412/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3573.1493
 - val_loss: 4146.7562
Epoch 413/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3573.9017
 - val_loss: 4150.5527
Epoch 414/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3572.0250
 - val_loss: 4147.5463
Epoch 415/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3567.0455
 - val_loss: 4139.9477
Epoch 416/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3563.9246
 - val_loss: 4138.0707
Epoch 417/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3561.6599
 - val_loss: 4143.4589
Epoch 418/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3557.9264
 - val_loss: 4137.2048
Epoch 419/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3557.9822
 - val_loss: 4133.0907
Epoch 420/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3553.5560
 - val_loss: 4135.6927
Epoch 421/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3552.7298
 - val_loss: 4129.8469
Epoch 422/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3548.7548
 - val_loss: 4131.2119
Epoch 423/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3545.3090
 - val_loss: 4127.5940
```

```
Epoch 424/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3543.8282
 - val_loss: 4130.3331
Epoch 425/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3541.1374
 - val_loss: 4126.8115
Epoch 426/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3537.9675
 - val_loss: 4124.3961
Epoch 427/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3535.5473
 - val_loss: 4124.8561
Epoch 428/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3533.7108
 - val_loss: 4125.7193
Epoch 429/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3530.0528
 - val_loss: 4120.3531
Epoch 430/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3528.4722
 - val_loss: 4134.8964
Epoch 431/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3522.9055
 - val_loss: 4118.7603
Epoch 432/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3524.3761
 - val_loss: 4118.6898
Epoch 433/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3519.3148
 - val_loss: 4122.0136
Epoch 434/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3516.0538
 - val_loss: 4117.4845
Epoch 435/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3515.3278
 - val_loss: 4117.9121
Epoch 436/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3510.7290
 - val_loss: 4112.1448
Epoch 437/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3511.5641
 - val_loss: 4122.1121
Epoch 438/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3506.3770
 - val_loss: 4117.5525
Epoch 439/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3504.7894
 - val_loss: 4132.4114
Epoch 440/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3502.6224
 - val_loss: 4115.3339
Epoch 441/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3498.4312
 - val_loss: 4105.7198
Epoch 442/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3498.5054
 - val_loss: 4118.8406
```

```
Epoch 443/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3494.6417
 - val_loss: 4105.9169
Epoch 444/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3493.4927
 - val_loss: 4106.0459
Epoch 445/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3488.2897
 - val_loss: 4102.0048
Epoch 446/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3488.5221
 - val_loss: 4108.1118
Epoch 447/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3483.4078
 - val_loss: 4117.5390
Epoch 448/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3481.9954
 - val_loss: 4101.4160
Epoch 449/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3478.0427
 - val_loss: 4100.0796
Epoch 450/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3477.3285
 - val_loss: 4100.6596
Epoch 451/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3473.5806
 - val_loss: 4104.2188
Epoch 452/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3471.4791
 - val_loss: 4099.6862
Epoch 453/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3466.7437
 - val_loss: 4095.6029
Epoch 454/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3467.1378
 - val_loss: 4106.1447
Epoch 455/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3463.0588
 - val_loss: 4099.3867
Epoch 456/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3462.2127
 - val_loss: 4091.5920
Epoch 457/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3454.0087
 - val_loss: 4111.0747
Epoch 458/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3459.9589
 - val_loss: 4089.6521
Epoch 459/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3454.0668
 - val_loss: 4089.9846
Epoch 460/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3450.9080
 - val_loss: 4092.7578
Epoch 461/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3447.4972
 - val_loss: 4097.5893
```

```
Epoch 462/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3448.4805
 - val_loss: 4089.5279
Epoch 463/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3444.0938
 - val_loss: 4088.4041
Epoch 464/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3441.3147
 - val_loss: 4086.1949
Epoch 465/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3438.1135
 - val_loss: 4092.6706
Epoch 466/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3438.6536
 - val_loss: 4084.0881
Epoch 467/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3433.4706
 - val_loss: 4085.2959
Epoch 468/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3431.6882
 - val_loss: 4082.8433
Epoch 469/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3428.1290
 - val_loss: 4095.3302
Epoch 470/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3425.4414
 - val_loss: 4078.6030
Epoch 471/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3423.7236
 - val_loss: 4074.6364
Epoch 472/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3420.0300
 - val_loss: 4084.3811
Epoch 473/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3418.5046
 - val_loss: 4079.9286
Epoch 474/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3415.0887
 - val_loss: 4078.2168
Epoch 475/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3414.4955
 - val_loss: 4071.7369
Epoch 476/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3410.2716
 - val_loss: 4070.3900
Epoch 477/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3408.3653
 - val_loss: 4074.1123
Epoch 478/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3406.6439
 - val_loss: 4083.7642
Epoch 479/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3403.2507
 - val_loss: 4067.9526
Epoch 480/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3400.8249
 - val_loss: 4073.9089
```

```
Epoch 481/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3398.4696
 - val_loss: 4069.4738
Epoch 482/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3394.3679
 - val_loss: 4064.1645
Epoch 483/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3391.7618
 - val_loss: 4077.9210
Epoch 484/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3393.6968
 - val_loss: 4062.4389
Epoch 485/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3387.3818
 - val_loss: 4063.8082
Epoch 486/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3387.0578
 - val_loss: 4073.4589
Epoch 487/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3381.9964
 - val_loss: 4062.0202
Epoch 488/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3382.1012
 - val_loss: 4064.5287
Epoch 489/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3375.6985
 - val_loss: 4063.7252
Epoch 490/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3378.3553
 - val_loss: 4066.8738
Epoch 491/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3372.1320
 - val_loss: 4063.3442
Epoch 492/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3370.8576
 - val_loss: 4052.5973
Epoch 493/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3366.6992
 - val_loss: 4061.0706
Epoch 494/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3367.4557
 - val_loss: 4053.3278
Epoch 495/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3363.5071
 - val_loss: 4051.1050
Epoch 496/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3359.2921
 - val_loss: 4048.8787
Epoch 497/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3357.9506
 - val_loss: 4047.3550
Epoch 498/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3353.9782
 - val_loss: 4048.4265
Epoch 499/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3353.5783
 - val_loss: 4047.1988
```

```
Epoch 500/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3350.1787
 - val_loss: 4063.5761
Epoch 501/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3346.3342
 - val_loss: 4045.7971
Epoch 502/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3347.1305
 - val_loss: 4050.1759
Epoch 503/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3341.4887
 - val_loss: 4054.5168
Epoch 504/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3340.0284
 - val_loss: 4045.9588
Epoch 505/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3337.1114
 - val_loss: 4039.2219
Epoch 506/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3334.6176
 - val_loss: 4045.1203
Epoch 507/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3333.5526
 - val_loss: 4042.6533
Epoch 508/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3328.0331
 - val_loss: 4036.5256
Epoch 509/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3326.7207
 - val_loss: 4037.4100
Epoch 510/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3326.0017
 - val_loss: 4083.9800
Epoch 511/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3321.9943
 - val_loss: 4036.2828
Epoch 512/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3318.1182
 - val_loss: 4032.1304
Epoch 513/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3318.4344
 - val_loss: 4042.8576
Epoch 514/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3312.1805
 - val_loss: 4030.9980
Epoch 515/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3312.3534
 - val_loss: 4029.8926
Epoch 516/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3309.3768
 - val_loss: 4025.5714
Epoch 517/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3307.1544
 - val_loss: 4028.9447
Epoch 518/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3303.6116
 - val_loss: 4035.0229
```

```
Epoch 519/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3300.2930
 - val_loss: 4028.0967
Epoch 520/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3300.9440
 - val_loss: 4022.0521
Epoch 521/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3295.8003
 - val_loss: 4027.7224
Epoch 522/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3290.4190
 - val_loss: 4023.3938
Epoch 523/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3292.2432
 - val_loss: 4031.0782
Epoch 524/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3285.9917
 - val_loss: 4025.9256
Epoch 525/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3285.5413
 - val_loss: 4011.6301
Epoch 526/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3281.1115
 - val_loss: 4030.2069
Epoch 527/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3279.8459
 - val_loss: 4015.2556
Epoch 528/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3277.6436
 - val_loss: 4050.2517
Epoch 529/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3272.2277
 - val_loss: 4021.6832
Epoch 530/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3271.9255
 - val_loss: 4008.9713
Epoch 531/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3268.3342
 - val_loss: 4007.2695
Epoch 532/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3266.2275
 - val_loss: 4007.5810
Epoch 533/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3264.7711
 - val_loss: 4012.0910
Epoch 534/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3259.2941
 - val_loss: 4004.5705
Epoch 535/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3259.5678
 - val_loss: 4000.0930
Epoch 536/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3254.6064
 - val_loss: 4008.6616
Epoch 537/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3253.2571
 - val_loss: 4023.8131
```

```
Epoch 538/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3249.2591
 - val_loss: 4014.1107
Epoch 539/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3246.3455
 - val_loss: 3999.9192
Epoch 540/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3244.3274
 - val_loss: 3991.8161
Epoch 541/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3239.5884
 - val_loss: 4032.2720
Epoch 542/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3235.9489
 - val_loss: 4006.9781
Epoch 543/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3237.0952
 - val_loss: 4007.7064
Epoch 544/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3232.9345
 - val_loss: 3982.7260
Epoch 545/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3227.3919
 - val_loss: 3996.3091
Epoch 546/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3230.7901
 - val_loss: 3980.7591
Epoch 547/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3221.9847
 - val_loss: 3982.4279
Epoch 548/550
1000/1000 [==============================] - 16s 16ms/step - loss: 3220.9860
 - val_loss: 3983.9258
Epoch 549/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3217.9298
 - val_loss: 4013.0693
Epoch 550/550
1000/1000 [==============================] - 15s 15ms/step - loss: 3213.9213
 - val_loss: 3975.3386
```

Out[15]: <keras.callbacks.History at 0x7f0cd42c0da0>

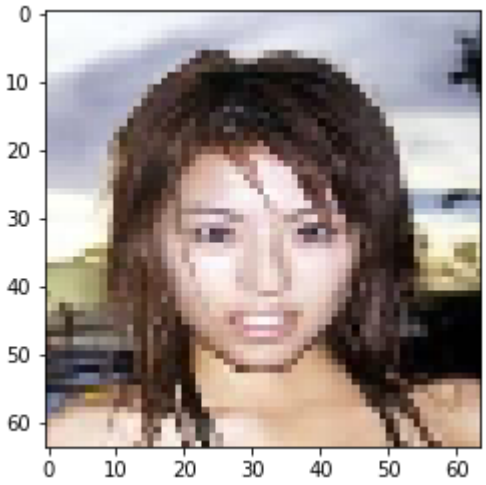
In [0]:
```
from keras.models import load_model

vae.save('PGM.h5')
```

In [0]:
```
e = encoder.predict(x_test)
```

In [0]:
```
f = decoder.predict(e)
```

In [21]:
```
plt.imshow(x_test[2])
```

Out[21]:
```
<matplotlib.image.AxesImage at 0x7f0ccd302208>
```



In [22]:
```
plt.imshow(f[2])
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for f
loats or [0..255] for integers).
```

Out[22]:
```
<matplotlib.image.AxesImage at 0x7f0ccd2daf98>
```