ML-Project-Lithium-ion-Battery

April 3, 2020

1 Machine Learning Project - Remaining Useful Life Prediction for Lithium-Ion Battery

1.0.1 Li-ion Battery Aging Dataset and Prediction of RUL (Using Neural Nets , SVM and Linear Regression)

A set of four Li-ion batteries (# 5, 6, 7 and 18) were run through 3 different operational profiles (charge, discharge and impedance) at room temperature. Charging was carried out in a constant current (CC) mode at 1.5A until the battery voltage reached 4.2V and then continued in a constant voltage (CV) mode until the charge current dropped to 20mA. Discharge was carried out at a constant current (CC) level of 2A until the battery voltage fell to 2.7V, 2.5V, 2.2V and 2.5V for batteries 5 6 7 and 18 respectively. Impedance measurement was carried out through an electrochemical impedance spectroscopy (EIS) frequency sweep from 0.1Hz to 5kHz. Repeated charge and discharge cycles result in accelerated aging of the batteries while impedance measurements provide insight into the internal battery parameters that change as aging progresses. The experiments were stopped when the batteries reached end-of-life (EOL) criteria, which was a 30% fade in rated capacity (from 2Ahr to 1.4Ahr). This dataset can be used for the prediction of both remaining charge (for a given discharge cycle) and remaining useful life (RUL).

[66]:
```
#import libraries
import sys
import scipy
import numpy as np
import matplotlib
import pandas
import sklearn
#checking versions
print('Python: {}'.format(sys.version))
print('scipy: {}'.format(scipy.__version__))
print('numpy: {}'.format(numpy.__version__))
print('matplotlib: {}'.format(matplotlib.__version__))
print('pandas: {}'.format(pandas.__version__))
print('sklearn: {}'.format(sklearn.__version__))
```

```
Python: 3.7.1 (default, Dec 10 2018, 22:54:23) [MSC v.1915 64 bit (AMD64)]
scipy: 1.4.1
numpy: 1.16.4
matplotlib: 3.1.1
```

```
pandas: 0.25.1
sklearn: 0.21.2
```

1.1 Initial Dataset

[2]:
```
#.mat file processing
from scipy.io import loadmat
b0005 = loadmat('B0005.mat')
print(b0005.keys())
# print(b0005.get('B0005'))
b0006 = loadmat('B0006.mat')
print(b0006.keys())
b0007 = loadmat('B0007.mat')
print(b0007.keys())

#mdata
mdata1 = b0005['B0005']
mdata2 = b0006['B0006']
mdata3 = b0007['B0007']
#type
mtype1 = mdata1.dtype
print(mtype1)
mtype2 = mdata2.dtype
mtype3 = mdata3.dtype
#ndata
ndata1 = {n: mdata1[n][0,0] for n in mtype1.names}
ndata2 = {n: mdata2[n][0,0] for n in mtype2.names}
ndata3 = {n: mdata3[n][0,0] for n in mtype3.names}
# print(ndata1.items())
# type(ndata)
print(ndata1.keys() , ndata2.keys() ,ndata3.keys() )
print(mtype1.names)
```

```
dict_keys(['__header__', '__version__', '__globals__', 'B0005'])
dict_keys(['__header__', '__version__', '__globals__', 'B0006'])
dict_keys(['__header__', '__version__', '__globals__', 'B0007'])
[('cycle', 'O')]
dict_keys(['cycle']) dict_keys(['cycle']) dict_keys(['cycle'])
('cycle',)
```

1.2 Importing dataset

the .mat file dataset is converted to .csv format. As python does not support .mat dataset. .mat datasets are generally used in MatLab environment

[3]:
```
import pandas as pd
df = pd.read_csv('dataset.csv')
print('shape of the dataset : {}'.format(df.shape))
```

```
print(df.loc[10])
```

```
shape of the dataset : (636, 7)
Cycle                             2
Capacity(Ah)                1.88066
Voltage Measured(V)         3.06327
Current Measured       -0.00315778
Temperature Measured        37.5081
Time Measured(Sec)          3651.64
SampleId                      B0007
Name: 10, dtype: object
```

1.3 Preprocess the data

here we check for null values in the dataset, and categorial dataset. #### Also we drop the SampleId column from the dataset

[4]:
```
# Preprocess the data
df.replace('?',-99999, inplace=True)
print(df.axes)
# Drop feature
df.drop(['SampleId'], 1, inplace=True)
```

```
[RangeIndex(start=0, stop=636, step=1), Index(['Cycle', 'Capacity(Ah)', 'Voltage
Measured(V)', 'Current Measured',
       'Temperature Measured', 'Time Measured(Sec)', 'SampleId'],
      dtype='object')]
```

1.4 Checking for null values in the data set

1.4.1 There are no missing values in the dataset also there are no categorialcal data

[19]:
```
missing_values = (X_train.isnull().sum())
print(missing_values[missing_values>0])
```

```
Series([], dtype: int64)
```

Describe the dataset Here we can see the total count, mean,std, min, max for all the columns in the dataset

[5]:
```
print(df.describe())
```

```
            Cycle  Capacity(Ah)  Voltage Measured(V)  Current Measured  \
count  636.000000    636.000000           636.000000        636.000000
mean    79.764151      1.581652             3.297086         -0.171153
std     47.137103      0.198765             0.382406          0.556974
min      0.000000      1.153818             1.813269         -2.012015
25%     39.000000      1.421123             3.260587         -0.003576
50%     79.000000      1.559695             3.397571         -0.001903
```

```
75%     119.000000      1.763486              3.529257         -0.000338
max     167.000000      2.035338              3.697170          0.009113

       Temperature Measured  Time Measured(Sec)
count            636.000000          636.000000
mean              36.318064         3116.977701
std                2.090171          242.197224
min               32.113473         2742.843000
25%               34.639503         2891.996250
50%               35.808964         3084.281000
75%               38.447301         3311.828000
max               41.049942         3690.234000
```

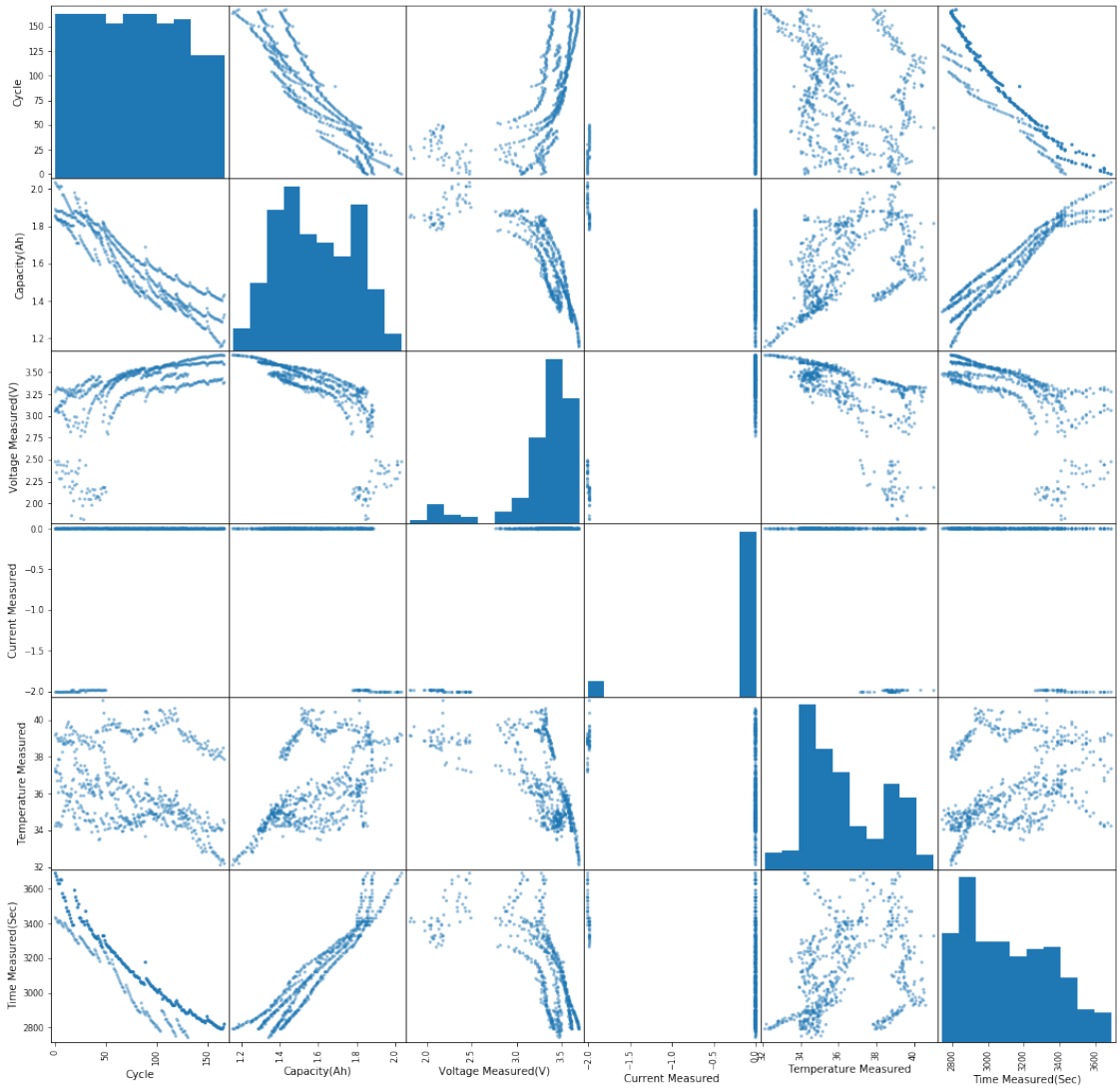
There's no categorical data in the dataset

[12]:
```
# Check features type
df.dtypes
```

[12]:
```
Cycle                      int64
Capacity(Ah)             float64
Voltage Measured(V)      float64
Current Measured         float64
Temperature Measured     float64
Time Measured(Sec)       float64
dtype: object
```

Scatter plot matrix shows relation between different feature to one another.

[9]:
```
# Create scatter plot matrix
from pandas.plotting import scatter_matrix
scatter_matrix(df, figsize = (18,18))
plt.show()
```



1.5 Feature extraction

Here we select important features from the dataset for the training

[10]:
```
df.head()
```

[10]:

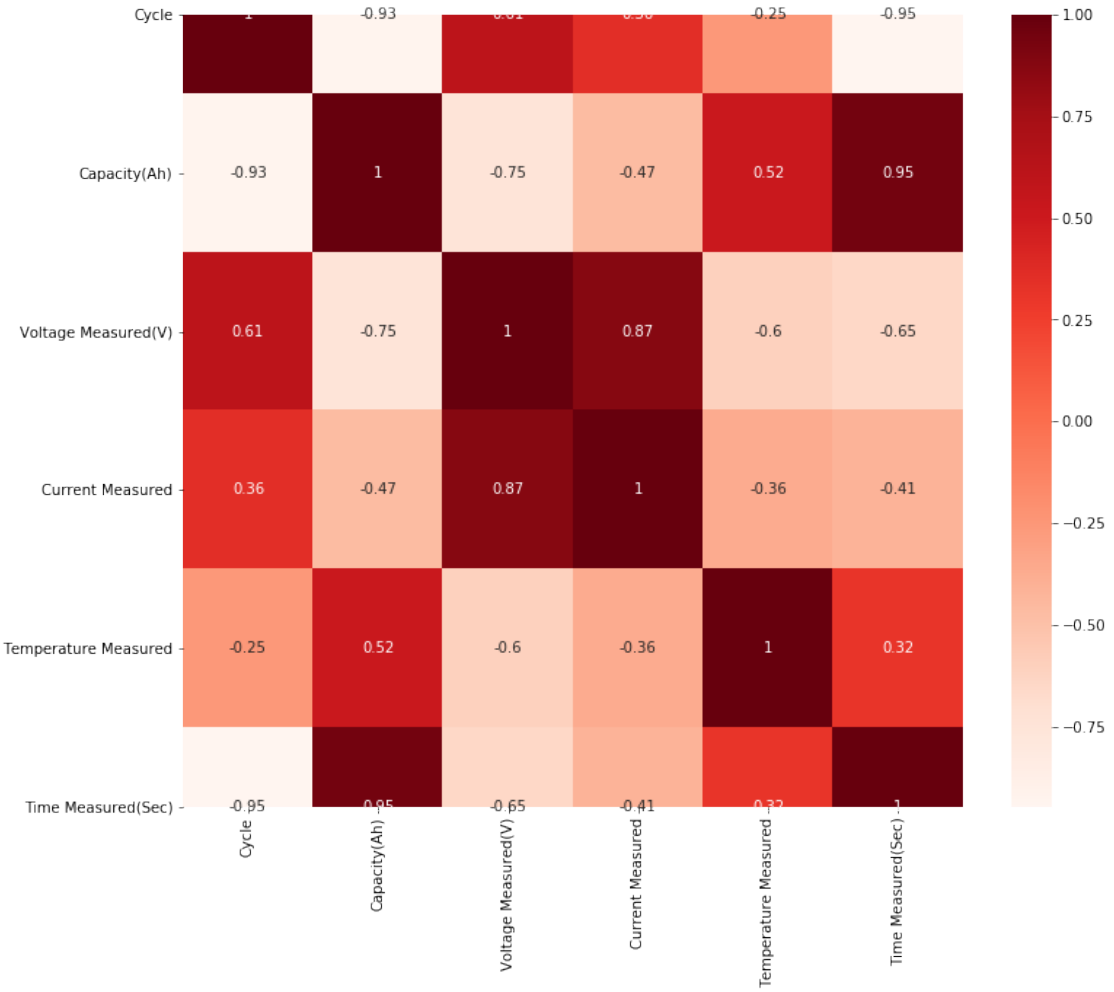
	Cycle	Capacity(Ah)	Voltage Measured(V)	Current Measured	\
0	0	1.856487	3.277170	-0.006528	
1	0	2.035338	2.475768	-2.009436	
2	0	1.891052	3.062113	-0.001433	
3	0	1.855005	3.053230	-0.002433	
4	1	1.846327	3.300245	-0.000448	

	Temperature Measured	Time Measured(Sec)

0	34.230853	3690.234
1	39.162987	3690.234
2	37.338478	3690.234
3	37.205671	3434.891
4	34.392137	3672.344

Correlation between the features We can see that Capacity and Voltage measured are strongly correlated to The target

[11]:
```
#Using Pearson Correlation
import seaborn as sns
plt.figure(figsize=(12,10))
cor = df.corr()
sns.heatmap(cor, annot=True, cmap=plt.cm.Reds)
plt.show()
```



[13]:
```
df.columns
```

[13]:
```
Index(['Cycle', 'Capacity(Ah)', 'Voltage Measured(V)', 'Current Measured',
       'Temperature Measured', 'Time Measured(Sec)'],
      dtype='object')
```

1.5.1 Selecting the Target and Features for training

[128]:
```
#divide the dataset

features = ['Cycle','Capacity(Ah)','Voltage Measured(V)','Current␣
 ↪Measured','Temperature Measured']

X = df[features]
Y = df['Time Measured(Sec)']

print(X.head())
print("Shape of X {} =".format(X.shape))
print("Shape of Y {} =".format(Y.shape))
```

```
   Cycle  Capacity(Ah)  Voltage Measured(V)  Current Measured  \
0      0      1.856487             3.277170         -0.006528
1      0      2.035338             2.475768         -2.009436
2      0      1.891052             3.062113         -0.001433
3      0      1.855005             3.053230         -0.002433
4      1      1.846327             3.300245         -0.000448

   Temperature Measured
0             34.230853
1             39.162987
2             37.338478
3             37.205671
4             34.392137
Shape of X (636, 5) =
Shape of Y (636,) =
```

[15]:
```
print(Y[:5])
```

```
0    3690.234
1    3690.234
2    3690.234
3    3434.891
4    3672.344
Name: Time Measured(Sec), dtype: float64
```

1.6 Normalize the data

Standardize features by removing the mean and scaling to unit variance.

Standardization of a dataset is a common requirement for many machine learning estimators: they might behave badly if the individual features do not more or less look like standard normally distributed data (e.g. Gaussian with 0 mean and unit variance).

[16]:
```
# Normalize the data using sklearn StandardScaler
from sklearn.preprocessing import StandardScaler

scaler = StandardScaler().fit(X)
print(scaler)
```

```
StandardScaler(copy=True, with_mean=True, with_std=True)
```

[17]:
```
# Transform and display the training data
X_standardized = scaler.transform(X)

data = pd.DataFrame(X_standardized)
data.describe()
```

[17]:

	0	1	2	3	4
count	6.360000e+02	6.360000e+02	6.360000e+02	6.360000e+02	6.360000e+02
mean	-1.787529e-16	-3.575058e-16	-4.468822e-17	-6.703233e-17	-1.117206e-15
std	1.000787e+00	1.000787e+00	1.000787e+00	1.000787e+00	1.000787e+00
min	-1.693505e+00	-2.154157e+00	-3.883268e+00	-3.307716e+00	-2.013184e+00
25%	-8.654803e-01	-8.082699e-01	-9.552023e-02	3.011072e-01	-8.037057e-01
50%	-1.622400e-02	-1.105548e-01	2.629765e-01	3.041144e-01	-2.437607e-01
75%	8.330323e-01	9.155417e-01	6.076094e-01	3.069263e-01	1.019492e+00
max	1.852140e+00	2.284324e+00	1.047051e+00	3.239088e-01	2.265653e+00

1.6.1 Spliting dataset into training and validation set

Here we are spliting up the dataset as the 80% ,20 % ratio. 80% for the training set and 20% data for the validation set.

[129]:
```
from sklearn.model_selection import train_test_split
X_train,X_val,y_train,y_valid = train_test_split(X_standardized,Y,train_size=0.
↪8,test_size=0.2,random_state=0)
```

1.7 Creating first model → Linear Regression

As we currently have all the data in numeric format. So Linear Regression will run with greater accuracy than Categorial (object) type data.

[130]:
```
from sklearn.linear_model import LinearRegression
model1 = LinearRegression()
model1.fit(X_train,y_train)
```

[130]:
```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

[131]:
```
model1.score(X_val,y_valid)
```

[131]:
```
0.9580456232103931
```

1.8 Checking the accuracy

Here we are using mean-absolute-error as a primary metric for the checking accuracy of a each model.

[134]:
```
from sklearn.metrics import mean_absolute_error
predictions1 = model1.predict(X_val)
score1 = mean_absolute_error(y_valid,predictions1)
score1
```

[134]:
```
36.13652878867846
```

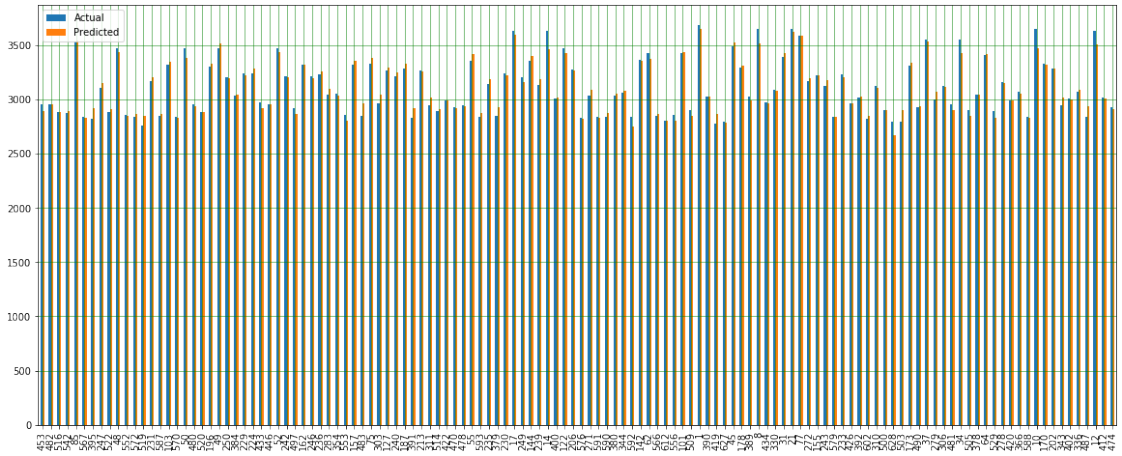
[135]:
```
actual_predicted = pd.DataFrame({'Actual':y_valid, 'Predicted':predictions1})
actual_predicted
```

[135]:

	Actual	Predicted
453	2956.406	2888.899562
482	2955.438	2959.027072
516	2882.906	2885.384279
542	2873.453	2894.118019
85	3531.578	3543.953886
..	…	…
336	3067.203	3090.595712
487	2840.016	2934.309986
12	3631.563	3507.528520
412	3020.110	3012.838991
474	2929.375	2913.345746

[128 rows x 2 columns]

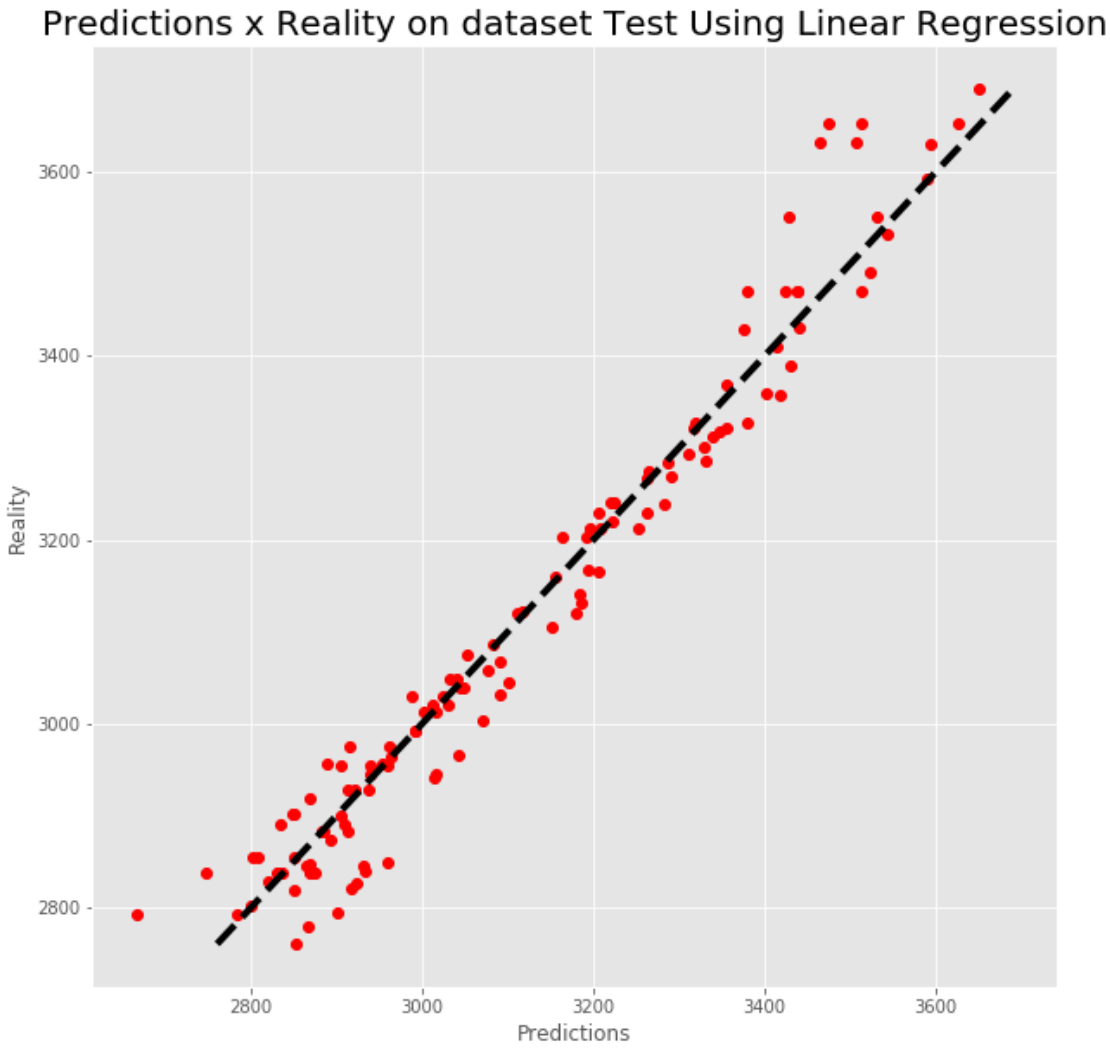
[24]:
```
actual_predicted.plot(kind='bar',figsize=(20,8))
plt.grid(which='major', linestyle='-', linewidth='0.5', color='green')
plt.grid(which='minor', linestyle=':', linewidth='0.5', color='black')
plt.show()
```



[138]:
```
plt.style.use('ggplot')

matplotlib.rc('xtick', labelsize=10)
matplotlib.rc('ytick', labelsize=10)

fig, ax = plt.subplots(figsize=(10, 10))
plt.plot(predictions1, y_valid, 'ro')
plt.xlabel('Predictions', fontsize = 12)
plt.ylabel('Reality', fontsize=12)
plt.title('Predictions x Reality on dataset Test Using Linear Regression',␣
 ↪fontsize = 20)
ax.plot([y_valid.min(), y_valid.max()], [y_valid.min(), y_valid.max()], 'k--',␣
 ↪lw=4)
plt.show()
```



1.9 Creating second model → SVM

Epsilon-Support Vector Regression.

The implementation is based on libsvm. The fit time complexity is more than quadratic with the number of samples which makes it hard to scale to datasets with more than a couple of 10000 samples

[140]:
```
from sklearn.svm import SVR
# most important SVR parameter is Kernel type. It can be linear,polynomial or␣
 ↪gaussian SVR.
# We have a non-linear condition #so we can select polynomial or gaussian but␣
 ↪here we select RBF(a #gaussian type) kernel.

model2 = SVR(kernel='',gamma='auto')
```

```
model2.fit(X_train,y_train)
```

[140]:
```
SVR(C=1.0, cache_size=200, coef0=0.0, degree=3, epsilon=0.1, gamma='auto',
    kernel='linear', max_iter=-1, shrinking=True, tol=0.001, verbose=False)
```

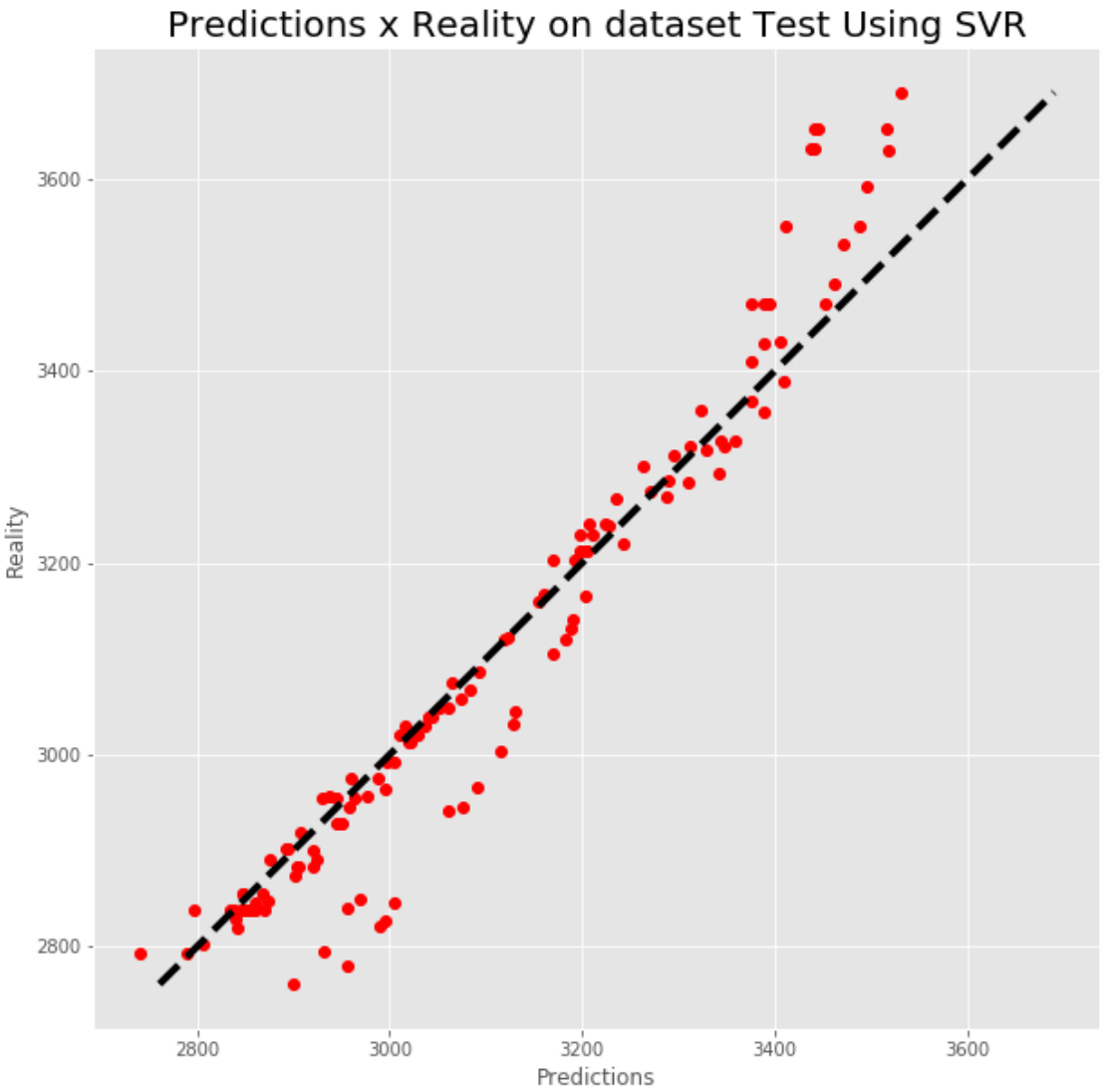
[141]:
```
model2.score(X_val,y_valid)
```

[141]:
```
0.9257831840874583
```

[142]:
```
predictions2 = model2.predict(X_val)
score2 = mean_absolute_error(y_valid,predictions2)
score2
```

[142]:
```
44.023475796925815
```

[144]:
```
# plt.style.use('ggplot')
matplotlib.rc('xtick', labelsize=10)
matplotlib.rc('ytick', labelsize=10)
#subplots
fig, ax = plt.subplots(figsize=(10, 10))
plt.plot(predictions2, y_valid, 'ro')
plt.xlabel('Predictions', fontsize = 12)
plt.ylabel('Reality', fontsize=12)
plt.title('Predictions x Reality on dataset Test Using SVR', fontsize = 20)
ax.plot([y_valid.min(), y_valid.max()], [y_valid.min(), y_valid.max()], 'k--',␣
 ↪lw=4)
plt.show()
```



1.10 Creating Neural Net → Deep neural net for prediction

Keras is a high-level neural networks API, written in Python and capable of running on top of TensorFlow, CNTK, or Theano. It was developed with a focus on enabling fast experimentation. Being able to go from idea to result with the least possible delay is key to doing good research.

[147]:
```
from keras.callbacks import ModelCheckpoint
from keras.models import Sequential
from keras.layers import Dense, Activation, Flatten

#neural network
NN_model = Sequential()
```

```
# The Input Layer :
NN_model.add(Dense(128, kernel_initializer='normal',input_dim = X_train.
 ↪shape[1],activation ='relu'))

# The Hidden Layers :
NN_model.add(Dense(256, kernel_initializer='normal',activation='relu'))
NN_model.add(Dense(256, kernel_initializer='normal',activation='relu'))
NN_model.add(Dense(256, kernel_initializer='normal',activation='relu'))

# The Output Layer :
NN_model.add(Dense(1, kernel_initializer='normal',activation='linear'))

# Compile the network :
NN_model.compile(loss='mean_absolute_error', optimizer='adam',␣
 ↪metrics=['mean_absolute_error','accuracy'])
NN_model.summary()
```

```
Model: "sequential_13"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_55 (Dense)             (None, 128)               768
_________________________________________________________________
dense_56 (Dense)             (None, 256)               33024
_________________________________________________________________
dense_57 (Dense)             (None, 256)               65792
_________________________________________________________________
dense_58 (Dense)             (None, 256)               65792
_________________________________________________________________
dense_59 (Dense)             (None, 1)                 257
=================================================================
Total params: 165,633
Trainable params: 165,633
Non-trainable params: 0
_________________________________________________________________
```

[150]:
```
history = NN_model.fit(X_train, y_train, validation_data=(X_val, y_valid),␣
 ↪epochs=300, verbose=1)
```

```
Train on 508 samples, validate on 128 samples
Epoch 1/300
508/508 [==============================] - 0s 171us/step - loss: 28.4188 -
mean_absolute_error: 28.4188 - accuracy: 0.0000e+00 - val_loss: 24.3431 -
val_mean_absolute_error: 24.3431 - val_accuracy: 0.0000e+00
Epoch 2/300
508/508 [==============================] - 0s 187us/step - loss: 27.8338 -
mean_absolute_error: 27.8338 - accuracy: 0.0000e+00 - val_loss: 25.0065 -
```

```
val_mean_absolute_error: 25.0065 - val_accuracy: 0.0000e+00
Epoch 3/300
508/508 [==============================] - 0s 199us/step - loss: 25.3526 -
mean_absolute_error: 25.3526 - accuracy: 0.0000e+00 - val_loss: 31.1519 -
val_mean_absolute_error: 31.1519 - val_accuracy: 0.0000e+00
Epoch 4/300
508/508 [==============================] - 0s 220us/step - loss: 26.1626 -
mean_absolute_error: 26.1626 - accuracy: 0.0000e+00 - val_loss: 16.6303 -
val_mean_absolute_error: 16.6303 - val_accuracy: 0.0000e+00
Epoch 5/300
508/508 [==============================] - 0s 165us/step - loss: 25.6363 -
mean_absolute_error: 25.6363 - accuracy: 0.0000e+00 - val_loss: 23.7143 -
val_mean_absolute_error: 23.7143 - val_accuracy: 0.0000e+00
Epoch 6/300
508/508 [==============================] - 0s 171us/step - loss: 29.1403 -
mean_absolute_error: 29.1403 - accuracy: 0.0000e+00 - val_loss: 31.7671 -
val_mean_absolute_error: 31.7671 - val_accuracy: 0.0000e+00
Epoch 7/300
508/508 [==============================] - 0s 171us/step - loss: 27.1761 -
mean_absolute_error: 27.1761 - accuracy: 0.0000e+00 - val_loss: 21.2945 -
val_mean_absolute_error: 21.2945 - val_accuracy: 0.0000e+00
Epoch 8/300
508/508 [==============================] - 0s 187us/step - loss: 32.0194 -
mean_absolute_error: 32.0194 - accuracy: 0.0020 - val_loss: 51.9504 -
val_mean_absolute_error: 51.9504 - val_accuracy: 0.0000e+00
Epoch 9/300
508/508 [==============================] - 0s 183us/step - loss: 34.0775 -
mean_absolute_error: 34.0775 - accuracy: 0.0000e+00 - val_loss: 18.7506 -
val_mean_absolute_error: 18.7506 - val_accuracy: 0.0000e+00
Epoch 10/300
508/508 [==============================] - 0s 179us/step - loss: 28.3812 -
mean_absolute_error: 28.3812 - accuracy: 0.0039 - val_loss: 22.0448 -
val_mean_absolute_error: 22.0448 - val_accuracy: 0.0000e+00
Epoch 11/300
508/508 [==============================] - 0s 185us/step - loss: 27.0993 -
mean_absolute_error: 27.0993 - accuracy: 0.0020 - val_loss: 26.4934 -
val_mean_absolute_error: 26.4934 - val_accuracy: 0.0000e+00
Epoch 12/300
508/508 [==============================] - 0s 193us/step - loss: 25.2371 -
mean_absolute_error: 25.2371 - accuracy: 0.0020 - val_loss: 17.6644 -
val_mean_absolute_error: 17.6644 - val_accuracy: 0.0000e+00
Epoch 13/300
508/508 [==============================] - 0s 185us/step - loss: 24.8986 -
mean_absolute_error: 24.8986 - accuracy: 0.0000e+00 - val_loss: 21.6056 -
val_mean_absolute_error: 21.6056 - val_accuracy: 0.0000e+00
Epoch 14/300
508/508 [==============================] - 0s 175us/step - loss: 24.3827 -
mean_absolute_error: 24.3827 - accuracy: 0.0000e+00 - val_loss: 18.5212 -
```

```
val_mean_absolute_error: 18.5212 - val_accuracy: 0.0000e+00
Epoch 15/300
508/508 [==============================] - 0s 234us/step - loss: 25.5337 -
mean_absolute_error: 25.5337 - accuracy: 0.0020 - val_loss: 18.3769 -
val_mean_absolute_error: 18.3769 - val_accuracy: 0.0000e+00
Epoch 16/300
508/508 [==============================] - 0s 175us/step - loss: 28.0738 -
mean_absolute_error: 28.0738 - accuracy: 0.0000e+00 - val_loss: 31.0949 -
val_mean_absolute_error: 31.0949 - val_accuracy: 0.0000e+00
Epoch 17/300
508/508 [==============================] - 0s 177us/step - loss: 25.3605 -
mean_absolute_error: 25.3605 - accuracy: 0.0000e+00 - val_loss: 22.9871 -
val_mean_absolute_error: 22.9871 - val_accuracy: 0.0000e+00
Epoch 18/300
508/508 [==============================] - 0s 220us/step - loss: 34.0031 -
mean_absolute_error: 34.0031 - accuracy: 0.0000e+00 - val_loss: 29.0469 -
val_mean_absolute_error: 29.0469 - val_accuracy: 0.0000e+00
Epoch 19/300
508/508 [==============================] - 0s 212us/step - loss: 27.4963 -
mean_absolute_error: 27.4963 - accuracy: 0.0000e+00 - val_loss: 32.4396 -
val_mean_absolute_error: 32.4396 - val_accuracy: 0.0000e+00
Epoch 20/300
508/508 [==============================] - 0s 191us/step - loss: 27.8047 -
mean_absolute_error: 27.8047 - accuracy: 0.0000e+00 - val_loss: 26.8093 -
val_mean_absolute_error: 26.8093 - val_accuracy: 0.0000e+00
Epoch 21/300
508/508 [==============================] - 0s 173us/step - loss: 24.7077 -
mean_absolute_error: 24.7077 - accuracy: 0.0000e+00 - val_loss: 22.9939 -
val_mean_absolute_error: 22.9939 - val_accuracy: 0.0000e+00
Epoch 22/300
508/508 [==============================] - 0s 214us/step - loss: 27.9619 -
mean_absolute_error: 27.9619 - accuracy: 0.0000e+00 - val_loss: 27.0963 -
val_mean_absolute_error: 27.0963 - val_accuracy: 0.0000e+00
Epoch 23/300
508/508 [==============================] - 0s 216us/step - loss: 23.9961 -
mean_absolute_error: 23.9961 - accuracy: 0.0000e+00 - val_loss: 31.9566 -
val_mean_absolute_error: 31.9566 - val_accuracy: 0.0000e+00
Epoch 24/300
508/508 [==============================] - 0s 171us/step - loss: 32.8149 -
mean_absolute_error: 32.8149 - accuracy: 0.0000e+00 - val_loss: 32.1303 -
val_mean_absolute_error: 32.1303 - val_accuracy: 0.0000e+00
Epoch 25/300
508/508 [==============================] - 0s 230us/step - loss: 29.6323 -
mean_absolute_error: 29.6323 - accuracy: 0.0000e+00 - val_loss: 28.9662 -
val_mean_absolute_error: 28.9662 - val_accuracy: 0.0078
Epoch 26/300
508/508 [==============================] - 0s 199us/step - loss: 26.4864 -
mean_absolute_error: 26.4864 - accuracy: 0.0000e+00 - val_loss: 35.8464 -
```

```
val_mean_absolute_error: 35.8464 - val_accuracy: 0.0078
Epoch 27/300
508/508 [==============================] - 0s 185us/step - loss: 28.2189 -
mean_absolute_error: 28.2188 - accuracy: 0.0020 - val_loss: 38.6851 -
val_mean_absolute_error: 38.6851 - val_accuracy: 0.0000e+00
Epoch 28/300
508/508 [==============================] - 0s 171us/step - loss: 30.8632 -
mean_absolute_error: 30.8632 - accuracy: 0.0000e+00 - val_loss: 30.1019 -
val_mean_absolute_error: 30.1019 - val_accuracy: 0.0000e+00
Epoch 29/300
508/508 [==============================] - 0s 159us/step - loss: 28.5324 -
mean_absolute_error: 28.5324 - accuracy: 0.0000e+00 - val_loss: 22.4596 -
val_mean_absolute_error: 22.4596 - val_accuracy: 0.0078
Epoch 30/300
508/508 [==============================] - 0s 197us/step - loss: 25.8329 -
mean_absolute_error: 25.8329 - accuracy: 0.0000e+00 - val_loss: 28.0263 -
val_mean_absolute_error: 28.0263 - val_accuracy: 0.0000e+00
Epoch 31/300
508/508 [==============================] - 0s 193us/step - loss: 24.5437 -
mean_absolute_error: 24.5437 - accuracy: 0.0000e+00 - val_loss: 20.9313 -
val_mean_absolute_error: 20.9313 - val_accuracy: 0.0000e+00
Epoch 32/300
508/508 [==============================] - 0s 199us/step - loss: 25.0884 -
mean_absolute_error: 25.0884 - accuracy: 0.0000e+00 - val_loss: 19.3323 -
val_mean_absolute_error: 19.3323 - val_accuracy: 0.0000e+00
Epoch 33/300
508/508 [==============================] - 0s 161us/step - loss: 23.8829 -
mean_absolute_error: 23.8829 - accuracy: 0.0000e+00 - val_loss: 20.6184 -
val_mean_absolute_error: 20.6184 - val_accuracy: 0.0000e+00
Epoch 34/300
508/508 [==============================] - 0s 173us/step - loss: 26.3114 -
mean_absolute_error: 26.3114 - accuracy: 0.0000e+00 - val_loss: 19.6149 -
val_mean_absolute_error: 19.6149 - val_accuracy: 0.0000e+00
Epoch 35/300
508/508 [==============================] - 0s 171us/step - loss: 26.4540 -
mean_absolute_error: 26.4540 - accuracy: 0.0000e+00 - val_loss: 25.9057 -
val_mean_absolute_error: 25.9057 - val_accuracy: 0.0000e+00
Epoch 36/300
508/508 [==============================] - 0s 205us/step - loss: 27.6525 -
mean_absolute_error: 27.6525 - accuracy: 0.0000e+00 - val_loss: 30.4097 -
val_mean_absolute_error: 30.4097 - val_accuracy: 0.0000e+00
Epoch 37/300
508/508 [==============================] - 0s 179us/step - loss: 26.7148 -
mean_absolute_error: 26.7148 - accuracy: 0.0020 - val_loss: 28.7123 -
val_mean_absolute_error: 28.7123 - val_accuracy: 0.0000e+00
Epoch 38/300
508/508 [==============================] - 0s 153us/step - loss: 25.9812 -
mean_absolute_error: 25.9812 - accuracy: 0.0000e+00 - val_loss: 23.8908 -
```

```
val_mean_absolute_error: 23.8908 - val_accuracy: 0.0000e+00
Epoch 39/300
508/508 [==============================] - 0s 181us/step - loss: 28.4206 -
mean_absolute_error: 28.4206 - accuracy: 0.0000e+00 - val_loss: 17.3550 -
val_mean_absolute_error: 17.3550 - val_accuracy: 0.0000e+00
Epoch 40/300
508/508 [==============================] - 0s 169us/step - loss: 24.6132 -
mean_absolute_error: 24.6133 - accuracy: 0.0020 - val_loss: 23.1434 -
val_mean_absolute_error: 23.1434 - val_accuracy: 0.0000e+00
Epoch 41/300
508/508 [==============================] - 0s 195us/step - loss: 27.9135 -
mean_absolute_error: 27.9135 - accuracy: 0.0000e+00 - val_loss: 28.6263 -
val_mean_absolute_error: 28.6263 - val_accuracy: 0.0000e+00
Epoch 42/300
508/508 [==============================] - 0s 236us/step - loss: 24.1754 -
mean_absolute_error: 24.1754 - accuracy: 0.0000e+00 - val_loss: 25.4446 -
val_mean_absolute_error: 25.4446 - val_accuracy: 0.0000e+00
Epoch 43/300
508/508 [==============================] - 0s 212us/step - loss: 26.0184 -
mean_absolute_error: 26.0184 - accuracy: 0.0000e+00 - val_loss: 25.5059 -
val_mean_absolute_error: 25.5059 - val_accuracy: 0.0000e+00
Epoch 44/300
508/508 [==============================] - 0s 177us/step - loss: 26.7348 -
mean_absolute_error: 26.7348 - accuracy: 0.0000e+00 - val_loss: 23.2893 -
val_mean_absolute_error: 23.2893 - val_accuracy: 0.0000e+00
Epoch 45/300
508/508 [==============================] - 0s 163us/step - loss: 25.0698 -
mean_absolute_error: 25.0698 - accuracy: 0.0000e+00 - val_loss: 19.7240 -
val_mean_absolute_error: 19.7240 - val_accuracy: 0.0000e+00
Epoch 46/300
508/508 [==============================] - 0s 199us/step - loss: 30.0701 -
mean_absolute_error: 30.0701 - accuracy: 0.0000e+00 - val_loss: 32.8098 -
val_mean_absolute_error: 32.8098 - val_accuracy: 0.0000e+00
Epoch 47/300
508/508 [==============================] - 0s 187us/step - loss: 27.4065 -
mean_absolute_error: 27.4065 - accuracy: 0.0000e+00 - val_loss: 27.0927 -
val_mean_absolute_error: 27.0927 - val_accuracy: 0.0078
Epoch 48/300
508/508 [==============================] - 0s 203us/step - loss: 24.5686 -
mean_absolute_error: 24.5686 - accuracy: 0.0000e+00 - val_loss: 16.3699 -
val_mean_absolute_error: 16.3699 - val_accuracy: 0.0000e+00
Epoch 49/300
508/508 [==============================] - 0s 191us/step - loss: 25.1621 -
mean_absolute_error: 25.1621 - accuracy: 0.0000e+00 - val_loss: 29.5592 -
val_mean_absolute_error: 29.5592 - val_accuracy: 0.0000e+00
Epoch 50/300
508/508 [==============================] - 0s 181us/step - loss: 27.6096 -
mean_absolute_error: 27.6096 - accuracy: 0.0000e+00 - val_loss: 23.0338 -
```

```
val_mean_absolute_error: 23.0338 - val_accuracy: 0.0000e+00
Epoch 51/300
508/508 [==============================] - 0s 159us/step - loss: 26.6822 -
mean_absolute_error: 26.6822 - accuracy: 0.0000e+00 - val_loss: 17.3127 -
val_mean_absolute_error: 17.3127 - val_accuracy: 0.0000e+00
Epoch 52/300
508/508 [==============================] - 0s 183us/step - loss: 24.1295 -
mean_absolute_error: 24.1295 - accuracy: 0.0000e+00 - val_loss: 21.5537 -
val_mean_absolute_error: 21.5537 - val_accuracy: 0.0000e+00
Epoch 53/300
508/508 [==============================] - 0s 171us/step - loss: 24.3983 -
mean_absolute_error: 24.3983 - accuracy: 0.0000e+00 - val_loss: 20.6875 -
val_mean_absolute_error: 20.6875 - val_accuracy: 0.0000e+00
Epoch 54/300
508/508 [==============================] - 0s 167us/step - loss: 24.6399 -
mean_absolute_error: 24.6399 - accuracy: 0.0000e+00 - val_loss: 27.0030 -
val_mean_absolute_error: 27.0030 - val_accuracy: 0.0000e+00
Epoch 55/300
508/508 [==============================] - 0s 183us/step - loss: 25.6809 -
mean_absolute_error: 25.6809 - accuracy: 0.0020 - val_loss: 18.3657 -
val_mean_absolute_error: 18.3657 - val_accuracy: 0.0000e+00
Epoch 56/300
508/508 [==============================] - 0s 165us/step - loss: 24.5149 -
mean_absolute_error: 24.5149 - accuracy: 0.0000e+00 - val_loss: 31.0548 -
val_mean_absolute_error: 31.0548 - val_accuracy: 0.0000e+00
Epoch 57/300
508/508 [==============================] - 0s 163us/step - loss: 28.8853 -
mean_absolute_error: 28.8853 - accuracy: 0.0000e+00 - val_loss: 23.7585 -
val_mean_absolute_error: 23.7585 - val_accuracy: 0.0000e+00
Epoch 58/300
508/508 [==============================] - 0s 216us/step - loss: 25.2551 -
mean_absolute_error: 25.2551 - accuracy: 0.0000e+00 - val_loss: 32.9064 -
val_mean_absolute_error: 32.9064 - val_accuracy: 0.0000e+00
Epoch 59/300
508/508 [==============================] - 0s 185us/step - loss: 25.4649 -
mean_absolute_error: 25.4649 - accuracy: 0.0000e+00 - val_loss: 19.3472 -
val_mean_absolute_error: 19.3472 - val_accuracy: 0.0000e+00
Epoch 60/300
508/508 [==============================] - 0s 165us/step - loss: 27.3335 -
mean_absolute_error: 27.3335 - accuracy: 0.0000e+00 - val_loss: 29.7553 -
val_mean_absolute_error: 29.7553 - val_accuracy: 0.0000e+00
Epoch 61/300
508/508 [==============================] - 0s 193us/step - loss: 26.0747 -
mean_absolute_error: 26.0747 - accuracy: 0.0020 - val_loss: 19.2034 -
val_mean_absolute_error: 19.2034 - val_accuracy: 0.0000e+00
Epoch 62/300
508/508 [==============================] - 0s 203us/step - loss: 25.9441 -
mean_absolute_error: 25.9441 - accuracy: 0.0000e+00 - val_loss: 26.6021 -
```

```
val_mean_absolute_error: 26.6021 - val_accuracy: 0.0000e+00
Epoch 63/300
508/508 [==============================] - 0s 193us/step - loss: 23.6811 -
mean_absolute_error: 23.6811 - accuracy: 0.0000e+00 - val_loss: 28.5898 -
val_mean_absolute_error: 28.5898 - val_accuracy: 0.0000e+00
Epoch 64/300
508/508 [==============================] - 0s 183us/step - loss: 32.2421 -
mean_absolute_error: 32.2421 - accuracy: 0.0000e+00 - val_loss: 38.3485 -
val_mean_absolute_error: 38.3485 - val_accuracy: 0.0000e+00
Epoch 65/300
508/508 [==============================] - 0s 187us/step - loss: 26.6014 -
mean_absolute_error: 26.6014 - accuracy: 0.0000e+00 - val_loss: 34.6081 -
val_mean_absolute_error: 34.6081 - val_accuracy: 0.0000e+00
Epoch 66/300
508/508 [==============================] - 0s 185us/step - loss: 26.3197 -
mean_absolute_error: 26.3197 - accuracy: 0.0000e+00 - val_loss: 22.0707 -
val_mean_absolute_error: 22.0707 - val_accuracy: 0.0000e+00
Epoch 67/300
508/508 [==============================] - 0s 191us/step - loss: 25.9280 -
mean_absolute_error: 25.9280 - accuracy: 0.0000e+00 - val_loss: 22.5281 -
val_mean_absolute_error: 22.5281 - val_accuracy: 0.0000e+00
Epoch 68/300
508/508 [==============================] - 0s 187us/step - loss: 24.7017 -
mean_absolute_error: 24.7017 - accuracy: 0.0039 - val_loss: 20.3509 -
val_mean_absolute_error: 20.3509 - val_accuracy: 0.0000e+00
Epoch 69/300
508/508 [==============================] - 0s 222us/step - loss: 21.5445 -
mean_absolute_error: 21.5445 - accuracy: 0.0000e+00 - val_loss: 20.6848 -
val_mean_absolute_error: 20.6848 - val_accuracy: 0.0000e+00
Epoch 70/300
508/508 [==============================] - 0s 179us/step - loss: 23.1823 -
mean_absolute_error: 23.1823 - accuracy: 0.0000e+00 - val_loss: 23.6136 -
val_mean_absolute_error: 23.6136 - val_accuracy: 0.0000e+00
Epoch 71/300
508/508 [==============================] - 0s 183us/step - loss: 26.5154 -
mean_absolute_error: 26.5154 - accuracy: 0.0000e+00 - val_loss: 32.7400 -
val_mean_absolute_error: 32.7400 - val_accuracy: 0.0000e+00
Epoch 72/300
508/508 [==============================] - 0s 181us/step - loss: 25.2475 -
mean_absolute_error: 25.2475 - accuracy: 0.0020 - val_loss: 27.3841 -
val_mean_absolute_error: 27.3841 - val_accuracy: 0.0000e+00
Epoch 73/300
508/508 [==============================] - 0s 175us/step - loss: 34.4825 -
mean_absolute_error: 34.4825 - accuracy: 0.0000e+00 - val_loss: 29.4034 -
val_mean_absolute_error: 29.4034 - val_accuracy: 0.0000e+00
Epoch 74/300
508/508 [==============================] - 0s 171us/step - loss: 35.5387 -
mean_absolute_error: 35.5387 - accuracy: 0.0000e+00 - val_loss: 23.1395 -
```

```
val_mean_absolute_error: 23.1395 - val_accuracy: 0.0000e+00
Epoch 75/300
508/508 [==============================] - 0s 191us/step - loss: 29.8837 -
mean_absolute_error: 29.8837 - accuracy: 0.0000e+00 - val_loss: 27.7018 -
val_mean_absolute_error: 27.7018 - val_accuracy: 0.0000e+00
Epoch 76/300
508/508 [==============================] - 0s 175us/step - loss: 28.5896 -
mean_absolute_error: 28.5896 - accuracy: 0.0000e+00 - val_loss: 45.8562 -
val_mean_absolute_error: 45.8562 - val_accuracy: 0.0000e+00
Epoch 77/300
508/508 [==============================] - 0s 181us/step - loss: 32.2195 -
mean_absolute_error: 32.2194 - accuracy: 0.0000e+00 - val_loss: 43.4494 -
val_mean_absolute_error: 43.4494 - val_accuracy: 0.0000e+00
Epoch 78/300
508/508 [==============================] - 0s 179us/step - loss: 34.2325 -
mean_absolute_error: 34.2325 - accuracy: 0.0000e+00 - val_loss: 44.4159 -
val_mean_absolute_error: 44.4160 - val_accuracy: 0.0000e+00
Epoch 79/300
508/508 [==============================] - 0s 171us/step - loss: 31.4234 -
mean_absolute_error: 31.4234 - accuracy: 0.0000e+00 - val_loss: 19.1923 -
val_mean_absolute_error: 19.1923 - val_accuracy: 0.0000e+00
Epoch 80/300
508/508 [==============================] - 0s 226us/step - loss: 23.1135 -
mean_absolute_error: 23.1134 - accuracy: 0.0000e+00 - val_loss: 17.9016 -
val_mean_absolute_error: 17.9016 - val_accuracy: 0.0000e+00
Epoch 81/300
508/508 [==============================] - 0s 185us/step - loss: 22.3611 -
mean_absolute_error: 22.3611 - accuracy: 0.0000e+00 - val_loss: 19.9732 -
val_mean_absolute_error: 19.9732 - val_accuracy: 0.0078
Epoch 82/300
508/508 [==============================] - 0s 189us/step - loss: 28.3281 -
mean_absolute_error: 28.3281 - accuracy: 0.0000e+00 - val_loss: 16.1824 -
val_mean_absolute_error: 16.1824 - val_accuracy: 0.0000e+00
Epoch 83/300
508/508 [==============================] - 0s 207us/step - loss: 28.0378 -
mean_absolute_error: 28.0378 - accuracy: 0.0000e+00 - val_loss: 32.0509 -
val_mean_absolute_error: 32.0509 - val_accuracy: 0.0000e+00
Epoch 84/300
508/508 [==============================] - 0s 175us/step - loss: 23.6618 -
mean_absolute_error: 23.6618 - accuracy: 0.0000e+00 - val_loss: 16.9123 -
val_mean_absolute_error: 16.9123 - val_accuracy: 0.0000e+00
Epoch 85/300
508/508 [==============================] - 0s 189us/step - loss: 21.2422 -
mean_absolute_error: 21.2422 - accuracy: 0.0000e+00 - val_loss: 19.6489 -
val_mean_absolute_error: 19.6489 - val_accuracy: 0.0000e+00
Epoch 86/300
508/508 [==============================] - 0s 189us/step - loss: 23.2868 -
mean_absolute_error: 23.2868 - accuracy: 0.0000e+00 - val_loss: 19.8034 -
```

```
val_mean_absolute_error: 19.8034 - val_accuracy: 0.0000e+00
Epoch 87/300
508/508 [==============================] - 0s 183us/step - loss: 24.3014 -
mean_absolute_error: 24.3014 - accuracy: 0.0020 - val_loss: 21.8275 -
val_mean_absolute_error: 21.8275 - val_accuracy: 0.0000e+00
Epoch 88/300
508/508 [==============================] - 0s 177us/step - loss: 25.6675 -
mean_absolute_error: 25.6675 - accuracy: 0.0020 - val_loss: 29.3513 -
val_mean_absolute_error: 29.3513 - val_accuracy: 0.0000e+00
Epoch 89/300
508/508 [==============================] - 0s 189us/step - loss: 37.4534 -
mean_absolute_error: 37.4534 - accuracy: 0.0000e+00 - val_loss: 20.0664 -
val_mean_absolute_error: 20.0664 - val_accuracy: 0.0000e+00
Epoch 90/300
508/508 [==============================] - 0s 242us/step - loss: 28.5407 -
mean_absolute_error: 28.5407 - accuracy: 0.0000e+00 - val_loss: 26.3939 -
val_mean_absolute_error: 26.3939 - val_accuracy: 0.0000e+00
Epoch 91/300
508/508 [==============================] - 0s 207us/step - loss: 27.5629 -
mean_absolute_error: 27.5629 - accuracy: 0.0000e+00 - val_loss: 30.1785 -
val_mean_absolute_error: 30.1785 - val_accuracy: 0.0000e+00
Epoch 92/300
508/508 [==============================] - 0s 191us/step - loss: 23.9498 -
mean_absolute_error: 23.9498 - accuracy: 0.0000e+00 - val_loss: 23.7731 -
val_mean_absolute_error: 23.7731 - val_accuracy: 0.0000e+00
Epoch 93/300
508/508 [==============================] - 0s 264us/step - loss: 23.5533 -
mean_absolute_error: 23.5533 - accuracy: 0.0000e+00 - val_loss: 24.0712 -
val_mean_absolute_error: 24.0712 - val_accuracy: 0.0000e+00
Epoch 94/300
508/508 [==============================] - 0s 165us/step - loss: 25.9662 -
mean_absolute_error: 25.9662 - accuracy: 0.0000e+00 - val_loss: 27.7934 -
val_mean_absolute_error: 27.7934 - val_accuracy: 0.0000e+00
Epoch 95/300
508/508 [==============================] - 0s 155us/step - loss: 30.4477 -
mean_absolute_error: 30.4477 - accuracy: 0.0020 - val_loss: 27.2646 -
val_mean_absolute_error: 27.2646 - val_accuracy: 0.0078
Epoch 96/300
508/508 [==============================] - 0s 144us/step - loss: 21.9774 -
mean_absolute_error: 21.9774 - accuracy: 0.0000e+00 - val_loss: 19.9967 -
val_mean_absolute_error: 19.9967 - val_accuracy: 0.0000e+00
Epoch 97/300
508/508 [==============================] - 0s 134us/step - loss: 21.3902 -
mean_absolute_error: 21.3902 - accuracy: 0.0000e+00 - val_loss: 20.9186 -
val_mean_absolute_error: 20.9186 - val_accuracy: 0.0000e+00
Epoch 98/300
508/508 [==============================] - 0s 138us/step - loss: 25.2559 -
mean_absolute_error: 25.2559 - accuracy: 0.0000e+00 - val_loss: 17.8925 -
```

```
val_mean_absolute_error: 17.8925 - val_accuracy: 0.0000e+00
Epoch 99/300
508/508 [==============================] - 0s 138us/step - loss: 30.0392 -
mean_absolute_error: 30.0392 - accuracy: 0.0000e+00 - val_loss: 41.8757 -
val_mean_absolute_error: 41.8757 - val_accuracy: 0.0000e+00
Epoch 100/300
508/508 [==============================] - 0s 153us/step - loss: 31.6114 -
mean_absolute_error: 31.6114 - accuracy: 0.0000e+00 - val_loss: 28.2445 -
val_mean_absolute_error: 28.2445 - val_accuracy: 0.0000e+00
Epoch 101/300
508/508 [==============================] - 0s 179us/step - loss: 30.0732 -
mean_absolute_error: 30.0732 - accuracy: 0.0000e+00 - val_loss: 18.4913 -
val_mean_absolute_error: 18.4913 - val_accuracy: 0.0000e+00
Epoch 102/300
508/508 [==============================] - 0s 230us/step - loss: 20.5233 -
mean_absolute_error: 20.5233 - accuracy: 0.0000e+00 - val_loss: 18.1562 -
val_mean_absolute_error: 18.1562 - val_accuracy: 0.0000e+00
Epoch 103/300
508/508 [==============================] - 0s 169us/step - loss: 21.5891 -
mean_absolute_error: 21.5891 - accuracy: 0.0000e+00 - val_loss: 23.7701 -
val_mean_absolute_error: 23.7701 - val_accuracy: 0.0000e+00
Epoch 104/300
508/508 [==============================] - 0s 181us/step - loss: 21.0775 -
mean_absolute_error: 21.0775 - accuracy: 0.0039 - val_loss: 21.9630 -
val_mean_absolute_error: 21.9630 - val_accuracy: 0.0000e+00
Epoch 105/300
508/508 [==============================] - 0s 185us/step - loss: 23.0975 -
mean_absolute_error: 23.0975 - accuracy: 0.0000e+00 - val_loss: 20.3885 -
val_mean_absolute_error: 20.3885 - val_accuracy: 0.0000e+00
Epoch 106/300
508/508 [==============================] - 0s 214us/step - loss: 20.9668 -
mean_absolute_error: 20.9668 - accuracy: 0.0000e+00 - val_loss: 15.8566 -
val_mean_absolute_error: 15.8566 - val_accuracy: 0.0000e+00
Epoch 107/300
508/508 [==============================] - 0s 270us/step - loss: 22.1458 -
mean_absolute_error: 22.1458 - accuracy: 0.0000e+00 - val_loss: 16.9467 -
val_mean_absolute_error: 16.9467 - val_accuracy: 0.0000e+00
Epoch 108/300
508/508 [==============================] - 0s 211us/step - loss: 21.4273 -
mean_absolute_error: 21.4273 - accuracy: 0.0000e+00 - val_loss: 22.1274 -
val_mean_absolute_error: 22.1274 - val_accuracy: 0.0000e+00
Epoch 109/300
508/508 [==============================] - 0s 169us/step - loss: 23.9334 -
mean_absolute_error: 23.9334 - accuracy: 0.0000e+00 - val_loss: 18.6803 -
val_mean_absolute_error: 18.6803 - val_accuracy: 0.0000e+00
Epoch 110/300
508/508 [==============================] - 0s 179us/step - loss: 21.5389 -
mean_absolute_error: 21.5389 - accuracy: 0.0000e+00 - val_loss: 26.9027 -
```

```
val_mean_absolute_error: 26.9027 - val_accuracy: 0.0000e+00
Epoch 111/300
508/508 [==============================] - 0s 185us/step - loss: 23.4557 -
mean_absolute_error: 23.4557 - accuracy: 0.0000e+00 - val_loss: 21.3801 -
val_mean_absolute_error: 21.3801 - val_accuracy: 0.0000e+00
Epoch 112/300
508/508 [==============================] - 0s 220us/step - loss: 22.6386 -
mean_absolute_error: 22.6386 - accuracy: 0.0000e+00 - val_loss: 16.7156 -
val_mean_absolute_error: 16.7156 - val_accuracy: 0.0000e+00
Epoch 113/300
508/508 [==============================] - 0s 191us/step - loss: 19.7191 -
mean_absolute_error: 19.7191 - accuracy: 0.0000e+00 - val_loss: 18.5050 -
val_mean_absolute_error: 18.5050 - val_accuracy: 0.0000e+00
Epoch 114/300
508/508 [==============================] - 0s 151us/step - loss: 20.7219 -
mean_absolute_error: 20.7219 - accuracy: 0.0000e+00 - val_loss: 15.5715 -
val_mean_absolute_error: 15.5715 - val_accuracy: 0.0000e+00
Epoch 115/300
508/508 [==============================] - 0s 159us/step - loss: 21.5813 -
mean_absolute_error: 21.5813 - accuracy: 0.0000e+00 - val_loss: 16.6692 -
val_mean_absolute_error: 16.6692 - val_accuracy: 0.0000e+00
Epoch 116/300
508/508 [==============================] - 0s 163us/step - loss: 27.6409 -
mean_absolute_error: 27.6409 - accuracy: 0.0000e+00 - val_loss: 26.8674 -
val_mean_absolute_error: 26.8674 - val_accuracy: 0.0000e+00
Epoch 117/300
508/508 [==============================] - 0s 163us/step - loss: 28.0660 -
mean_absolute_error: 28.0660 - accuracy: 0.0000e+00 - val_loss: 16.2209 -
val_mean_absolute_error: 16.2209 - val_accuracy: 0.0000e+00
Epoch 118/300
508/508 [==============================] - 0s 161us/step - loss: 22.8826 -
mean_absolute_error: 22.8826 - accuracy: 0.0000e+00 - val_loss: 16.6801 -
val_mean_absolute_error: 16.6801 - val_accuracy: 0.0000e+00
Epoch 119/300
508/508 [==============================] - 0s 157us/step - loss: 23.7309 -
mean_absolute_error: 23.7309 - accuracy: 0.0020 - val_loss: 26.3707 -
val_mean_absolute_error: 26.3707 - val_accuracy: 0.0078
Epoch 120/300
508/508 [==============================] - 0s 175us/step - loss: 23.1157 -
mean_absolute_error: 23.1157 - accuracy: 0.0000e+00 - val_loss: 19.5136 -
val_mean_absolute_error: 19.5136 - val_accuracy: 0.0000e+00
Epoch 121/300
508/508 [==============================] - 0s 173us/step - loss: 20.9493 -
mean_absolute_error: 20.9493 - accuracy: 0.0020 - val_loss: 17.1224 -
val_mean_absolute_error: 17.1224 - val_accuracy: 0.0000e+00
Epoch 122/300
508/508 [==============================] - 0s 187us/step - loss: 23.4962 -
mean_absolute_error: 23.4962 - accuracy: 0.0020 - val_loss: 27.1701 -
```

```
val_mean_absolute_error: 27.1701 - val_accuracy: 0.0000e+00
Epoch 123/300
508/508 [==============================] - 0s 163us/step - loss: 26.2785 -
mean_absolute_error: 26.2785 - accuracy: 0.0000e+00 - val_loss: 21.9882 -
val_mean_absolute_error: 21.9882 - val_accuracy: 0.0000e+00
Epoch 124/300
508/508 [==============================] - 0s 220us/step - loss: 21.6805 -
mean_absolute_error: 21.6805 - accuracy: 0.0000e+00 - val_loss: 24.3407 -
val_mean_absolute_error: 24.3407 - val_accuracy: 0.0000e+00
Epoch 125/300
508/508 [==============================] - 0s 157us/step - loss: 22.8391 -
mean_absolute_error: 22.8391 - accuracy: 0.0000e+00 - val_loss: 22.8309 -
val_mean_absolute_error: 22.8309 - val_accuracy: 0.0000e+00
Epoch 126/300
508/508 [==============================] - 0s 155us/step - loss: 21.5230 -
mean_absolute_error: 21.5230 - accuracy: 0.0000e+00 - val_loss: 18.6525 -
val_mean_absolute_error: 18.6525 - val_accuracy: 0.0000e+00
Epoch 127/300
508/508 [==============================] - 0s 175us/step - loss: 23.6750 -
mean_absolute_error: 23.6750 - accuracy: 0.0000e+00 - val_loss: 18.0117 -
val_mean_absolute_error: 18.0117 - val_accuracy: 0.0000e+00
Epoch 128/300
508/508 [==============================] - 0s 173us/step - loss: 19.4294 -
mean_absolute_error: 19.4294 - accuracy: 0.0020 - val_loss: 21.6146 -
val_mean_absolute_error: 21.6146 - val_accuracy: 0.0000e+00
Epoch 129/300
508/508 [==============================] - 0s 177us/step - loss: 22.2426 -
mean_absolute_error: 22.2426 - accuracy: 0.0000e+00 - val_loss: 22.2685 -
val_mean_absolute_error: 22.2685 - val_accuracy: 0.0000e+00
Epoch 130/300
508/508 [==============================] - 0s 171us/step - loss: 22.8613 -
mean_absolute_error: 22.8613 - accuracy: 0.0020 - val_loss: 21.7269 -
val_mean_absolute_error: 21.7269 - val_accuracy: 0.0000e+00
Epoch 131/300
508/508 [==============================] - 0s 175us/step - loss: 22.2211 -
mean_absolute_error: 22.2211 - accuracy: 0.0000e+00 - val_loss: 18.7210 -
val_mean_absolute_error: 18.7210 - val_accuracy: 0.0000e+00
Epoch 132/300
508/508 [==============================] - 0s 179us/step - loss: 20.8424 -
mean_absolute_error: 20.8424 - accuracy: 0.0000e+00 - val_loss: 17.2326 -
val_mean_absolute_error: 17.2326 - val_accuracy: 0.0000e+00
Epoch 133/300
508/508 [==============================] - 0s 173us/step - loss: 19.5776 -
mean_absolute_error: 19.5776 - accuracy: 0.0000e+00 - val_loss: 14.8658 -
val_mean_absolute_error: 14.8658 - val_accuracy: 0.0000e+00
Epoch 134/300
508/508 [==============================] - 0s 171us/step - loss: 19.6180 -
mean_absolute_error: 19.6180 - accuracy: 0.0000e+00 - val_loss: 19.4449 -
```

```
val_mean_absolute_error: 19.4449 - val_accuracy: 0.0000e+00
Epoch 135/300
508/508 [==============================] - 0s 205us/step - loss: 24.2382 -
mean_absolute_error: 24.2382 - accuracy: 0.0000e+00 - val_loss: 20.1839 -
val_mean_absolute_error: 20.1839 - val_accuracy: 0.0000e+00
Epoch 136/300
508/508 [==============================] - 0s 181us/step - loss: 21.8376 -
mean_absolute_error: 21.8376 - accuracy: 0.0000e+00 - val_loss: 32.4816 -
val_mean_absolute_error: 32.4816 - val_accuracy: 0.0000e+00
Epoch 137/300
508/508 [==============================] - 0s 171us/step - loss: 28.6678 -
mean_absolute_error: 28.6678 - accuracy: 0.0000e+00 - val_loss: 22.3352 -
val_mean_absolute_error: 22.3352 - val_accuracy: 0.0000e+00
Epoch 138/300
508/508 [==============================] - 0s 157us/step - loss: 25.4471 -
mean_absolute_error: 25.4471 - accuracy: 0.0020 - val_loss: 17.1650 -
val_mean_absolute_error: 17.1650 - val_accuracy: 0.0000e+00
Epoch 139/300
508/508 [==============================] - 0s 171us/step - loss: 20.8280 -
mean_absolute_error: 20.8280 - accuracy: 0.0020 - val_loss: 22.1439 -
val_mean_absolute_error: 22.1439 - val_accuracy: 0.0000e+00
Epoch 140/300
508/508 [==============================] - 0s 169us/step - loss: 27.1665 -
mean_absolute_error: 27.1665 - accuracy: 0.0000e+00 - val_loss: 28.9751 -
val_mean_absolute_error: 28.9751 - val_accuracy: 0.0078
Epoch 141/300
508/508 [==============================] - 0s 177us/step - loss: 26.7340 -
mean_absolute_error: 26.7340 - accuracy: 0.0020 - val_loss: 23.0163 -
val_mean_absolute_error: 23.0163 - val_accuracy: 0.0000e+00
Epoch 142/300
508/508 [==============================] - 0s 161us/step - loss: 26.0527 -
mean_absolute_error: 26.0527 - accuracy: 0.0000e+00 - val_loss: 20.5708 -
val_mean_absolute_error: 20.5708 - val_accuracy: 0.0078
Epoch 143/300
508/508 [==============================] - 0s 171us/step - loss: 21.2639 -
mean_absolute_error: 21.2639 - accuracy: 0.0000e+00 - val_loss: 20.4441 -
val_mean_absolute_error: 20.4441 - val_accuracy: 0.0000e+00
Epoch 144/300
508/508 [==============================] - 0s 179us/step - loss: 20.6632 -
mean_absolute_error: 20.6632 - accuracy: 0.0000e+00 - val_loss: 22.4899 -
val_mean_absolute_error: 22.4899 - val_accuracy: 0.0000e+00
Epoch 145/300
508/508 [==============================] - 0s 165us/step - loss: 23.6253 -
mean_absolute_error: 23.6253 - accuracy: 0.0000e+00 - val_loss: 22.0584 -
val_mean_absolute_error: 22.0584 - val_accuracy: 0.0000e+00
Epoch 146/300
508/508 [==============================] - 0s 161us/step - loss: 21.0968 -
mean_absolute_error: 21.0968 - accuracy: 0.0020 - val_loss: 18.8466 -
```

```
val_mean_absolute_error: 18.8466 - val_accuracy: 0.0000e+00
Epoch 147/300
508/508 [==============================] - 0s 214us/step - loss: 21.8380 -
mean_absolute_error: 21.8380 - accuracy: 0.0000e+00 - val_loss: 17.1053 -
val_mean_absolute_error: 17.1053 - val_accuracy: 0.0000e+00
Epoch 148/300
508/508 [==============================] - 0s 173us/step - loss: 22.3411 -
mean_absolute_error: 22.3411 - accuracy: 0.0000e+00 - val_loss: 22.0281 -
val_mean_absolute_error: 22.0281 - val_accuracy: 0.0000e+00
Epoch 149/300
508/508 [==============================] - 0s 173us/step - loss: 26.8098 -
mean_absolute_error: 26.8098 - accuracy: 0.0000e+00 - val_loss: 17.0555 -
val_mean_absolute_error: 17.0555 - val_accuracy: 0.0000e+00
Epoch 150/300
508/508 [==============================] - 0s 169us/step - loss: 29.6735 -
mean_absolute_error: 29.6735 - accuracy: 0.0000e+00 - val_loss: 36.6047 -
val_mean_absolute_error: 36.6047 - val_accuracy: 0.0000e+00
Epoch 151/300
508/508 [==============================] - 0s 159us/step - loss: 26.8370 -
mean_absolute_error: 26.8370 - accuracy: 0.0020 - val_loss: 25.2065 -
val_mean_absolute_error: 25.2065 - val_accuracy: 0.0000e+00
Epoch 152/300
508/508 [==============================] - 0s 179us/step - loss: 31.7308 -
mean_absolute_error: 31.7308 - accuracy: 0.0000e+00 - val_loss: 31.6392 -
val_mean_absolute_error: 31.6392 - val_accuracy: 0.0000e+00
Epoch 153/300
508/508 [==============================] - 0s 167us/step - loss: 26.9697 -
mean_absolute_error: 26.9697 - accuracy: 0.0000e+00 - val_loss: 20.4652 -
val_mean_absolute_error: 20.4652 - val_accuracy: 0.0000e+00
Epoch 154/300
508/508 [==============================] - 0s 169us/step - loss: 24.1889 -
mean_absolute_error: 24.1889 - accuracy: 0.0000e+00 - val_loss: 14.5284 -
val_mean_absolute_error: 14.5284 - val_accuracy: 0.0000e+00
Epoch 155/300
508/508 [==============================] - 0s 167us/step - loss: 18.7343 -
mean_absolute_error: 18.7343 - accuracy: 0.0000e+00 - val_loss: 15.8465 -
val_mean_absolute_error: 15.8465 - val_accuracy: 0.0000e+00
Epoch 156/300
508/508 [==============================] - 0s 163us/step - loss: 20.1323 -
mean_absolute_error: 20.1323 - accuracy: 0.0000e+00 - val_loss: 21.6535 -
val_mean_absolute_error: 21.6535 - val_accuracy: 0.0000e+00
Epoch 157/300
508/508 [==============================] - 0s 173us/step - loss: 21.7785 -
mean_absolute_error: 21.7785 - accuracy: 0.0020 - val_loss: 14.8934 -
val_mean_absolute_error: 14.8934 - val_accuracy: 0.0000e+00
Epoch 158/300
508/508 [==============================] - 0s 175us/step - loss: 26.0230 -
mean_absolute_error: 26.0230 - accuracy: 0.0020 - val_loss: 30.5354 -
```

```
val_mean_absolute_error: 30.5354 - val_accuracy: 0.0000e+00
Epoch 159/300
508/508 [==============================] - 0s 216us/step - loss: 32.2251 -
mean_absolute_error: 32.2251 - accuracy: 0.0000e+00 - val_loss: 15.4765 -
val_mean_absolute_error: 15.4765 - val_accuracy: 0.0000e+00
Epoch 160/300
508/508 [==============================] - 0s 151us/step - loss: 24.5340 -
mean_absolute_error: 24.5340 - accuracy: 0.0000e+00 - val_loss: 34.1500 -
val_mean_absolute_error: 34.1500 - val_accuracy: 0.0000e+00
Epoch 161/300
508/508 [==============================] - 0s 159us/step - loss: 24.7920 -
mean_absolute_error: 24.7920 - accuracy: 0.0000e+00 - val_loss: 31.1073 -
val_mean_absolute_error: 31.1073 - val_accuracy: 0.0000e+00
Epoch 162/300
508/508 [==============================] - 0s 157us/step - loss: 24.1297 -
mean_absolute_error: 24.1297 - accuracy: 0.0000e+00 - val_loss: 20.3864 -
val_mean_absolute_error: 20.3864 - val_accuracy: 0.0000e+00
Epoch 163/300
508/508 [==============================] - 0s 165us/step - loss: 20.1794 -
mean_absolute_error: 20.1794 - accuracy: 0.0020 - val_loss: 14.8365 -
val_mean_absolute_error: 14.8365 - val_accuracy: 0.0000e+00
Epoch 164/300
508/508 [==============================] - 0s 185us/step - loss: 27.5024 -
mean_absolute_error: 27.5024 - accuracy: 0.0000e+00 - val_loss: 30.7363 -
val_mean_absolute_error: 30.7363 - val_accuracy: 0.0000e+00
Epoch 165/300
508/508 [==============================] - 0s 161us/step - loss: 22.9711 -
mean_absolute_error: 22.9711 - accuracy: 0.0000e+00 - val_loss: 25.2027 -
val_mean_absolute_error: 25.2027 - val_accuracy: 0.0000e+00
Epoch 166/300
508/508 [==============================] - 0s 169us/step - loss: 24.4249 -
mean_absolute_error: 24.4249 - accuracy: 0.0000e+00 - val_loss: 21.4920 -
val_mean_absolute_error: 21.4920 - val_accuracy: 0.0000e+00
Epoch 167/300
508/508 [==============================] - 0s 169us/step - loss: 21.2193 -
mean_absolute_error: 21.2193 - accuracy: 0.0020 - val_loss: 17.1850 -
val_mean_absolute_error: 17.1850 - val_accuracy: 0.0000e+00
Epoch 168/300
508/508 [==============================] - 0s 171us/step - loss: 23.3558 -
mean_absolute_error: 23.3558 - accuracy: 0.0000e+00 - val_loss: 29.9646 -
val_mean_absolute_error: 29.9646 - val_accuracy: 0.0000e+00
Epoch 169/300
508/508 [==============================] - 0s 179us/step - loss: 21.4862 -
mean_absolute_error: 21.4862 - accuracy: 0.0020 - val_loss: 20.1131 -
val_mean_absolute_error: 20.1131 - val_accuracy: 0.0000e+00
Epoch 170/300
508/508 [==============================] - 0s 228us/step - loss: 17.7400 -
mean_absolute_error: 17.7400 - accuracy: 0.0000e+00 - val_loss: 14.6047 -
```

```
val_mean_absolute_error: 14.6047 - val_accuracy: 0.0000e+00
Epoch 171/300
508/508 [==============================] - 0s 155us/step - loss: 20.0293 -
mean_absolute_error: 20.0293 - accuracy: 0.0020 - val_loss: 23.0551 -
val_mean_absolute_error: 23.0551 - val_accuracy: 0.0000e+00
Epoch 172/300
508/508 [==============================] - 0s 161us/step - loss: 18.5875 -
mean_absolute_error: 18.5875 - accuracy: 0.0000e+00 - val_loss: 17.6383 -
val_mean_absolute_error: 17.6383 - val_accuracy: 0.0000e+00
Epoch 173/300
508/508 [==============================] - 0s 167us/step - loss: 22.4593 -
mean_absolute_error: 22.4593 - accuracy: 0.0000e+00 - val_loss: 32.0061 -
val_mean_absolute_error: 32.0061 - val_accuracy: 0.0000e+00
Epoch 174/300
508/508 [==============================] - 0s 167us/step - loss: 27.4382 -
mean_absolute_error: 27.4382 - accuracy: 0.0000e+00 - val_loss: 17.5806 -
val_mean_absolute_error: 17.5806 - val_accuracy: 0.0000e+00
Epoch 175/300
508/508 [==============================] - 0s 193us/step - loss: 24.3175 -
mean_absolute_error: 24.3175 - accuracy: 0.0020 - val_loss: 19.4167 -
val_mean_absolute_error: 19.4167 - val_accuracy: 0.0000e+00
Epoch 176/300
508/508 [==============================] - 0s 169us/step - loss: 21.3748 -
mean_absolute_error: 21.3748 - accuracy: 0.0000e+00 - val_loss: 18.9597 -
val_mean_absolute_error: 18.9597 - val_accuracy: 0.0000e+00
Epoch 177/300
508/508 [==============================] - 0s 167us/step - loss: 23.1385 -
mean_absolute_error: 23.1385 - accuracy: 0.0000e+00 - val_loss: 18.2914 -
val_mean_absolute_error: 18.2914 - val_accuracy: 0.0000e+00
Epoch 178/300
508/508 [==============================] - 0s 165us/step - loss: 21.3747 -
mean_absolute_error: 21.3747 - accuracy: 0.0000e+00 - val_loss: 15.7224 -
val_mean_absolute_error: 15.7224 - val_accuracy: 0.0000e+00
Epoch 179/300
508/508 [==============================] - 0s 177us/step - loss: 19.6590 -
mean_absolute_error: 19.6590 - accuracy: 0.0000e+00 - val_loss: 22.6040 -
val_mean_absolute_error: 22.6040 - val_accuracy: 0.0078
Epoch 180/300
508/508 [==============================] - 0s 189us/step - loss: 21.9546 -
mean_absolute_error: 21.9546 - accuracy: 0.0000e+00 - val_loss: 17.5045 -
val_mean_absolute_error: 17.5045 - val_accuracy: 0.0000e+00
Epoch 181/300
508/508 [==============================] - 0s 169us/step - loss: 21.8897 -
mean_absolute_error: 21.8897 - accuracy: 0.0000e+00 - val_loss: 25.9155 -
val_mean_absolute_error: 25.9155 - val_accuracy: 0.0000e+00
Epoch 182/300
508/508 [==============================] - 0s 201us/step - loss: 23.5540 -
mean_absolute_error: 23.5540 - accuracy: 0.0000e+00 - val_loss: 30.0185 -
```

```
val_mean_absolute_error: 30.0185 - val_accuracy: 0.0000e+00
Epoch 183/300
508/508 [==============================] - 0s 163us/step - loss: 21.0227 -
mean_absolute_error: 21.0227 - accuracy: 0.0000e+00 - val_loss: 15.9648 -
val_mean_absolute_error: 15.9648 - val_accuracy: 0.0000e+00
Epoch 184/300
508/508 [==============================] - 0s 171us/step - loss: 21.9994 -
mean_absolute_error: 21.9994 - accuracy: 0.0000e+00 - val_loss: 18.6689 -
val_mean_absolute_error: 18.6689 - val_accuracy: 0.0000e+00
Epoch 185/300
508/508 [==============================] - 0s 197us/step - loss: 23.3700 -
mean_absolute_error: 23.3700 - accuracy: 0.0000e+00 - val_loss: 23.0063 -
val_mean_absolute_error: 23.0063 - val_accuracy: 0.0000e+00
Epoch 186/300
508/508 [==============================] - 0s 165us/step - loss: 28.5820 -
mean_absolute_error: 28.5820 - accuracy: 0.0000e+00 - val_loss: 55.1959 -
val_mean_absolute_error: 55.1959 - val_accuracy: 0.0000e+00
Epoch 187/300
508/508 [==============================] - 0s 161us/step - loss: 43.8857 -
mean_absolute_error: 43.8857 - accuracy: 0.0000e+00 - val_loss: 29.3755 -
val_mean_absolute_error: 29.3755 - val_accuracy: 0.0000e+00
Epoch 188/300
508/508 [==============================] - 0s 175us/step - loss: 28.2435 -
mean_absolute_error: 28.2435 - accuracy: 0.0000e+00 - val_loss: 17.6976 -
val_mean_absolute_error: 17.6976 - val_accuracy: 0.0000e+00
Epoch 189/300
508/508 [==============================] - 0s 151us/step - loss: 29.7244 -
mean_absolute_error: 29.7244 - accuracy: 0.0000e+00 - val_loss: 18.1495 -
val_mean_absolute_error: 18.1495 - val_accuracy: 0.0000e+00
Epoch 190/300
508/508 [==============================] - 0s 165us/step - loss: 22.4289 -
mean_absolute_error: 22.4289 - accuracy: 0.0000e+00 - val_loss: 15.8286 -
val_mean_absolute_error: 15.8286 - val_accuracy: 0.0078
Epoch 191/300
508/508 [==============================] - 0s 171us/step - loss: 18.3384 -
mean_absolute_error: 18.3384 - accuracy: 0.0000e+00 - val_loss: 22.4548 -
val_mean_absolute_error: 22.4548 - val_accuracy: 0.0000e+00
Epoch 192/300
508/508 [==============================] - 0s 181us/step - loss: 24.1195 -
mean_absolute_error: 24.1195 - accuracy: 0.0000e+00 - val_loss: 15.5953 -
val_mean_absolute_error: 15.5953 - val_accuracy: 0.0000e+00
Epoch 193/300
508/508 [==============================] - 0s 222us/step - loss: 21.0634 -
mean_absolute_error: 21.0634 - accuracy: 0.0000e+00 - val_loss: 27.0708 -
val_mean_absolute_error: 27.0708 - val_accuracy: 0.0000e+00
Epoch 194/300
508/508 [==============================] - 0s 179us/step - loss: 23.0001 -
mean_absolute_error: 23.0001 - accuracy: 0.0000e+00 - val_loss: 20.2095 -
```

```
val_mean_absolute_error: 20.2095 - val_accuracy: 0.0000e+00
Epoch 195/300
508/508 [==============================] - 0s 165us/step - loss: 20.2654 -
mean_absolute_error: 20.2654 - accuracy: 0.0020 - val_loss: 16.5034 -
val_mean_absolute_error: 16.5034 - val_accuracy: 0.0000e+00
Epoch 196/300
508/508 [==============================] - 0s 177us/step - loss: 20.0564 -
mean_absolute_error: 20.0564 - accuracy: 0.0000e+00 - val_loss: 19.4761 -
val_mean_absolute_error: 19.4761 - val_accuracy: 0.0000e+00
Epoch 197/300
508/508 [==============================] - 0s 167us/step - loss: 23.1663 -
mean_absolute_error: 23.1663 - accuracy: 0.0000e+00 - val_loss: 34.2666 -
val_mean_absolute_error: 34.2666 - val_accuracy: 0.0000e+00
Epoch 198/300
508/508 [==============================] - 0s 157us/step - loss: 28.3439 -
mean_absolute_error: 28.3439 - accuracy: 0.0000e+00 - val_loss: 29.0130 -
val_mean_absolute_error: 29.0130 - val_accuracy: 0.0000e+00
Epoch 199/300
508/508 [==============================] - 0s 175us/step - loss: 23.1440 -
mean_absolute_error: 23.1440 - accuracy: 0.0000e+00 - val_loss: 22.7874 -
val_mean_absolute_error: 22.7874 - val_accuracy: 0.0000e+00
Epoch 200/300
508/508 [==============================] - 0s 207us/step - loss: 19.5921 -
mean_absolute_error: 19.5921 - accuracy: 0.0000e+00 - val_loss: 21.0412 -
val_mean_absolute_error: 21.0412 - val_accuracy: 0.0000e+00
Epoch 201/300
508/508 [==============================] - 0s 167us/step - loss: 20.3109 -
mean_absolute_error: 20.3109 - accuracy: 0.0000e+00 - val_loss: 19.5569 -
val_mean_absolute_error: 19.5569 - val_accuracy: 0.0000e+00
Epoch 202/300
508/508 [==============================] - 0s 163us/step - loss: 20.5013 -
mean_absolute_error: 20.5013 - accuracy: 0.0000e+00 - val_loss: 22.5770 -
val_mean_absolute_error: 22.5770 - val_accuracy: 0.0000e+00
Epoch 203/300
508/508 [==============================] - 0s 175us/step - loss: 26.7398 -
mean_absolute_error: 26.7398 - accuracy: 0.0000e+00 - val_loss: 31.1589 -
val_mean_absolute_error: 31.1589 - val_accuracy: 0.0000e+00
Epoch 204/300
508/508 [==============================] - 0s 197us/step - loss: 20.2761 -
mean_absolute_error: 20.2761 - accuracy: 0.0000e+00 - val_loss: 13.5108 -
val_mean_absolute_error: 13.5108 - val_accuracy: 0.0000e+00
Epoch 205/300
508/508 [==============================] - 0s 191us/step - loss: 22.7943 -
mean_absolute_error: 22.7943 - accuracy: 0.0000e+00 - val_loss: 29.3507 -
val_mean_absolute_error: 29.3507 - val_accuracy: 0.0000e+00
Epoch 206/300
508/508 [==============================] - 0s 201us/step - loss: 25.3277 -
mean_absolute_error: 25.3277 - accuracy: 0.0000e+00 - val_loss: 20.7778 -
```

```
val_mean_absolute_error: 20.7778 - val_accuracy: 0.0000e+00
Epoch 207/300
508/508 [==============================] - 0s 175us/step - loss: 23.4946 -
mean_absolute_error: 23.4946 - accuracy: 0.0020 - val_loss: 17.2507 -
val_mean_absolute_error: 17.2507 - val_accuracy: 0.0000e+00
Epoch 208/300
508/508 [==============================] - 0s 179us/step - loss: 20.4094 -
mean_absolute_error: 20.4094 - accuracy: 0.0020 - val_loss: 19.1462 -
val_mean_absolute_error: 19.1462 - val_accuracy: 0.0000e+00
Epoch 209/300
508/508 [==============================] - 0s 148us/step - loss: 20.5179 -
mean_absolute_error: 20.5178 - accuracy: 0.0000e+00 - val_loss: 23.8654 -
val_mean_absolute_error: 23.8654 - val_accuracy: 0.0000e+00
Epoch 210/300
508/508 [==============================] - 0s 175us/step - loss: 19.6639 -
mean_absolute_error: 19.6639 - accuracy: 0.0000e+00 - val_loss: 17.9909 -
val_mean_absolute_error: 17.9909 - val_accuracy: 0.0000e+00
Epoch 211/300
508/508 [==============================] - 0s 185us/step - loss: 16.8997 -
mean_absolute_error: 16.8997 - accuracy: 0.0000e+00 - val_loss: 15.1579 -
val_mean_absolute_error: 15.1579 - val_accuracy: 0.0000e+00
Epoch 212/300
508/508 [==============================] - 0s 175us/step - loss: 18.6861 -
mean_absolute_error: 18.6861 - accuracy: 0.0000e+00 - val_loss: 14.5662 -
val_mean_absolute_error: 14.5662 - val_accuracy: 0.0000e+00
Epoch 213/300
508/508 [==============================] - 0s 167us/step - loss: 19.7528 -
mean_absolute_error: 19.7528 - accuracy: 0.0000e+00 - val_loss: 19.0911 -
val_mean_absolute_error: 19.0911 - val_accuracy: 0.0000e+00
Epoch 214/300
508/508 [==============================] - 0s 169us/step - loss: 21.5773 -
mean_absolute_error: 21.5773 - accuracy: 0.0020 - val_loss: 24.1836 -
val_mean_absolute_error: 24.1836 - val_accuracy: 0.0000e+00
Epoch 215/300
508/508 [==============================] - 0s 185us/step - loss: 27.6835 -
mean_absolute_error: 27.6835 - accuracy: 0.0000e+00 - val_loss: 26.8559 -
val_mean_absolute_error: 26.8559 - val_accuracy: 0.0000e+00
Epoch 216/300
508/508 [==============================] - 0s 238us/step - loss: 22.2730 -
mean_absolute_error: 22.2730 - accuracy: 0.0000e+00 - val_loss: 26.3108 -
val_mean_absolute_error: 26.3108 - val_accuracy: 0.0000e+00
Epoch 217/300
508/508 [==============================] - 0s 185us/step - loss: 24.6446 -
mean_absolute_error: 24.6446 - accuracy: 0.0000e+00 - val_loss: 22.3968 -
val_mean_absolute_error: 22.3968 - val_accuracy: 0.0000e+00
Epoch 218/300
508/508 [==============================] - 0s 177us/step - loss: 16.9555 -
mean_absolute_error: 16.9555 - accuracy: 0.0020 - val_loss: 27.9198 -
```

```
val_mean_absolute_error: 27.9198 - val_accuracy: 0.0000e+00
Epoch 219/300
508/508 [==============================] - 0s 171us/step - loss: 22.8844 -
mean_absolute_error: 22.8844 - accuracy: 0.0000e+00 - val_loss: 21.8492 -
val_mean_absolute_error: 21.8492 - val_accuracy: 0.0000e+00
Epoch 220/300
508/508 [==============================] - 0s 171us/step - loss: 22.9913 -
mean_absolute_error: 22.9913 - accuracy: 0.0000e+00 - val_loss: 16.4419 -
val_mean_absolute_error: 16.4419 - val_accuracy: 0.0000e+00
Epoch 221/300
508/508 [==============================] - 0s 183us/step - loss: 30.2753 -
mean_absolute_error: 30.2753 - accuracy: 0.0000e+00 - val_loss: 33.4211 -
val_mean_absolute_error: 33.4211 - val_accuracy: 0.0000e+00
Epoch 222/300
508/508 [==============================] - 0s 181us/step - loss: 27.8253 -
mean_absolute_error: 27.8253 - accuracy: 0.0000e+00 - val_loss: 21.9337 -
val_mean_absolute_error: 21.9337 - val_accuracy: 0.0000e+00
Epoch 223/300
508/508 [==============================] - 0s 165us/step - loss: 34.5146 -
mean_absolute_error: 34.5146 - accuracy: 0.0000e+00 - val_loss: 29.0819 -
val_mean_absolute_error: 29.0819 - val_accuracy: 0.0000e+00
Epoch 224/300
508/508 [==============================] - 0s 157us/step - loss: 30.3678 -
mean_absolute_error: 30.3678 - accuracy: 0.0000e+00 - val_loss: 18.1530 -
val_mean_absolute_error: 18.1530 - val_accuracy: 0.0000e+00
Epoch 225/300
508/508 [==============================] - 0s 187us/step - loss: 21.7916 -
mean_absolute_error: 21.7916 - accuracy: 0.0020 - val_loss: 19.6744 -
val_mean_absolute_error: 19.6744 - val_accuracy: 0.0078
Epoch 226/300
508/508 [==============================] - 0s 165us/step - loss: 20.5611 -
mean_absolute_error: 20.5611 - accuracy: 0.0020 - val_loss: 17.4323 -
val_mean_absolute_error: 17.4323 - val_accuracy: 0.0000e+00
Epoch 227/300
508/508 [==============================] - 0s 232us/step - loss: 24.2641 -
mean_absolute_error: 24.2641 - accuracy: 0.0000e+00 - val_loss: 30.6635 -
val_mean_absolute_error: 30.6635 - val_accuracy: 0.0000e+00
Epoch 228/300
508/508 [==============================] - 0s 191us/step - loss: 24.7274 -
mean_absolute_error: 24.7274 - accuracy: 0.0000e+00 - val_loss: 25.9454 -
val_mean_absolute_error: 25.9454 - val_accuracy: 0.0000e+00
Epoch 229/300
508/508 [==============================] - 0s 171us/step - loss: 25.2667 -
mean_absolute_error: 25.2667 - accuracy: 0.0000e+00 - val_loss: 21.9599 -
val_mean_absolute_error: 21.9599 - val_accuracy: 0.0000e+00
Epoch 230/300
508/508 [==============================] - 0s 173us/step - loss: 20.5933 -
mean_absolute_error: 20.5933 - accuracy: 0.0000e+00 - val_loss: 21.8172 -
```

```
val_mean_absolute_error: 21.8172 - val_accuracy: 0.0000e+00
Epoch 231/300
508/508 [==============================] - 0s 179us/step - loss: 18.9619 -
mean_absolute_error: 18.9619 - accuracy: 0.0000e+00 - val_loss: 18.7086 -
val_mean_absolute_error: 18.7086 - val_accuracy: 0.0000e+00
Epoch 232/300
508/508 [==============================] - 0s 165us/step - loss: 17.2223 -
mean_absolute_error: 17.2223 - accuracy: 0.0000e+00 - val_loss: 15.8454 -
val_mean_absolute_error: 15.8454 - val_accuracy: 0.0000e+00
Epoch 233/300
508/508 [==============================] - 0s 171us/step - loss: 16.1719 -
mean_absolute_error: 16.1719 - accuracy: 0.0039 - val_loss: 14.8643 -
val_mean_absolute_error: 14.8643 - val_accuracy: 0.0000e+00
Epoch 234/300
508/508 [==============================] - 0s 181us/step - loss: 18.6676 -
mean_absolute_error: 18.6676 - accuracy: 0.0020 - val_loss: 14.2400 -
val_mean_absolute_error: 14.2400 - val_accuracy: 0.0000e+00
Epoch 235/300
508/508 [==============================] - 0s 171us/step - loss: 20.1890 -
mean_absolute_error: 20.1890 - accuracy: 0.0020 - val_loss: 20.2904 -
val_mean_absolute_error: 20.2904 - val_accuracy: 0.0000e+00
Epoch 236/300
508/508 [==============================] - 0s 165us/step - loss: 25.0835 -
mean_absolute_error: 25.0835 - accuracy: 0.0020 - val_loss: 16.3432 -
val_mean_absolute_error: 16.3432 - val_accuracy: 0.0000e+00
Epoch 237/300
508/508 [==============================] - 0s 179us/step - loss: 23.3273 -
mean_absolute_error: 23.3273 - accuracy: 0.0000e+00 - val_loss: 41.0269 -
val_mean_absolute_error: 41.0269 - val_accuracy: 0.0000e+00
Epoch 238/300
508/508 [==============================] - 0s 201us/step - loss: 23.9865 -
mean_absolute_error: 23.9865 - accuracy: 0.0000e+00 - val_loss: 14.5265 -
val_mean_absolute_error: 14.5265 - val_accuracy: 0.0000e+00
Epoch 239/300
508/508 [==============================] - 0s 205us/step - loss: 16.8257 -
mean_absolute_error: 16.8257 - accuracy: 0.0000e+00 - val_loss: 12.9688 -
val_mean_absolute_error: 12.9688 - val_accuracy: 0.0000e+00
Epoch 240/300
508/508 [==============================] - 0s 165us/step - loss: 19.5091 -
mean_absolute_error: 19.5091 - accuracy: 0.0020 - val_loss: 15.0352 -
val_mean_absolute_error: 15.0352 - val_accuracy: 0.0000e+00
Epoch 241/300
508/508 [==============================] - 0s 173us/step - loss: 19.9110 -
mean_absolute_error: 19.9110 - accuracy: 0.0000e+00 - val_loss: 25.3986 -
val_mean_absolute_error: 25.3986 - val_accuracy: 0.0000e+00
Epoch 242/300
508/508 [==============================] - 0s 177us/step - loss: 19.4670 -
mean_absolute_error: 19.4670 - accuracy: 0.0000e+00 - val_loss: 17.3333 -
```

```
val_mean_absolute_error: 17.3333 - val_accuracy: 0.0000e+00
Epoch 243/300
508/508 [==============================] - 0s 181us/step - loss: 17.4656 -
mean_absolute_error: 17.4656 - accuracy: 0.0020 - val_loss: 17.3843 -
val_mean_absolute_error: 17.3843 - val_accuracy: 0.0000e+00
Epoch 244/300
508/508 [==============================] - 0s 155us/step - loss: 18.2099 -
mean_absolute_error: 18.2099 - accuracy: 0.0000e+00 - val_loss: 16.4028 -
val_mean_absolute_error: 16.4028 - val_accuracy: 0.0000e+00
Epoch 245/300
508/508 [==============================] - 0s 197us/step - loss: 22.0290 -
mean_absolute_error: 22.0290 - accuracy: 0.0000e+00 - val_loss: 15.0949 -
val_mean_absolute_error: 15.0949 - val_accuracy: 0.0000e+00
Epoch 246/300
508/508 [==============================] - 0s 181us/step - loss: 18.5606 -
mean_absolute_error: 18.5606 - accuracy: 0.0000e+00 - val_loss: 17.6628 -
val_mean_absolute_error: 17.6628 - val_accuracy: 0.0000e+00
Epoch 247/300
508/508 [==============================] - 0s 175us/step - loss: 24.6239 -
mean_absolute_error: 24.6239 - accuracy: 0.0000e+00 - val_loss: 20.5100 -
val_mean_absolute_error: 20.5100 - val_accuracy: 0.0000e+00
Epoch 248/300
508/508 [==============================] - 0s 167us/step - loss: 17.2839 -
mean_absolute_error: 17.2839 - accuracy: 0.0020 - val_loss: 20.7413 -
val_mean_absolute_error: 20.7413 - val_accuracy: 0.0000e+00
Epoch 249/300
508/508 [==============================] - 0s 187us/step - loss: 18.3204 -
mean_absolute_error: 18.3204 - accuracy: 0.0000e+00 - val_loss: 21.2720 -
val_mean_absolute_error: 21.2720 - val_accuracy: 0.0000e+00
Epoch 250/300
508/508 [==============================] - 0s 226us/step - loss: 23.6265 -
mean_absolute_error: 23.6265 - accuracy: 0.0000e+00 - val_loss: 16.9621 -
val_mean_absolute_error: 16.9621 - val_accuracy: 0.0000e+00
Epoch 251/300
508/508 [==============================] - 0s 167us/step - loss: 24.4189 -
mean_absolute_error: 24.4189 - accuracy: 0.0000e+00 - val_loss: 26.6118 -
val_mean_absolute_error: 26.6118 - val_accuracy: 0.0000e+00
Epoch 252/300
508/508 [==============================] - 0s 175us/step - loss: 28.1202 -
mean_absolute_error: 28.1202 - accuracy: 0.0000e+00 - val_loss: 15.4898 -
val_mean_absolute_error: 15.4898 - val_accuracy: 0.0000e+00
Epoch 253/300
508/508 [==============================] - 0s 171us/step - loss: 24.7145 -
mean_absolute_error: 24.7145 - accuracy: 0.0000e+00 - val_loss: 38.7990 -
val_mean_absolute_error: 38.7990 - val_accuracy: 0.0000e+00
Epoch 254/300
508/508 [==============================] - ETA: 0s - loss: 31.2226 -
mean_absolute_error: 31.2226 - accuracy: 0.0000e+ - 0s 171us/step - loss:
```

```
28.9026 - mean_absolute_error: 28.9026 - accuracy: 0.0000e+00 - val_loss:
21.3043 - val_mean_absolute_error: 21.3043 - val_accuracy: 0.0000e+00
Epoch 255/300
508/508 [==============================] - 0s 181us/step - loss: 20.5447 -
mean_absolute_error: 20.5447 - accuracy: 0.0000e+00 - val_loss: 15.8403 -
val_mean_absolute_error: 15.8403 - val_accuracy: 0.0000e+00
Epoch 256/300
508/508 [==============================] - 0s 173us/step - loss: 20.1912 -
mean_absolute_error: 20.1912 - accuracy: 0.0000e+00 - val_loss: 19.8156 -
val_mean_absolute_error: 19.8156 - val_accuracy: 0.0000e+00
Epoch 257/300
508/508 [==============================] - 0s 183us/step - loss: 18.2864 -
mean_absolute_error: 18.2864 - accuracy: 0.0020 - val_loss: 14.6496 -
val_mean_absolute_error: 14.6496 - val_accuracy: 0.0000e+00
Epoch 258/300
508/508 [==============================] - 0s 177us/step - loss: 17.3096 -
mean_absolute_error: 17.3096 - accuracy: 0.0000e+00 - val_loss: 21.9479 -
val_mean_absolute_error: 21.9479 - val_accuracy: 0.0000e+00
Epoch 259/300
508/508 [==============================] - 0s 177us/step - loss: 20.3401 -
mean_absolute_error: 20.3401 - accuracy: 0.0039 - val_loss: 12.6034 -
val_mean_absolute_error: 12.6034 - val_accuracy: 0.0000e+00
Epoch 260/300
508/508 [==============================] - 0s 163us/step - loss: 19.2939 -
mean_absolute_error: 19.2939 - accuracy: 0.0000e+00 - val_loss: 20.5013 -
val_mean_absolute_error: 20.5013 - val_accuracy: 0.0000e+00
Epoch 261/300
508/508 [==============================] - 0s 226us/step - loss: 17.8146 -
mean_absolute_error: 17.8146 - accuracy: 0.0000e+00 - val_loss: 19.9022 -
val_mean_absolute_error: 19.9022 - val_accuracy: 0.0000e+00
Epoch 262/300
508/508 [==============================] - 0s 171us/step - loss: 18.7269 -
mean_absolute_error: 18.7269 - accuracy: 0.0000e+00 - val_loss: 13.9013 -
val_mean_absolute_error: 13.9013 - val_accuracy: 0.0000e+00
Epoch 263/300
508/508 [==============================] - 0s 157us/step - loss: 22.4382 -
mean_absolute_error: 22.4382 - accuracy: 0.0000e+00 - val_loss: 38.4598 -
val_mean_absolute_error: 38.4598 - val_accuracy: 0.0000e+00
Epoch 264/300
508/508 [==============================] - 0s 175us/step - loss: 21.6997 -
mean_absolute_error: 21.6997 - accuracy: 0.0000e+00 - val_loss: 15.9616 -
val_mean_absolute_error: 15.9616 - val_accuracy: 0.0000e+00
Epoch 265/300
508/508 [==============================] - 0s 159us/step - loss: 23.1937 -
mean_absolute_error: 23.1937 - accuracy: 0.0000e+00 - val_loss: 24.1334 -
val_mean_absolute_error: 24.1334 - val_accuracy: 0.0000e+00
Epoch 266/300
508/508 [==============================] - 0s 169us/step - loss: 20.0573 -
```

```
mean_absolute_error: 20.0573 - accuracy: 0.0000e+00 - val_loss: 16.9548 -
val_mean_absolute_error: 16.9548 - val_accuracy: 0.0000e+00
Epoch 267/300
508/508 [==============================] - 0s 153us/step - loss: 18.0136 -
mean_absolute_error: 18.0136 - accuracy: 0.0000e+00 - val_loss: 13.9694 -
val_mean_absolute_error: 13.9694 - val_accuracy: 0.0000e+00
Epoch 268/300
508/508 [==============================] - 0s 171us/step - loss: 19.2749 -
mean_absolute_error: 19.2749 - accuracy: 0.0000e+00 - val_loss: 20.9620 -
val_mean_absolute_error: 20.9620 - val_accuracy: 0.0078
Epoch 269/300
508/508 [==============================] - 0s 167us/step - loss: 16.4412 -
mean_absolute_error: 16.4412 - accuracy: 0.0000e+00 - val_loss: 18.0866 -
val_mean_absolute_error: 18.0866 - val_accuracy: 0.0000e+00
Epoch 270/300
508/508 [==============================] - 0s 150us/step - loss: 17.0153 -
mean_absolute_error: 17.0153 - accuracy: 0.0000e+00 - val_loss: 17.2112 -
val_mean_absolute_error: 17.2112 - val_accuracy: 0.0000e+00
Epoch 271/300
508/508 [==============================] - 0s 169us/step - loss: 18.6430 -
mean_absolute_error: 18.6430 - accuracy: 0.0000e+00 - val_loss: 24.3077 -
val_mean_absolute_error: 24.3077 - val_accuracy: 0.0000e+00
Epoch 272/300
508/508 [==============================] - 0s 165us/step - loss: 22.8320 -
mean_absolute_error: 22.8320 - accuracy: 0.0000e+00 - val_loss: 30.6233 -
val_mean_absolute_error: 30.6233 - val_accuracy: 0.0000e+00
Epoch 273/300
508/508 [==============================] - 0s 232us/step - loss: 22.0056 -
mean_absolute_error: 22.0056 - accuracy: 0.0000e+00 - val_loss: 17.6570 -
val_mean_absolute_error: 17.6570 - val_accuracy: 0.0000e+00
Epoch 274/300
508/508 [==============================] - 0s 175us/step - loss: 19.3381 -
mean_absolute_error: 19.3381 - accuracy: 0.0000e+00 - val_loss: 18.9806 -
val_mean_absolute_error: 18.9806 - val_accuracy: 0.0000e+00
Epoch 275/300
508/508 [==============================] - 0s 155us/step - loss: 16.7865 -
mean_absolute_error: 16.7865 - accuracy: 0.0000e+00 - val_loss: 21.6450 -
val_mean_absolute_error: 21.6450 - val_accuracy: 0.0000e+00
Epoch 276/300
508/508 [==============================] - 0s 167us/step - loss: 19.2643 -
mean_absolute_error: 19.2643 - accuracy: 0.0000e+00 - val_loss: 15.9716 -
val_mean_absolute_error: 15.9716 - val_accuracy: 0.0000e+00
Epoch 277/300
508/508 [==============================] - 0s 228us/step - loss: 19.5096 -
mean_absolute_error: 19.5096 - accuracy: 0.0020 - val_loss: 12.6794 -
val_mean_absolute_error: 12.6794 - val_accuracy: 0.0000e+00
Epoch 278/300
508/508 [==============================] - 0s 177us/step - loss: 17.8480 -
```

```
mean_absolute_error: 17.8480 - accuracy: 0.0039 - val_loss: 25.0085 -
val_mean_absolute_error: 25.0085 - val_accuracy: 0.0000e+00
Epoch 279/300
508/508 [==============================] - 0s 155us/step - loss: 22.7144 -
mean_absolute_error: 22.7144 - accuracy: 0.0000e+00 - val_loss: 23.9910 -
val_mean_absolute_error: 23.9910 - val_accuracy: 0.0000e+00
Epoch 280/300
508/508 [==============================] - 0s 155us/step - loss: 18.9668 -
mean_absolute_error: 18.9668 - accuracy: 0.0000e+00 - val_loss: 16.7137 -
val_mean_absolute_error: 16.7137 - val_accuracy: 0.0000e+00
Epoch 281/300
508/508 [==============================] - 0s 179us/step - loss: 23.8646 -
mean_absolute_error: 23.8646 - accuracy: 0.0000e+00 - val_loss: 23.3499 -
val_mean_absolute_error: 23.3499 - val_accuracy: 0.0000e+00
Epoch 282/300
508/508 [==============================] - 0s 177us/step - loss: 17.4068 -
mean_absolute_error: 17.4068 - accuracy: 0.0000e+00 - val_loss: 13.4045 -
val_mean_absolute_error: 13.4045 - val_accuracy: 0.0000e+00
Epoch 283/300
508/508 [==============================] - 0s 183us/step - loss: 21.8416 -
mean_absolute_error: 21.8416 - accuracy: 0.0000e+00 - val_loss: 19.8822 -
val_mean_absolute_error: 19.8822 - val_accuracy: 0.0000e+00
Epoch 284/300
508/508 [==============================] - 0s 242us/step - loss: 18.8883 -
mean_absolute_error: 18.8883 - accuracy: 0.0000e+00 - val_loss: 17.7807 -
val_mean_absolute_error: 17.7807 - val_accuracy: 0.0000e+00
Epoch 285/300
508/508 [==============================] - 0s 171us/step - loss: 22.7540 -
mean_absolute_error: 22.7540 - accuracy: 0.0000e+00 - val_loss: 49.6364 -
val_mean_absolute_error: 49.6364 - val_accuracy: 0.0000e+00
Epoch 286/300
508/508 [==============================] - 0s 157us/step - loss: 22.8188 -
mean_absolute_error: 22.8188 - accuracy: 0.0000e+00 - val_loss: 17.6292 -
val_mean_absolute_error: 17.6292 - val_accuracy: 0.0000e+00
Epoch 287/300
508/508 [==============================] - 0s 175us/step - loss: 21.7880 -
mean_absolute_error: 21.7880 - accuracy: 0.0000e+00 - val_loss: 26.2979 -
val_mean_absolute_error: 26.2979 - val_accuracy: 0.0000e+00
Epoch 288/300
508/508 [==============================] - 0s 185us/step - loss: 26.4871 -
mean_absolute_error: 26.4871 - accuracy: 0.0000e+00 - val_loss: 33.9208 -
val_mean_absolute_error: 33.9208 - val_accuracy: 0.0000e+00
Epoch 289/300
508/508 [==============================] - 0s 161us/step - loss: 33.4532 -
mean_absolute_error: 33.4532 - accuracy: 0.0000e+00 - val_loss: 40.3862 -
val_mean_absolute_error: 40.3862 - val_accuracy: 0.0000e+00
Epoch 290/300
508/508 [==============================] - 0s 177us/step - loss: 23.1585 -
```

```
mean_absolute_error: 23.1585 - accuracy: 0.0000e+00 - val_loss: 21.5779 -
val_mean_absolute_error: 21.5779 - val_accuracy: 0.0000e+00
Epoch 291/300
508/508 [==============================] - 0s 175us/step - loss: 29.3432 -
mean_absolute_error: 29.3432 - accuracy: 0.0000e+00 - val_loss: 47.0602 -
val_mean_absolute_error: 47.0602 - val_accuracy: 0.0000e+00
Epoch 292/300
508/508 [==============================] - 0s 169us/step - loss: 34.6722 -
mean_absolute_error: 34.6722 - accuracy: 0.0000e+00 - val_loss: 30.6815 -
val_mean_absolute_error: 30.6815 - val_accuracy: 0.0000e+00
Epoch 293/300
508/508 [==============================] - 0s 175us/step - loss: 24.3607 -
mean_absolute_error: 24.3607 - accuracy: 0.0020 - val_loss: 28.9649 -
val_mean_absolute_error: 28.9649 - val_accuracy: 0.0000e+00
Epoch 294/300
508/508 [==============================] - 0s 161us/step - loss: 22.4615 -
mean_absolute_error: 22.4615 - accuracy: 0.0020 - val_loss: 27.8504 -
val_mean_absolute_error: 27.8504 - val_accuracy: 0.0000e+00
Epoch 295/300
508/508 [==============================] - 0s 199us/step - loss: 21.5019 -
mean_absolute_error: 21.5019 - accuracy: 0.0020 - val_loss: 18.1495 -
val_mean_absolute_error: 18.1495 - val_accuracy: 0.0000e+00
Epoch 296/300
508/508 [==============================] - 0s 197us/step - loss: 19.1190 -
mean_absolute_error: 19.1190 - accuracy: 0.0000e+00 - val_loss: 17.7926 -
val_mean_absolute_error: 17.7926 - val_accuracy: 0.0000e+00
Epoch 297/300
508/508 [==============================] - 0s 151us/step - loss: 20.3941 -
mean_absolute_error: 20.3941 - accuracy: 0.0000e+00 - val_loss: 14.0619 -
val_mean_absolute_error: 14.0619 - val_accuracy: 0.0000e+00
Epoch 298/300
508/508 [==============================] - 0s 163us/step - loss: 24.0682 -
mean_absolute_error: 24.0682 - accuracy: 0.0000e+00 - val_loss: 21.3069 -
val_mean_absolute_error: 21.3069 - val_accuracy: 0.0078
Epoch 299/300
508/508 [==============================] - 0s 181us/step - loss: 20.9386 -
mean_absolute_error: 20.9386 - accuracy: 0.0000e+00 - val_loss: 21.4589 -
val_mean_absolute_error: 21.4589 - val_accuracy: 0.0000e+00
Epoch 300/300
508/508 [==============================] - 0s 177us/step - loss: 20.4337 -
mean_absolute_error: 20.4337 - accuracy: 0.0020 - val_loss: 21.4964 -
val_mean_absolute_error: 21.4964 - val_accuracy: 0.0000e+00
```

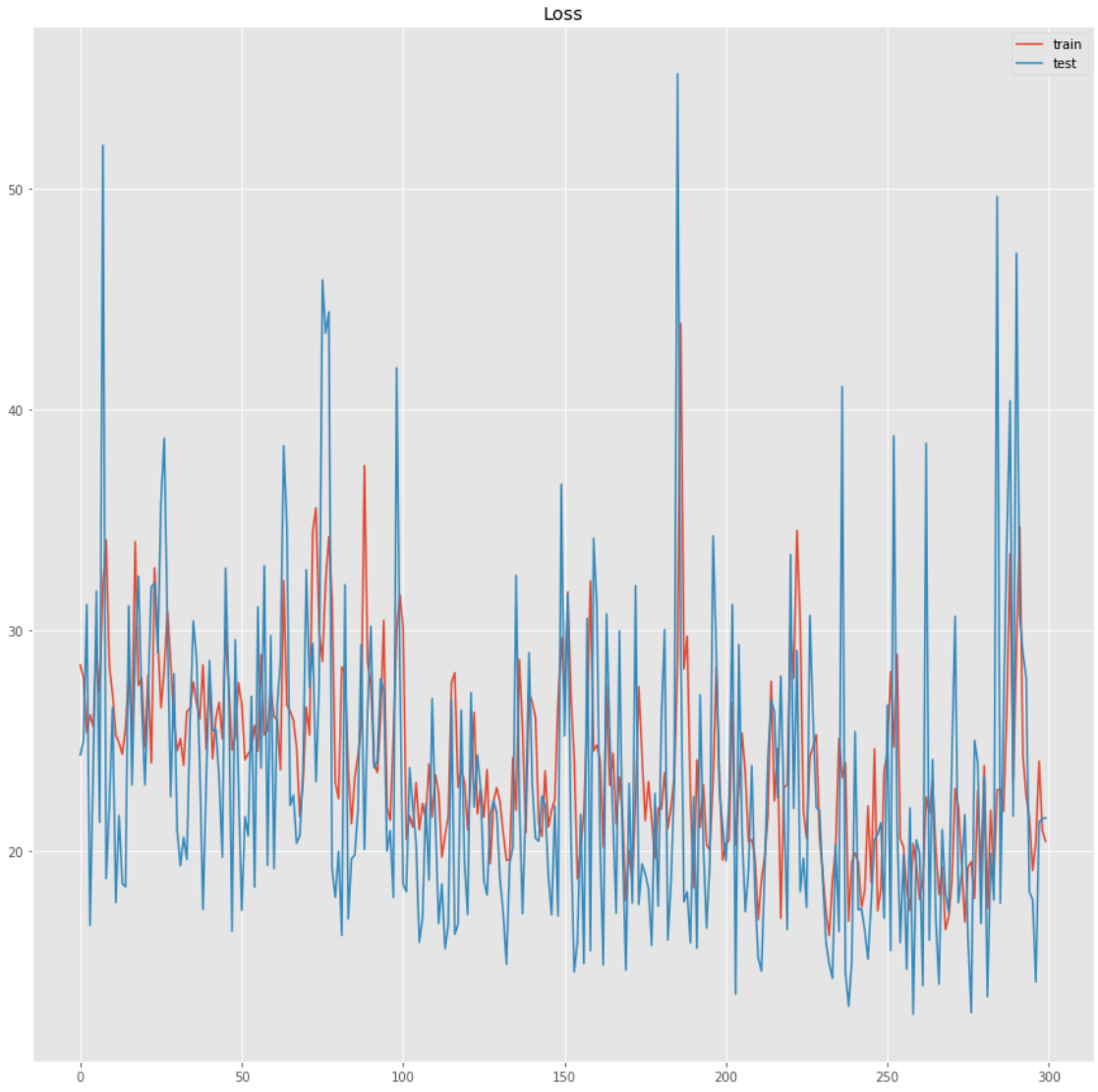
[151]:
```
predictions3 = NN_model.predict(X_val)
score3 = mean_absolute_error(y_valid,predictions3)
score3
```

[151]: 21.49637435913103

[152]:
```
# plot loss during training
import matplotlib.pyplot as pyplot

plt.figure(figsize=(15,15))
pyplot.title('Loss')
pyplot.plot(history.history['loss'], label='train')
pyplot.plot(history.history['val_loss'], label='test')
pyplot.legend()
```

[152]: <matplotlib.legend.Legend at 0x28e7ec31390>



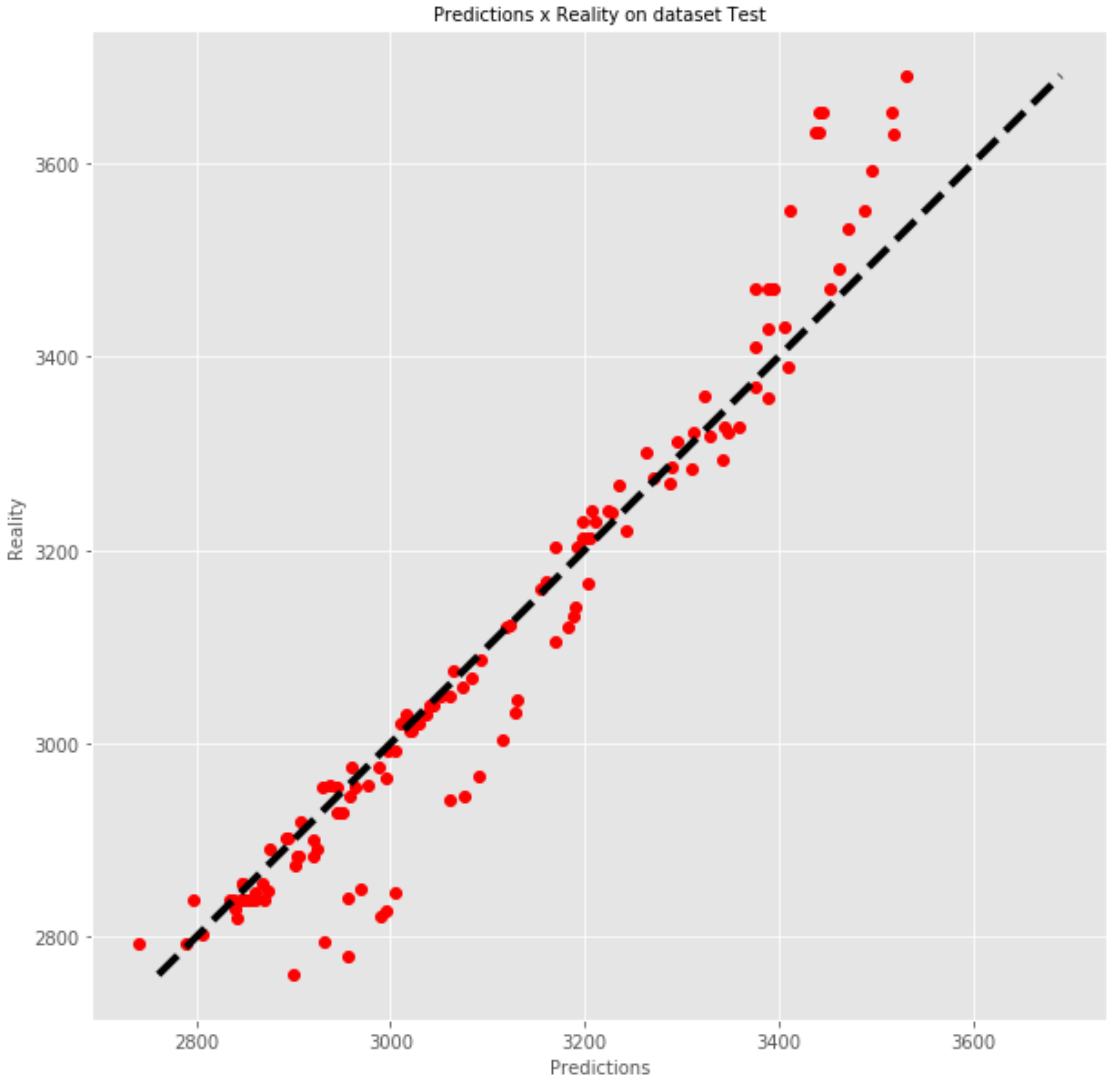
[61]:
```
history.params
```

[61]:
```
{'batch_size': 32,
 'epochs': 300,
 'steps': None,
 'samples': 508,
 'verbose': 0,
 'do_validation': True,
 'metrics': ['loss',
  'mean_absolute_error',
  'accuracy',
  'val_loss',
  'val_mean_absolute_error',
  'val_accuracy']}
```

[153]:
```
plt.style.use('ggplot')

matplotlib.rc('xtick', labelsize=10)
matplotlib.rc('ytick', labelsize=10)

fig, ax = plt.subplots(figsize=(10, 10))
plt.plot(predictions2, y_valid, 'ro')
plt.xlabel('Predictions', fontsize = 10)
plt.ylabel('Reality', fontsize=10)
plt.title('Predictions x Reality on dataset Test', fontsize = 10)
ax.plot([y_valid.min(), y_valid.max()], [y_valid.min(), y_valid.max()], 'k--',␣
 ↪lw=4)
plt.show()
```



1.10.1 KerasRegressor for improving performance

To improve the performance of the neural net we shall use sklearn wrapper for keras KerasRegressor .

[154]:
```
# define base model
def baseline_model():
    # create model
    model = Sequential()
    model.add(Dense(16, input_dim=5, activation='relu'))
    model.add(Dense(8, input_dim=7, activation='relu'))
    model.add(Dense(1))
    # Compile model
    model.compile(loss='mean_squared_error', optimizer='adam')
```

```
    return model
```

[155]:
```
X_np =np.asarray(X)
Y_np =np.asarray(Y)

X_train_1, X_test_1, y_train_1, y_test_1 = train_test_split(
     X,Y, test_size=0.2, random_state=0)

from sklearn.preprocessing import MinMaxScaler
scaler =  MinMaxScaler()
X_train_1=scaler.fit_transform(X_train_1)
X_test_1=scaler.fit_transform(X_test_1)
```

[168]:
```
from keras.wrappers.scikit_learn import KerasRegressor

estimator = KerasRegressor(build_fn=baseline_model, epochs=500, batch_size=3,␣
 ↪verbose=1)
```

[169]:
```
history=estimator.fit(X_train_1,y_train_1)
```

```
Epoch 1/500
508/508 [==============================] - 1s 1ms/step - loss: 9768062.8996
Epoch 2/500
508/508 [==============================] - 0s 559us/step - loss: 9667734.6102
Epoch 3/500
508/508 [==============================] - 0s 559us/step - loss: 9346702.3317
Epoch 4/500
508/508 [==============================] - 0s 570us/step - loss: 8700891.2500
Epoch 5/500
508/508 [==============================] - 0s 662us/step - loss: 7696996.9813
Epoch 6/500
508/508 [==============================] - 0s 707us/step - loss: 6383714.4035
Epoch 7/500
508/508 [==============================] - 0s 570us/step - loss: 4896268.5699
Epoch 8/500
508/508 [==============================] - 0s 647us/step - loss: 3422668.4670
Epoch 9/500
508/508 [==============================] - 0s 550us/step - loss: 2155351.2530
Epoch 10/500
508/508 [==============================] - 0s 551us/step - loss: 1228764.5389
Epoch 11/500
508/508 [==============================] - 0s 584us/step - loss: 668719.2652
Epoch 12/500
508/508 [==============================] - 0s 634us/step - loss: 397283.9333
Epoch 13/500
508/508 [==============================] - 0s 580us/step - loss: 290025.9938
Epoch 14/500
```

```
508/508 [==============================] - 0s 632us/step - loss: 254086.9466
Epoch 15/500
508/508 [==============================] - 0s 630us/step - loss: 240759.2385
Epoch 16/500
508/508 [==============================] - 0s 561us/step - loss: 232437.3121
Epoch 17/500
508/508 [==============================] - 0s 573us/step - loss: 225221.8937
Epoch 18/500
508/508 [==============================] - 0s 573us/step - loss: 218327.0145
Epoch 19/500
508/508 [==============================] - 0s 647us/step - loss: 211298.6608
Epoch 20/500
508/508 [==============================] - 0s 585us/step - loss: 204067.3397
Epoch 21/500
508/508 [==============================] - 0s 572us/step - loss: 196809.7639
Epoch 22/500
508/508 [==============================] - 0s 634us/step - loss: 189628.6882
Epoch 23/500
508/508 [==============================] - 0s 555us/step - loss: 182633.2058
Epoch 24/500
508/508 [==============================] - 0s 559us/step - loss: 175769.8310
Epoch 25/500
508/508 [==============================] - 0s 589us/step - loss: 168841.6452
Epoch 26/500
508/508 [==============================] - 0s 636us/step - loss: 162231.6045
Epoch 27/500
508/508 [==============================] - 0s 557us/step - loss: 156039.4525
Epoch 28/500
508/508 [==============================] - 0s 897us/step - loss: 149574.7160
Epoch 29/500
508/508 [==============================] - 0s 777us/step - loss: 143691.6018
Epoch 30/500
508/508 [==============================] - 0s 676us/step - loss: 137800.3598
Epoch 31/500
508/508 [==============================] - 0s 880us/step - loss: 132037.7008
Epoch 32/500
508/508 [==============================] - 0s 792us/step - loss: 126777.6397
Epoch 33/500
508/508 [==============================] - 0s 706us/step - loss: 121545.4214
Epoch 34/500
508/508 [==============================] - 0s 559us/step - loss: 116633.7327
Epoch 35/500
508/508 [==============================] - 0s 620us/step - loss: 112127.8474
Epoch 36/500
508/508 [==============================] - 0s 581us/step - loss: 107707.6475
Epoch 37/500
508/508 [==============================] - 0s 570us/step - loss: 103706.1653
Epoch 38/500
```

```
508/508 [==============================] - 0s 633us/step - loss: 99904.9057
Epoch 39/500
508/508 [==============================] - 0s 654us/step - loss: 96203.6482
Epoch 40/500
508/508 [==============================] - 0s 625us/step - loss: 92617.5005
Epoch 41/500
508/508 [==============================] - 0s 556us/step - loss: 89845.8083
Epoch 42/500
508/508 [==============================] - 0s 649us/step - loss: 86834.2042
Epoch 43/500
508/508 [==============================] - 0s 573us/step - loss: 84288.3757
Epoch 44/500
508/508 [==============================] - 0s 694us/step - loss: 81760.3352
Epoch 45/500
508/508 [==============================] - 0s 629us/step - loss: 79567.2800
Epoch 46/500
508/508 [==============================] - 0s 561us/step - loss: 77262.1517
Epoch 47/500
508/508 [==============================] - 0s 606us/step - loss: 75106.4347
Epoch 48/500
508/508 [==============================] - 0s 557us/step - loss: 73347.3963
Epoch 49/500
508/508 [==============================] - 0s 689us/step - loss: 71493.6608
Epoch 50/500
508/508 [==============================] - 0s 638us/step - loss: 69889.9345
Epoch 51/500
508/508 [==============================] - 0s 580us/step - loss: 68362.0047
Epoch 52/500
508/508 [==============================] - 0s 666us/step - loss: 66879.0550
Epoch 53/500
508/508 [==============================] - 0s 580us/step - loss: 65502.7072
Epoch 54/500
508/508 [==============================] - 0s 542us/step - loss: 64316.3669
Epoch 55/500
508/508 [==============================] - 0s 538us/step - loss: 62759.2671
Epoch 56/500
508/508 [==============================] - 0s 608us/step - loss: 61733.6785
Epoch 57/500
508/508 [==============================] - 0s 549us/step - loss: 60333.4464
Epoch 58/500
508/508 [==============================] - 0s 540us/step - loss: 58815.2547
Epoch 59/500
508/508 [==============================] - 0s 557us/step - loss: 58163.7647
Epoch 60/500
508/508 [==============================] - 0s 620us/step - loss: 56989.9207
Epoch 61/500
508/508 [==============================] - 0s 594us/step - loss: 55828.9966
Epoch 62/500
```

```
508/508 [==============================] - 0s 555us/step - loss: 54793.8505
Epoch 63/500
508/508 [==============================] - 0s 650us/step - loss: 53889.9205
Epoch 64/500
508/508 [==============================] - 0s 556us/step - loss: 52666.7650
Epoch 65/500
508/508 [==============================] - 0s 649us/step - loss: 51741.3820
Epoch 66/500
508/508 [==============================] - 0s 800us/step - loss: 50625.6216
Epoch 67/500
508/508 [==============================] - 0s 591us/step - loss: 49866.9313
Epoch 68/500
508/508 [==============================] - 0s 637us/step - loss: 48763.1575
Epoch 69/500
508/508 [==============================] - 0s 673us/step - loss: 47875.4543
Epoch 70/500
508/508 [==============================] - 0s 650us/step - loss: 46914.0512
Epoch 71/500
508/508 [==============================] - 0s 724us/step - loss: 45990.4675
Epoch 72/500
508/508 [==============================] - 0s 585us/step - loss: 44977.7691
Epoch 73/500
508/508 [==============================] - 0s 731us/step - loss: 44136.7880
Epoch 74/500
508/508 [==============================] - 0s 597us/step - loss: 43310.7209
Epoch 75/500
508/508 [==============================] - 0s 594us/step - loss: 42334.2000
Epoch 76/500
508/508 [==============================] - 0s 680us/step - loss: 41543.1315
Epoch 77/500
508/508 [==============================] - 0s 661us/step - loss: 40626.9488
Epoch 78/500
508/508 [==============================] - 0s 649us/step - loss: 39741.3058
Epoch 79/500
508/508 [==============================] - 0s 709us/step - loss: 38985.8840
Epoch 80/500
508/508 [==============================] - 0s 665us/step - loss: 38145.5224
Epoch 81/500
508/508 [==============================] - 0s 679us/step - loss: 37211.2657
Epoch 82/500
508/508 [==============================] - 0s 689us/step - loss: 36443.7538
Epoch 83/500
508/508 [==============================] - 0s 647us/step - loss: 35806.0643
Epoch 84/500
508/508 [==============================] - 0s 663us/step - loss: 34968.8245
Epoch 85/500
508/508 [==============================] - 0s 624us/step - loss: 34049.2742
Epoch 86/500
```

```
508/508 [==============================] - 0s 683us/step - loss: 33242.8558
Epoch 87/500
508/508 [==============================] - 0s 662us/step - loss: 32577.5400
Epoch 88/500
508/508 [==============================] - 0s 670us/step - loss: 31784.7002
Epoch 89/500
508/508 [==============================] - 0s 720us/step - loss: 30928.5948
Epoch 90/500
508/508 [==============================] - 0s 629us/step - loss: 30239.1197
Epoch 91/500
508/508 [==============================] - 0s 600us/step - loss: 29277.5308
Epoch 92/500
508/508 [==============================] - 0s 722us/step - loss: 28887.8455
Epoch 93/500
508/508 [==============================] - 0s 636us/step - loss: 27812.4020
Epoch 94/500
508/508 [==============================] - 0s 629us/step - loss: 27363.1822
Epoch 95/500
508/508 [==============================] - 0s 772us/step - loss: 26586.5042
Epoch 96/500
508/508 [==============================] - 0s 746us/step - loss: 25888.3323
Epoch 97/500
508/508 [==============================] - 0s 641us/step - loss: 25147.7944
Epoch 98/500
508/508 [==============================] - 0s 563us/step - loss: 24534.3051
Epoch 99/500
508/508 [==============================] - 0s 724us/step - loss: 23512.1432
Epoch 100/500
508/508 [==============================] - 0s 562us/step - loss: 23214.4548
Epoch 101/500
508/508 [==============================] - 0s 600us/step - loss: 22403.9263
Epoch 102/500
508/508 [==============================] - 0s 657us/step - loss: 21777.7096
Epoch 103/500
508/508 [==============================] - 0s 587us/step - loss: 21177.3156
Epoch 104/500
508/508 [==============================] - 0s 555us/step - loss: 20513.6717
Epoch 105/500
508/508 [==============================] - 0s 573us/step - loss: 20140.9808
Epoch 106/500
508/508 [==============================] - 0s 610us/step - loss: 19353.2192
Epoch 107/500
508/508 [==============================] - 0s 599us/step - loss: 18890.7231
Epoch 108/500
508/508 [==============================] - 0s 559us/step - loss: 18101.5819
Epoch 109/500
508/508 [==============================] - 0s 622us/step - loss: 17535.2654
Epoch 110/500
```

```
508/508 [==============================] - 0s 538us/step - loss: 17087.9056
Epoch 111/500
508/508 [==============================] - 0s 567us/step - loss: 16546.3985
Epoch 112/500
508/508 [==============================] - 0s 563us/step - loss: 16088.4520
Epoch 113/500
508/508 [==============================] - 0s 649us/step - loss: 15492.6495
Epoch 114/500
508/508 [==============================] - 0s 566us/step - loss: 15012.2991
Epoch 115/500
508/508 [==============================] - 0s 558us/step - loss: 14436.1156
Epoch 116/500
508/508 [==============================] - 0s 581us/step - loss: 13971.4280
Epoch 117/500
508/508 [==============================] - 0s 595us/step - loss: 13477.1367
Epoch 118/500
508/508 [==============================] - 0s 563us/step - loss: 12994.1804
Epoch 119/500
508/508 [==============================] - 0s 570us/step - loss: 12604.0057
Epoch 120/500
508/508 [==============================] - 0s 645us/step - loss: 12237.5047
Epoch 121/500
508/508 [==============================] - 0s 570us/step - loss: 11646.4713
Epoch 122/500
508/508 [==============================] - 0s 578us/step - loss: 11428.0132
Epoch 123/500
508/508 [==============================] - 0s 591us/step - loss: 11012.1490
Epoch 124/500
508/508 [==============================] - 0s 706us/step - loss: 10536.9368
Epoch 125/500
508/508 [==============================] - 0s 591us/step - loss: 10266.1306
Epoch 126/500
508/508 [==============================] - 0s 562us/step - loss: 9876.3687
Epoch 127/500
508/508 [==============================] - 1s 2ms/step - loss: 9624.6267
Epoch 128/500
508/508 [==============================] - 1s 1ms/step - loss: 9137.0286
Epoch 129/500
508/508 [==============================] - 0s 912us/step - loss: 8911.3363
Epoch 130/500
508/508 [==============================] - 0s 674us/step - loss: 8542.0806
Epoch 131/500
508/508 [==============================] - 0s 673us/step - loss: 8232.7563
Epoch 132/500
508/508 [==============================] - 0s 908us/step - loss: 7987.5691
Epoch 133/500
508/508 [==============================] - 0s 676us/step - loss: 7718.6568
Epoch 134/500
```

```
508/508 [==============================] - 1s 1ms/step - loss: 7504.2482
Epoch 135/500
508/508 [==============================] - 0s 960us/step - loss: 7296.3195
Epoch 136/500
508/508 [==============================] - 1s 1ms/step - loss: 7049.9800
Epoch 137/500
508/508 [==============================] - 0s 816us/step - loss: 6798.2046
Epoch 138/500
508/508 [==============================] - 0s 781us/step - loss: 6655.9596
Epoch 139/500
508/508 [==============================] - 0s 907us/step - loss: 6438.3921
Epoch 140/500
508/508 [==============================] - 0s 862us/step - loss: 6275.7879
Epoch 141/500
508/508 [==============================] - 1s 1ms/step - loss: 6098.1654
Epoch 142/500
508/508 [==============================] - 0s 868us/step - loss: 5931.9412
Epoch 143/500
508/508 [==============================] - 0s 881us/step - loss: 5850.4690
Epoch 144/500
508/508 [==============================] - 0s 968us/step - loss: 5732.7449
Epoch 145/500
508/508 [==============================] - 0s 846us/step - loss: 5554.0434
Epoch 146/500
508/508 [==============================] - 0s 856us/step - loss: 5428.9015
Epoch 147/500
508/508 [==============================] - 0s 940us/step - loss: 5312.0629
Epoch 148/500
508/508 [==============================] - 1s 1ms/step - loss: 5323.0374
Epoch 149/500
508/508 [==============================] - 1s 1ms/step - loss: 5180.3536
Epoch 150/500
508/508 [==============================] - 1s 1ms/step - loss: 5132.0577
Epoch 151/500
508/508 [==============================] - 0s 931us/step - loss: 5042.3173
Epoch 152/500
508/508 [==============================] - 1s 1ms/step - loss: 4971.1299
Epoch 153/500
508/508 [==============================] - 0s 919us/step - loss: 4900.4473
Epoch 154/500
508/508 [==============================] - 0s 915us/step - loss: 4886.5990
Epoch 155/500
508/508 [==============================] - 0s 909us/step - loss: 4761.2638
Epoch 156/500
508/508 [==============================] - 0s 837us/step - loss: 4734.9535
Epoch 157/500
508/508 [==============================] - 1s 1ms/step - loss: 4680.5984
Epoch 158/500
```

```
508/508 [==============================] - 0s 914us/step - loss: 4660.6409
Epoch 159/500
508/508 [==============================] - 0s 863us/step - loss: 4608.7256
Epoch 160/500
508/508 [==============================] - 1s 1ms/step - loss: 4644.5581
Epoch 161/500
508/508 [==============================] - 1s 1ms/step - loss: 4557.9911
Epoch 162/500
508/508 [==============================] - 1s 1ms/step - loss: 4548.3632
Epoch 163/500
508/508 [==============================] - 1s 992us/step - loss: 4527.8343
Epoch 164/500
508/508 [==============================] - 1s 1ms/step - loss: 4487.5896
Epoch 165/500
508/508 [==============================] - 1s 1ms/step - loss: 4490.9762
Epoch 166/500
508/508 [==============================] - 0s 968us/step - loss: 4478.4026
Epoch 167/500
508/508 [==============================] - 0s 937us/step - loss: 4517.8962
Epoch 168/500
508/508 [==============================] - 0s 902us/step - loss: 4452.3067
Epoch 169/500
508/508 [==============================] - 0s 625us/step - loss: 4426.7961
Epoch 170/500
508/508 [==============================] - 0s 859us/step - loss: 4426.3430
Epoch 171/500
508/508 [==============================] - 1s 1ms/step - loss: 4385.6719
Epoch 172/500
508/508 [==============================] - 0s 941us/step - loss: 4395.2023
Epoch 173/500
508/508 [==============================] - 1s 1ms/step - loss: 4394.7799
Epoch 174/500
508/508 [==============================] - 0s 900us/step - loss: 4355.4505
Epoch 175/500
508/508 [==============================] - 0s 643us/step - loss: 4357.6319
Epoch 176/500
508/508 [==============================] - 0s 897us/step - loss: 4358.5404
Epoch 177/500
508/508 [==============================] - 0s 701us/step - loss: 4330.6700
Epoch 178/500
508/508 [==============================] - 1s 1ms/step - loss: 4332.4454
Epoch 179/500
508/508 [==============================] - 0s 742us/step - loss: 4362.3618
Epoch 180/500
508/508 [==============================] - 0s 663us/step - loss: 4319.4325
Epoch 181/500
508/508 [==============================] - 0s 791us/step - loss: 4320.3207
Epoch 182/500
```

```
508/508 [==============================] - 0s 659us/step - loss: 4298.6894
Epoch 183/500
508/508 [==============================] - 0s 593us/step - loss: 4331.0175
Epoch 184/500
508/508 [==============================] - 0s 663us/step - loss: 4315.5116
Epoch 185/500
508/508 [==============================] - 0s 665us/step - loss: 4269.5535
Epoch 186/500
508/508 [==============================] - 0s 649us/step - loss: 4295.2788
Epoch 187/500
508/508 [==============================] - 0s 726us/step - loss: 4252.19090s -
los
Epoch 188/500
508/508 [==============================] - 0s 869us/step - loss: 4326.9490
Epoch 189/500
508/508 [==============================] - 0s 597us/step - loss: 4232.0057
Epoch 190/500
508/508 [==============================] - 0s 913us/step - loss: 4289.4633
Epoch 191/500
508/508 [==============================] - 0s 939us/step - loss: 4262.3958
Epoch 192/500
508/508 [==============================] - 0s 703us/step - loss: 4273.1727
Epoch 193/500
508/508 [==============================] - 0s 855us/step - loss: 4229.3483
Epoch 194/500
508/508 [==============================] - 0s 801us/step - loss: 4216.4450
Epoch 195/500
508/508 [==============================] - 0s 652us/step - loss: 4207.5933
Epoch 196/500
508/508 [==============================] - 0s 818us/step - loss: 4254.1954
Epoch 197/500
508/508 [==============================] - 0s 657us/step - loss: 4175.0098
Epoch 198/500
508/508 [==============================] - 0s 750us/step - loss: 4169.9877
Epoch 199/500
508/508 [==============================] - 0s 754us/step - loss: 4189.4095
Epoch 200/500
508/508 [==============================] - 0s 652us/step - loss: 4195.4014
Epoch 201/500
508/508 [==============================] - 0s 574us/step - loss: 4219.1125
Epoch 202/500
508/508 [==============================] - 0s 707us/step - loss: 4117.8650
Epoch 203/500
508/508 [==============================] - 0s 620us/step - loss: 4192.8343
Epoch 204/500
508/508 [==============================] - 0s 635us/step - loss: 4163.5724
Epoch 205/500
508/508 [==============================] - 0s 737us/step - loss: 4195.1962
```

```
Epoch 206/500
508/508 [==============================] - 0s 809us/step - loss: 4172.1183
Epoch 207/500
508/508 [==============================] - 0s 667us/step - loss: 4152.1553
Epoch 208/500
508/508 [==============================] - 0s 739us/step - loss: 4137.4986
Epoch 209/500
508/508 [==============================] - 0s 560us/step - loss: 4181.0353
Epoch 210/500
508/508 [==============================] - 0s 555us/step - loss: 4122.8481
Epoch 211/500
508/508 [==============================] - 0s 647us/step - loss: 4138.9537
Epoch 212/500
508/508 [==============================] - 0s 566us/step - loss: 4101.9950
Epoch 213/500
508/508 [==============================] - 0s 606us/step - loss: 4212.7683
Epoch 214/500
508/508 [==============================] - 0s 585us/step - loss: 4117.4912
Epoch 215/500
508/508 [==============================] - 0s 665us/step - loss: 4091.7235
Epoch 216/500
508/508 [==============================] - 0s 620us/step - loss: 4162.3633
Epoch 217/500
508/508 [==============================] - 0s 639us/step - loss: 4076.7676
Epoch 218/500
508/508 [==============================] - ETA: 0s - loss: 4008.93 - 0s
763us/step - loss: 4071.7574
Epoch 219/500
508/508 [==============================] - 0s 652us/step - loss: 4082.8898
Epoch 220/500
508/508 [==============================] - 0s 639us/step - loss: 4064.3338
Epoch 221/500
508/508 [==============================] - 0s 691us/step - loss: 4056.2705
Epoch 222/500
508/508 [==============================] - 0s 590us/step - loss: 4052.4548
Epoch 223/500
508/508 [==============================] - 0s 622us/step - loss: 4093.6388
Epoch 224/500
508/508 [==============================] - 0s 572us/step - loss: 4049.9545
Epoch 225/500
508/508 [==============================] - 0s 648us/step - loss: 4045.7645
Epoch 226/500
508/508 [==============================] - 0s 581us/step - loss: 4041.8227
Epoch 227/500
508/508 [==============================] - 0s 584us/step - loss: 4043.9336
Epoch 228/500
508/508 [==============================] - 0s 644us/step - loss: 4036.4022: 0s -
loss
```

```
Epoch 229/500
508/508 [==============================] - 0s 561us/step - loss: 4000.5814
Epoch 230/500
508/508 [==============================] - 0s 577us/step - loss: 4028.1960
Epoch 231/500
508/508 [==============================] - 0s 569us/step - loss: 4058.9774
Epoch 232/500
508/508 [==============================] - 0s 682us/step - loss: 4035.7394
Epoch 233/500
508/508 [==============================] - 0s 697us/step - loss: 3996.4041
Epoch 234/500
508/508 [==============================] - 0s 589us/step - loss: 4074.1347
Epoch 235/500
508/508 [==============================] - 0s 675us/step - loss: 4009.7838
Epoch 236/500
508/508 [==============================] - 0s 685us/step - loss: 3968.7488
Epoch 237/500
508/508 [==============================] - 0s 617us/step - loss: 3930.7598
Epoch 238/500
508/508 [==============================] - 0s 724us/step - loss: 4075.4291
Epoch 239/500
508/508 [==============================] - 0s 681us/step - loss: 4011.5551
Epoch 240/500
508/508 [==============================] - 0s 669us/step - loss: 3966.5459
Epoch 241/500
508/508 [==============================] - 0s 743us/step - loss: 3963.8531
Epoch 242/500
508/508 [==============================] - 0s 608us/step - loss: 3948.6141
Epoch 243/500
508/508 [==============================] - 0s 550us/step - loss: 3978.5627
Epoch 244/500
508/508 [==============================] - 0s 591us/step - loss: 3954.3164
Epoch 245/500
508/508 [==============================] - 0s 648us/step - loss: 3961.5379
Epoch 246/500
508/508 [==============================] - 0s 573us/step - loss: 3947.5759
Epoch 247/500
508/508 [==============================] - 0s 581us/step - loss: 3937.8474
Epoch 248/500
508/508 [==============================] - 0s 565us/step - loss: 3948.1365
Epoch 249/500
508/508 [==============================] - 0s 632us/step - loss: 3947.1903
Epoch 250/500
508/508 [==============================] - 0s 757us/step - loss: 3947.9667
Epoch 251/500
508/508 [==============================] - 0s 575us/step - loss: 3916.0215
Epoch 252/500
508/508 [==============================] - 0s 675us/step - loss: 3991.9310
```

```
Epoch 253/500
508/508 [==============================] - 0s 580us/step - loss: 3926.7711
Epoch 254/500
508/508 [==============================] - 0s 692us/step - loss: 3931.3510
Epoch 255/500
508/508 [==============================] - 0s 791us/step - loss: 3919.1520
Epoch 256/500
508/508 [==============================] - 0s 572us/step - loss: 3893.3979
Epoch 257/500
508/508 [==============================] - 0s 582us/step - loss: 3897.5157
Epoch 258/500
508/508 [==============================] - 0s 662us/step - loss: 3851.0226
Epoch 259/500
508/508 [==============================] - 0s 600us/step - loss: 3889.7726
Epoch 260/500
508/508 [==============================] - 0s 550us/step - loss: 3921.8697
Epoch 261/500
508/508 [==============================] - 0s 577us/step - loss: 3886.7071
Epoch 262/500
508/508 [==============================] - 0s 642us/step - loss: 3888.7728
Epoch 263/500
508/508 [==============================] - 0s 597us/step - loss: 3891.17320s -
loss: 4
Epoch 264/500
508/508 [==============================] - 0s 563us/step - loss: 3857.6207
Epoch 265/500
508/508 [==============================] - 0s 628us/step - loss: 3803.2601
Epoch 266/500
508/508 [==============================] - 0s 583us/step - loss: 3907.1891
Epoch 267/500
508/508 [==============================] - 0s 703us/step - loss: 3846.8278
Epoch 268/500
508/508 [==============================] - 0s 573us/step - loss: 3890.3173
Epoch 269/500
508/508 [==============================] - 0s 681us/step - loss: 3839.1602
Epoch 270/500
508/508 [==============================] - 0s 590us/step - loss: 3822.6175
Epoch 271/500
508/508 [==============================] - 0s 595us/step - loss: 3831.7392
Epoch 272/500
508/508 [==============================] - 0s 640us/step - loss: 3825.7285
Epoch 273/500
508/508 [==============================] - 0s 649us/step - loss: 3823.2482
Epoch 274/500
508/508 [==============================] - 0s 626us/step - loss: 3818.8400
Epoch 275/500
508/508 [==============================] - 0s 573us/step - loss: 3809.3078
Epoch 276/500
```

```
508/508 [==============================] - 0s 724us/step - loss: 3813.4683
Epoch 277/500
508/508 [==============================] - 0s 519us/step - loss: 3813.4807
Epoch 278/500
508/508 [==============================] - 0s 717us/step - loss: 3829.2734
Epoch 279/500
508/508 [==============================] - 0s 606us/step - loss: 3765.8131
Epoch 280/500
508/508 [==============================] - 0s 806us/step - loss: 3803.5065
Epoch 281/500
508/508 [==============================] - 0s 636us/step - loss: 3770.6523
Epoch 282/500
508/508 [==============================] - 0s 676us/step - loss: 3792.9988
Epoch 283/500
508/508 [==============================] - 0s 579us/step - loss: 3750.6680
Epoch 284/500
508/508 [==============================] - 0s 633us/step - loss: 3775.0955
Epoch 285/500
508/508 [==============================] - 0s 626us/step - loss: 3786.1712
Epoch 286/500
508/508 [==============================] - 0s 740us/step - loss: 3771.6122
Epoch 287/500
508/508 [==============================] - 0s 543us/step - loss: 3754.3085
Epoch 288/500
508/508 [==============================] - 0s 562us/step - loss: 3757.61130s -
loss: 3
Epoch 289/500
508/508 [==============================] - 0s 636us/step - loss: 3807.0802
Epoch 290/500
508/508 [==============================] - 0s 550us/step - loss: 3802.4886
Epoch 291/500
508/508 [==============================] - 0s 558us/step - loss: 3725.9312
Epoch 292/500
508/508 [==============================] - 0s 573us/step - loss: 3730.9959
Epoch 293/500
508/508 [==============================] - 0s 602us/step - loss: 3788.1168
Epoch 294/500
508/508 [==============================] - 0s 561us/step - loss: 3745.2681
Epoch 295/500
508/508 [==============================] - 0s 551us/step - loss: 3728.0517
Epoch 296/500
508/508 [==============================] - 0s 691us/step - loss: 3667.8653
Epoch 297/500
508/508 [==============================] - 0s 827us/step - loss: 3809.5697
Epoch 298/500
508/508 [==============================] - 0s 603us/step - loss: 3777.3837
Epoch 299/500
508/508 [==============================] - 0s 607us/step - loss: 3723.0536
```

```
Epoch 300/500
508/508 [==============================] - 0s 624us/step - loss: 3687.1428
Epoch 301/500
508/508 [==============================] - 0s 580us/step - loss: 3736.7606
Epoch 302/500
508/508 [==============================] - 0s 661us/step - loss: 3709.4956
Epoch 303/500
508/508 [==============================] - 0s 687us/step - loss: 3743.2870
Epoch 304/500
508/508 [==============================] - 0s 568us/step - loss: 3724.8235
Epoch 305/500
508/508 [==============================] - 0s 645us/step - loss: 3676.4817
Epoch 306/500
508/508 [==============================] - 0s 733us/step - loss: 3680.7370
Epoch 307/500
508/508 [==============================] - 0s 649us/step - loss: 3681.9045
Epoch 308/500
508/508 [==============================] - 0s 638us/step - loss: 3687.8362
Epoch 309/500
508/508 [==============================] - 0s 729us/step - loss: 3692.4426
Epoch 310/500
508/508 [==============================] - 0s 713us/step - loss: 3723.7796
Epoch 311/500
508/508 [==============================] - 0s 675us/step - loss: 3677.1989
Epoch 312/500
508/508 [==============================] - 0s 683us/step - loss: 3610.6000
Epoch 313/500
508/508 [==============================] - 0s 639us/step - loss: 3744.3078
Epoch 314/500
508/508 [==============================] - 0s 663us/step - loss: 3647.7197
Epoch 315/500
508/508 [==============================] - 0s 667us/step - loss: 3655.3797
Epoch 316/500
508/508 [==============================] - 0s 752us/step - loss: 3689.0840
Epoch 317/500
508/508 [==============================] - 0s 690us/step - loss: 3649.2296
Epoch 318/500
508/508 [==============================] - 0s 742us/step - loss: 3642.1777
Epoch 319/500
508/508 [==============================] - 0s 633us/step - loss: 3613.8162
Epoch 320/500
508/508 [==============================] - 0s 699us/step - loss: 3725.8655
Epoch 321/500
508/508 [==============================] - 0s 689us/step - loss: 3643.0166
Epoch 322/500
508/508 [==============================] - 0s 738us/step - loss: 3601.4502
Epoch 323/500
508/508 [==============================] - 0s 719us/step - loss: 3641.7438
```

```
Epoch 324/500
508/508 [==============================] - 0s 927us/step - loss: 3600.8333
Epoch 325/500
508/508 [==============================] - 0s 683us/step - loss: 3631.9926
Epoch 326/500
508/508 [==============================] - 0s 669us/step - loss: 3660.1932
Epoch 327/500
508/508 [==============================] - 0s 749us/step - loss: 3611.0086
Epoch 328/500
508/508 [==============================] - 0s 623us/step - loss: 3598.4167
Epoch 329/500
508/508 [==============================] - 0s 706us/step - loss: 3606.4144
Epoch 330/500
508/508 [==============================] - 0s 674us/step - loss: 3640.0607
Epoch 331/500
508/508 [==============================] - 0s 653us/step - loss: 3591.4278
Epoch 332/500
508/508 [==============================] - 0s 626us/step - loss: 3589.2178
Epoch 333/500
508/508 [==============================] - 0s 601us/step - loss: 3619.7794
Epoch 334/500
508/508 [==============================] - 0s 673us/step - loss: 3590.2163
Epoch 335/500
508/508 [==============================] - 0s 593us/step - loss: 3567.4977
Epoch 336/500
508/508 [==============================] - 0s 644us/step - loss: 3626.6369
Epoch 337/500
508/508 [==============================] - 0s 780us/step - loss: 3599.8924
Epoch 338/500
508/508 [==============================] - 0s 748us/step - loss: 3607.2620
Epoch 339/500
508/508 [==============================] - 0s 616us/step - loss: 3517.1121
Epoch 340/500
508/508 [==============================] - 0s 730us/step - loss: 3574.2743
Epoch 341/500
508/508 [==============================] - 0s 632us/step - loss: 3612.2605
Epoch 342/500
508/508 [==============================] - 0s 568us/step - loss: 3541.8607
Epoch 343/500
508/508 [==============================] - 0s 572us/step - loss: 3584.7020
Epoch 344/500
508/508 [==============================] - 0s 644us/step - loss: 3514.2489
Epoch 345/500
508/508 [==============================] - 0s 584us/step - loss: 3562.2230
Epoch 346/500
508/508 [==============================] - 0s 581us/step - loss: 3578.4034
Epoch 347/500
508/508 [==============================] - 0s 636us/step - loss: 3551.7687
```

```
Epoch 348/500
508/508 [==============================] - 0s 584us/step - loss: 3605.5721
Epoch 349/500
508/508 [==============================] - 0s 554us/step - loss: 3528.0958
Epoch 350/500
508/508 [==============================] - 0s 570us/step - loss: 3536.9374
Epoch 351/500
508/508 [==============================] - 0s 654us/step - loss: 3551.0626
Epoch 352/500
508/508 [==============================] - 0s 650us/step - loss: 3552.0276
Epoch 353/500
508/508 [==============================] - 0s 700us/step - loss: 3535.4964
Epoch 354/500
508/508 [==============================] - 0s 673us/step - loss: 3530.4307
Epoch 355/500
508/508 [==============================] - 0s 622us/step - loss: 3543.1779
Epoch 356/500
508/508 [==============================] - 0s 541us/step - loss: 3559.3337
Epoch 357/500
508/508 [==============================] - 0s 632us/step - loss: 3531.0101
Epoch 358/500
508/508 [==============================] - 0s 584us/step - loss: 3518.0727
Epoch 359/500
508/508 [==============================] - 0s 683us/step - loss: 3494.4039
Epoch 360/500
508/508 [==============================] - 0s 595us/step - loss: 3532.3482
Epoch 361/500
508/508 [==============================] - 0s 665us/step - loss: 3512.6514
Epoch 362/500
508/508 [==============================] - 0s 607us/step - loss: 3502.8920
Epoch 363/500
508/508 [==============================] - 0s 567us/step - loss: 3513.3853
Epoch 364/500
508/508 [==============================] - 0s 645us/step - loss: 3520.4927
Epoch 365/500
508/508 [==============================] - 0s 573us/step - loss: 3509.6426
Epoch 366/500
508/508 [==============================] - 0s 578us/step - loss: 3533.0281
Epoch 367/500
508/508 [==============================] - 0s 562us/step - loss: 3510.0322
Epoch 368/500
508/508 [==============================] - 0s 609us/step - loss: 3517.7466
Epoch 369/500
508/508 [==============================] - 0s 559us/step - loss: 3460.1077
Epoch 370/500
508/508 [==============================] - 0s 569us/step - loss: 3471.8885
Epoch 371/500
508/508 [==============================] - 0s 593us/step - loss: 3470.7522
```

```
Epoch 372/500
508/508 [==============================] - 0s 726us/step - loss: 3459.7303
Epoch 373/500
508/508 [==============================] - 0s 533us/step - loss: 3477.2779
Epoch 374/500
508/508 [==============================] - 0s 552us/step - loss: 3457.3309
Epoch 375/500
508/508 [==============================] - 0s 622us/step - loss: 3481.2928
Epoch 376/500
508/508 [==============================] - 0s 547us/step - loss: 3497.4622
Epoch 377/500
508/508 [==============================] - 0s 544us/step - loss: 3516.2238
Epoch 378/500
508/508 [==============================] - 0s 565us/step - loss: 3471.9567
Epoch 379/500
508/508 [==============================] - 0s 640us/step - loss: 3462.5365
Epoch 380/500
508/508 [==============================] - 0s 556us/step - loss: 3461.8921
Epoch 381/500
508/508 [==============================] - 0s 574us/step - loss: 3431.9245
Epoch 382/500
508/508 [==============================] - 0s 619us/step - loss: 3437.8900
Epoch 383/500
508/508 [==============================] - 0s 551us/step - loss: 3461.0727
Epoch 384/500
508/508 [==============================] - 0s 547us/step - loss: 3457.5170
Epoch 385/500
508/508 [==============================] - 0s 542us/step - loss: 3449.3305
Epoch 386/500
508/508 [==============================] - 0s 669us/step - loss: 3469.6620
Epoch 387/500
508/508 [==============================] - 0s 678us/step - loss: 3429.2381
Epoch 388/500
508/508 [==============================] - 0s 557us/step - loss: 3393.5117
Epoch 389/500
508/508 [==============================] - 0s 643us/step - loss: 3491.8042
Epoch 390/500
508/508 [==============================] - 0s 605us/step - loss: 3438.0077
Epoch 391/500
508/508 [==============================] - 0s 605us/step - loss: 3445.1521
Epoch 392/500
508/508 [==============================] - 0s 676us/step - loss: 3444.2756
Epoch 393/500
508/508 [==============================] - 0s 689us/step - loss: 3420.4562
Epoch 394/500
508/508 [==============================] - 0s 577us/step - loss: 3436.0254
Epoch 395/500
508/508 [==============================] - 0s 563us/step - loss: 3451.9370
```

```
Epoch 396/500
508/508 [==============================] - 0s 657us/step - loss: 3426.5062
Epoch 397/500
508/508 [==============================] - 0s 577us/step - loss: 3401.3002
Epoch 398/500
508/508 [==============================] - 0s 571us/step - loss: 3392.4268
Epoch 399/500
508/508 [==============================] - 0s 562us/step - loss: 3398.4453
Epoch 400/500
508/508 [==============================] - 0s 659us/step - loss: 3361.9500
Epoch 401/500
508/508 [==============================] - 0s 560us/step - loss: 3396.8318
Epoch 402/500
508/508 [==============================] - 0s 579us/step - loss: 3409.3589
Epoch 403/500
508/508 [==============================] - 0s 567us/step - loss: 3388.3032
Epoch 404/500
508/508 [==============================] - 0s 640us/step - loss: 3405.3654
Epoch 405/500
508/508 [==============================] - 0s 575us/step - loss: 3379.2761
Epoch 406/500
508/508 [==============================] - 0s 577us/step - loss: 3397.4700
Epoch 407/500
508/508 [==============================] - 0s 741us/step - loss: 3352.3358
Epoch 408/500
508/508 [==============================] - 0s 569us/step - loss: 3374.8806
Epoch 409/500
508/508 [==============================] - 0s 562us/step - loss: 3377.1524
Epoch 410/500
508/508 [==============================] - 0s 575us/step - loss: 3372.2900
Epoch 411/500
508/508 [==============================] - 0s 665us/step - loss: 3350.5732
Epoch 412/500
508/508 [==============================] - 0s 556us/step - loss: 3364.7544
Epoch 413/500
508/508 [==============================] - 0s 581us/step - loss: 3383.4802
Epoch 414/500
508/508 [==============================] - 0s 619us/step - loss: 3396.4311
Epoch 415/500
508/508 [==============================] - 0s 552us/step - loss: 3369.9570
Epoch 416/500
508/508 [==============================] - 0s 563us/step - loss: 3355.6296
Epoch 417/500
508/508 [==============================] - 0s 604us/step - loss: 3345.8667
Epoch 418/500
508/508 [==============================] - 0s 644us/step - loss: 3366.4249
Epoch 419/500
508/508 [==============================] - 0s 565us/step - loss: 3379.6305
```

```
Epoch 420/500
508/508 [==============================] - 0s 575us/step - loss: 3302.8693
Epoch 421/500
508/508 [==============================] - 0s 638us/step - loss: 3408.7019
Epoch 422/500
508/508 [==============================] - 0s 564us/step - loss: 3335.5639
Epoch 423/500
508/508 [==============================] - 0s 570us/step - loss: 3343.6550
Epoch 424/500
508/508 [==============================] - 0s 573us/step - loss: 3357.3050
Epoch 425/500
508/508 [==============================] - 0s 669us/step - loss: 3358.7729
Epoch 426/500
508/508 [==============================] - 0s 575us/step - loss: 3293.6016
Epoch 427/500
508/508 [==============================] - 0s 602us/step - loss: 3335.8216
Epoch 428/500
508/508 [==============================] - 0s 597us/step - loss: 3324.3105
Epoch 429/500
508/508 [==============================] - 0s 596us/step - loss: 3301.1021
Epoch 430/500
508/508 [==============================] - 0s 561us/step - loss: 3348.4411
Epoch 431/500
508/508 [==============================] - 0s 554us/step - loss: 3312.4339
Epoch 432/500
508/508 [==============================] - 0s 672us/step - loss: 3335.5928
Epoch 433/500
508/508 [==============================] - 0s 579us/step - loss: 3326.7150
Epoch 434/500
508/508 [==============================] - 0s 639us/step - loss: 3318.9642
Epoch 435/500
508/508 [==============================] - 0s 629us/step - loss: 3326.1708
Epoch 436/500
508/508 [==============================] - 0s 591us/step - loss: 3367.8153
Epoch 437/500
508/508 [==============================] - 0s 550us/step - loss: 3328.5460
Epoch 438/500
508/508 [==============================] - 0s 582us/step - loss: 3309.3052
Epoch 439/500
508/508 [==============================] - 0s 639us/step - loss: 3337.7205
Epoch 440/500
508/508 [==============================] - 0s 640us/step - loss: 3356.1507
Epoch 441/500
508/508 [==============================] - 0s 584us/step - loss: 3336.6112
Epoch 442/500
508/508 [==============================] - 0s 582us/step - loss: 3305.8430
Epoch 443/500
508/508 [==============================] - 0s 682us/step - loss: 3311.0758
```

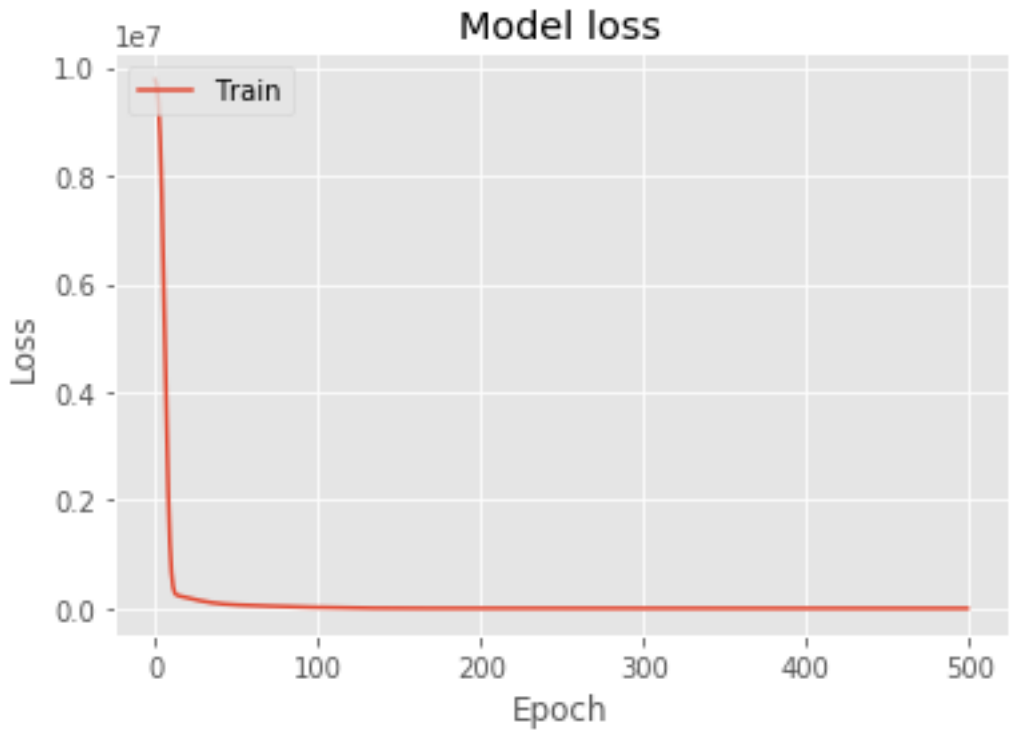
```
Epoch 444/500
508/508 [==============================] - 0s 705us/step - loss: 3293.8067
Epoch 445/500
508/508 [==============================] - 0s 583us/step - loss: 3312.2947
Epoch 446/500
508/508 [==============================] - 0s 628us/step - loss: 3282.8458
Epoch 447/500
508/508 [==============================] - 0s 581us/step - loss: 3304.2757
Epoch 448/500
508/508 [==============================] - 0s 569us/step - loss: 3288.8612
Epoch 449/500
508/508 [==============================] - 0s 646us/step - loss: 3301.9717
Epoch 450/500
508/508 [==============================] - 0s 589us/step - loss: 3301.1302
Epoch 451/500
508/508 [==============================] - 0s 574us/step - loss: 3277.2411
Epoch 452/500
508/508 [==============================] - 0s 578us/step - loss: 3297.6784
Epoch 453/500
508/508 [==============================] - 0s 775us/step - loss: 3261.1601
Epoch 454/500
508/508 [==============================] - 0s 573us/step - loss: 3298.4230
Epoch 455/500
508/508 [==============================] - 0s 581us/step - loss: 3263.6782
Epoch 456/500
508/508 [==============================] - 0s 650us/step - loss: 3276.16480s -
los
Epoch 457/500
508/508 [==============================] - 0s 588us/step - loss: 3272.9931
Epoch 458/500
508/508 [==============================] - 0s 563us/step - loss: 3276.5292
Epoch 459/500
508/508 [==============================] - 0s 591us/step - loss: 3278.7048
Epoch 460/500
508/508 [==============================] - 0s 602us/step - loss: 3275.0609
Epoch 461/500
508/508 [==============================] - 0s 552us/step - loss: 3260.3850
Epoch 462/500
508/508 [==============================] - 0s 577us/step - loss: 3265.1818
Epoch 463/500
508/508 [==============================] - 0s 638us/step - loss: 3259.3282
Epoch 464/500
508/508 [==============================] - 0s 565us/step - loss: 3289.9041: 0s -
loss:
Epoch 465/500
508/508 [==============================] - 0s 597us/step - loss: 3272.3405
Epoch 466/500
508/508 [==============================] - 0s 561us/step - loss: 3242.1568
```

```
Epoch 467/500
508/508 [==============================] - 0s 653us/step - loss: 3249.3821
Epoch 468/500
508/508 [==============================] - 0s 567us/step - loss: 3262.5191
Epoch 469/500
508/508 [==============================] - 0s 570us/step - loss: 3231.6073
Epoch 470/500
508/508 [==============================] - 0s 558us/step - loss: 3258.6880
Epoch 471/500
508/508 [==============================] - 0s 635us/step - loss: 3243.6835
Epoch 472/500
508/508 [==============================] - 0s 583us/step - loss: 3213.7271
Epoch 473/500
508/508 [==============================] - 0s 639us/step - loss: 3283.0517
Epoch 474/500
508/508 [==============================] - 0s 710us/step - loss: 3244.6243
Epoch 475/500
508/508 [==============================] - 0s 559us/step - loss: 3251.7626
Epoch 476/500
508/508 [==============================] - 0s 581us/step - loss: 3228.7846
Epoch 477/500
508/508 [==============================] - 0s 570us/step - loss: 3264.5133
Epoch 478/500
508/508 [==============================] - 0s 602us/step - loss: 3233.4588
Epoch 479/500
508/508 [==============================] - 0s 564us/step - loss: 3253.6699
Epoch 480/500
508/508 [==============================] - 0s 558us/step - loss: 3243.0297
Epoch 481/500
508/508 [==============================] - 0s 614us/step - loss: 3201.3072
Epoch 482/500
508/508 [==============================] - 0s 541us/step - loss: 3267.1046
Epoch 483/500
508/508 [==============================] - 0s 563us/step - loss: 3264.6379
Epoch 484/500
508/508 [==============================] - 0s 572us/step - loss: 3220.3462
Epoch 485/500
508/508 [==============================] - 0s 659us/step - loss: 3226.3068
Epoch 486/500
508/508 [==============================] - 0s 563us/step - loss: 3212.2779
Epoch 487/500
508/508 [==============================] - 0s 563us/step - loss: 3210.1816
Epoch 488/500
508/508 [==============================] - 0s 632us/step - loss: 3198.1603
Epoch 489/500
508/508 [==============================] - 0s 573us/step - loss: 3206.2143
Epoch 490/500
508/508 [==============================] - 0s 568us/step - loss: 3178.2568
```

```
Epoch 491/500
508/508 [==============================] - 0s 571us/step - loss: 3324.6960
Epoch 492/500
508/508 [==============================] - 0s 664us/step - loss: 3224.8130
Epoch 493/500
508/508 [==============================] - 0s 564us/step - loss: 3150.5516
Epoch 494/500
508/508 [==============================] - 0s 556us/step - loss: 3275.9398
Epoch 495/500
508/508 [==============================] - 0s 576us/step - loss: 3230.8911
Epoch 496/500
508/508 [==============================] - 0s 645us/step - loss: 3220.5238
Epoch 497/500
508/508 [==============================] - 0s 593us/step - loss: 3205.3119
Epoch 498/500
508/508 [==============================] - 0s 575us/step - loss: 3192.8647
Epoch 499/500
508/508 [==============================] - 0s 656us/step - loss: 3219.5106
Epoch 500/500
508/508 [==============================] - 0s 576us/step - loss: 3232.4796
```

[170]:
```
plt.plot(history.history['loss'])

plt.title('Model loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='upper left')
plt.show()
```



[171]:
```
from sklearn.metrics import accuracy_score
prediction = estimator.predict(X_test_1)
```

```
128/128 [==============================] - 0s 3ms/step
```

[172]:
```
estimator.score(X_test_1,y_test_1)
```

```
128/128 [==============================] - 0s 3ms/step
```

[172]:
```
-4288.3324654102325
```

[173]:
```
print('MAE ',mean_absolute_error(y_test_1,prediction))
```

```
MAE  48.05379222106933
```

[174]:
```
from sklearn.metrics import r2_score
print("r_square score: ", r2_score(y_test_1,prediction))
```

```
r_square score:  0.9309478369586071
```

[175]:
```
train_error =  np.abs(y_test_1 - prediction)
mean_error = np.mean(train_error)
min_error = np.min(train_error)
max_error = np.max(train_error)
```

```
std_error = np.std(train_error)
```

[176]:
```
print("std_error: ",std_error)
print("mean_error: ",mean_error)
print("min_error: ",min_error)
print("max_error: ",max_error)
```

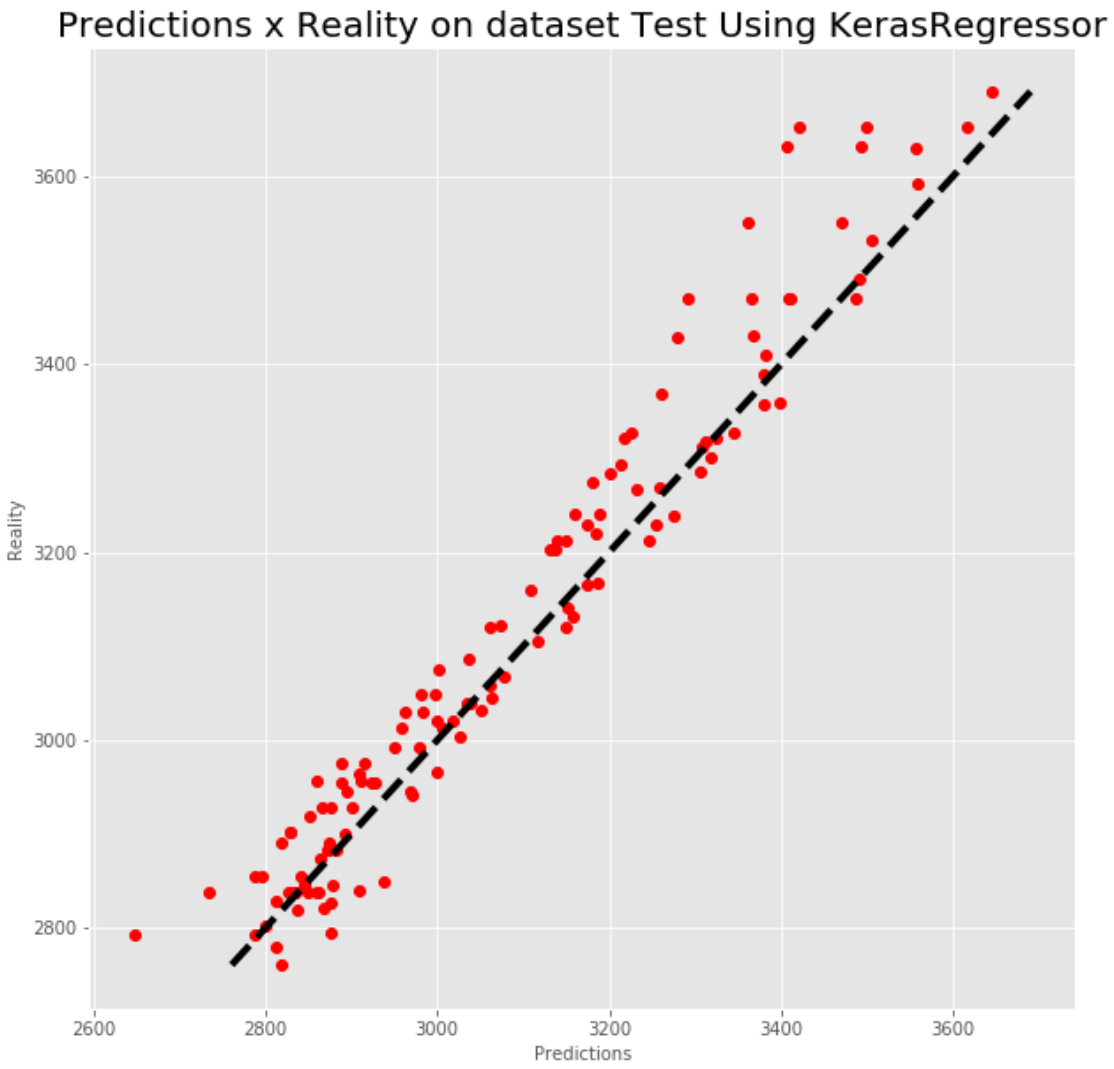
```
std_error:  44.487803650147704
mean_error:  48.05379222106933
min_error:  0.15003320312462165
max_error:  231.48987695312462
```

[178]:
```
preds4 = estimator.predict(X_test_1)

plt.style.use('ggplot')
matplotlib.rc('xtick', labelsize=10)
matplotlib.rc('ytick', labelsize=10)

fig, ax = plt.subplots(figsize=(10, 10))
plt.plot(preds4, y_valid, 'ro')
plt.xlabel('Predictions', fontsize = 10)
plt.ylabel('Reality', fontsize=10)
plt.title('Predictions x Reality on dataset Test Using KerasRegressor',␣
 ↪fontsize = 20)
ax.plot([y_test_1.min(), y_test_1.max()], [y_test_1.min(), y_test_1.max()],␣
 ↪'k--', lw=4)
plt.show()
```

```
128/128 [==============================] - 0s 367us/step
```



1.11 RandomForest

RandomForestRegressor is generally best suited for the regression type of problems in ML. We shall add one to check it works better than Neuralnet

MAE = 21 minimal error in all the models.

[179]:
```
from sklearn.ensemble import RandomForestRegressor

model2 =␣
 ↪RandomForestRegressor(n_estimators=100,random_state=0,criterion='mae',max_depth=10)
model2.fit(X_train,y_train)
model2.score(X_val,y_valid)
```

[179]: 0.991053127839923

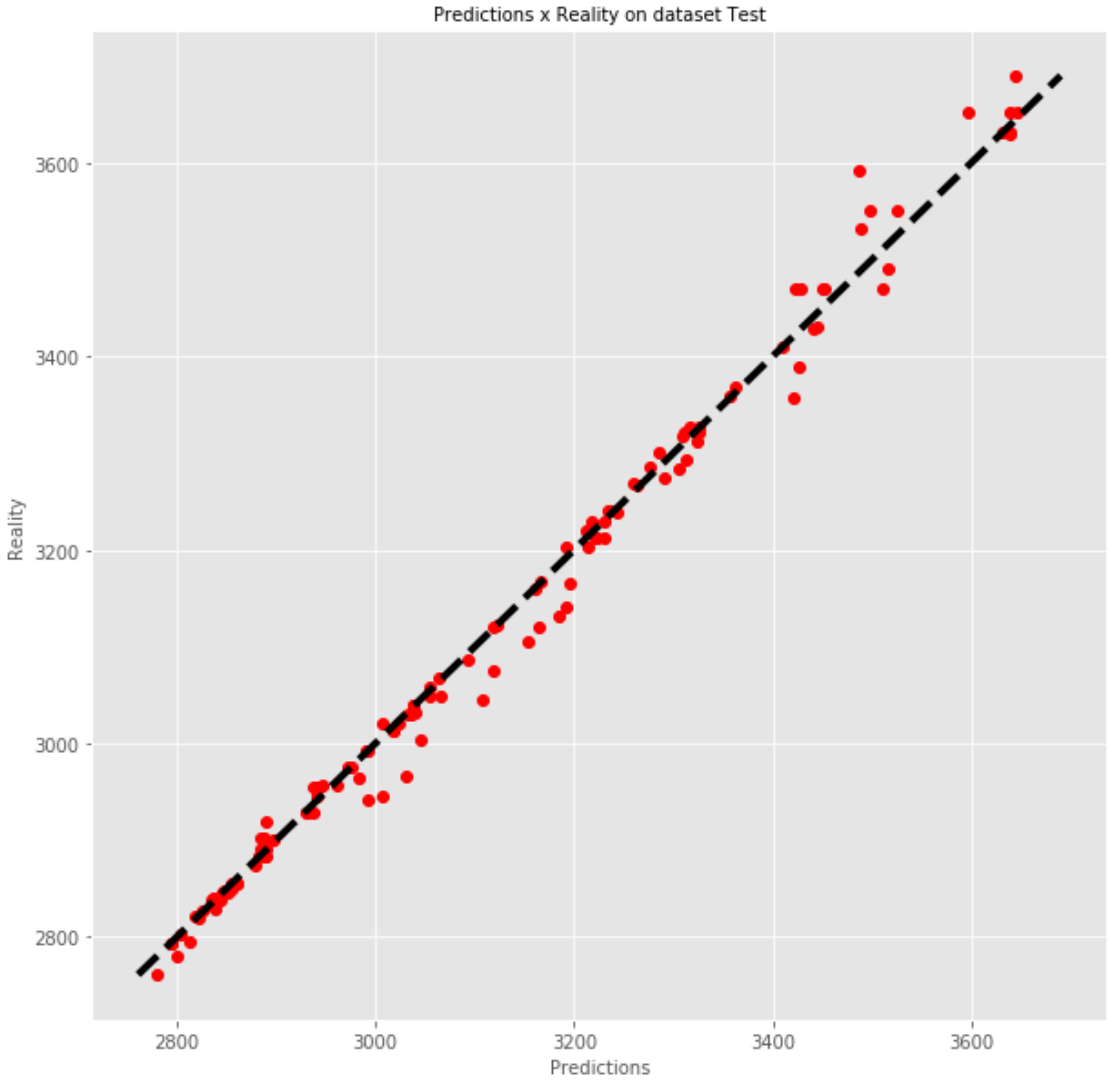
[180]:
```
#making the predictions
prediction4 = model2.predict(X_val)
```

[182]:
```
mean_absolute_error(y_valid,prediction4)
```

[182]: 14.808303906250103

[183]:
```
plt.style.use('ggplot')
matplotlib.rc('xtick', labelsize=10)
matplotlib.rc('ytick', labelsize=10)

fig, ax = plt.subplots(figsize=(10, 10))
plt.plot(prediction4, y_valid, 'ro')
plt.xlabel('Predictions', fontsize = 10)
plt.ylabel('Reality', fontsize=10)
plt.title('Predictions x Reality on dataset Test', fontsize = 10)
ax.plot([y_valid.min(), y_valid.max()], [y_valid.min(), y_valid.max()], 'k--',␣
↪lw=4)
plt.show()
```



[121]:
```
from xgboost import XGBRegressor

model5 = XGBRegressor(n_estimators=500,learning_rate=0.01)
model5.fit(X_train_1,y_train_1,early_stopping_rounds=5,␣
 ↪eval_set=[(X_test_1,y_test_1)],verbose=True )

# model5.fit(X_train_1,y_train_1)
```

```
[16:42:59] WARNING: src/objective/regression_obj.cu:152: reg:linear is now
deprecated in favor of reg:squarederror.
[0]     validation_0-rmse:3088.9
Will train until validation_0-rmse hasn't improved in 5 rounds.
[1]     validation_0-rmse:3058.12
[2]     validation_0-rmse:3027.75
```

```
[3]     validation_0-rmse:2997.57
[4]     validation_0-rmse:2967.8
[5]     validation_0-rmse:2938.22
[6]     validation_0-rmse:2909.05
[7]     validation_0-rmse:2880.11
[8]     validation_0-rmse:2851.5
[9]     validation_0-rmse:2823.09
[10]    validation_0-rmse:2794.98
[11]    validation_0-rmse:2767.21
[12]    validation_0-rmse:2739.69
[13]    validation_0-rmse:2712.49
[14]    validation_0-rmse:2685.49
[15]    validation_0-rmse:2658.73
[16]    validation_0-rmse:2632.32
[17]    validation_0-rmse:2606.11
[18]    validation_0-rmse:2580.23
[19]    validation_0-rmse:2554.61
[20]    validation_0-rmse:2529.18
[21]    validation_0-rmse:2504.07
[22]    validation_0-rmse:2479.14
[23]    validation_0-rmse:2454.52
[24]    validation_0-rmse:2430.1
[25]    validation_0-rmse:2405.91
[26]    validation_0-rmse:2382
[27]    validation_0-rmse:2358.36
[28]    validation_0-rmse:2334.96
[29]    validation_0-rmse:2311.72
[30]    validation_0-rmse:2288.75
[31]    validation_0-rmse:2266.04
[32]    validation_0-rmse:2243.49
[33]    validation_0-rmse:2221.2
[34]    validation_0-rmse:2199.2
[35]    validation_0-rmse:2177.37
[36]    validation_0-rmse:2155.71
[37]    validation_0-rmse:2134.3
[38]    validation_0-rmse:2113.16
[39]    validation_0-rmse:2092.2
[40]    validation_0-rmse:2071.42
[41]    validation_0-rmse:2050.91
[42]    validation_0-rmse:2030.61
[43]    validation_0-rmse:2010.41
[44]    validation_0-rmse:1990.45
[45]    validation_0-rmse:1970.69
[46]    validation_0-rmse:1951.15
[47]    validation_0-rmse:1931.74
[48]    validation_0-rmse:1912.58
[49]    validation_0-rmse:1893.56
[50]    validation_0-rmse:1874.91
```

```
[51]    validation_0-rmse:1856.31
[52]    validation_0-rmse:1837.89
[53]    validation_0-rmse:1819.58
[54]    validation_0-rmse:1801.56
[55]    validation_0-rmse:1783.61
[56]    validation_0-rmse:1766.02
[57]    validation_0-rmse:1748.54
[58]    validation_0-rmse:1731.23
[59]    validation_0-rmse:1713.99
[60]    validation_0-rmse:1697.1
[61]    validation_0-rmse:1680.3
[62]    validation_0-rmse:1663.8
[63]    validation_0-rmse:1647.23
[64]    validation_0-rmse:1630.93
[65]    validation_0-rmse:1614.87
[66]    validation_0-rmse:1599.01
[67]    validation_0-rmse:1583.2
[68]    validation_0-rmse:1567.44
[69]    validation_0-rmse:1551.96
[70]    validation_0-rmse:1536.63
[71]    validation_0-rmse:1521.51
[72]    validation_0-rmse:1506.58
[73]    validation_0-rmse:1491.59
[74]    validation_0-rmse:1476.86
[75]    validation_0-rmse:1462.32
[76]    validation_0-rmse:1447.82
[77]    validation_0-rmse:1433.53
[78]    validation_0-rmse:1419.32
[79]    validation_0-rmse:1405.37
[80]    validation_0-rmse:1391.59
[81]    validation_0-rmse:1377.82
[82]    validation_0-rmse:1364.31
[83]    validation_0-rmse:1350.81
[84]    validation_0-rmse:1337.58
[85]    validation_0-rmse:1324.33
[86]    validation_0-rmse:1311.36
[87]    validation_0-rmse:1298.4
[88]    validation_0-rmse:1285.54
[89]    validation_0-rmse:1272.96
[90]    validation_0-rmse:1260.36
[91]    validation_0-rmse:1248.02
[92]    validation_0-rmse:1235.75
[93]    validation_0-rmse:1223.52
[94]    validation_0-rmse:1211.5
[95]    validation_0-rmse:1199.48
[96]    validation_0-rmse:1187.72
[97]    validation_0-rmse:1175.98
[98]    validation_0-rmse:1164.46
```

```
[99]    validation_0-rmse:1153.04
[100]   validation_0-rmse:1141.62
[101]   validation_0-rmse:1130.41
[102]   validation_0-rmse:1119.29
[103]   validation_0-rmse:1108.21
[104]   validation_0-rmse:1097.29
[105]   validation_0-rmse:1086.46
[106]   validation_0-rmse:1075.78
[107]   validation_0-rmse:1065.12
[108]   validation_0-rmse:1054.65
[109]   validation_0-rmse:1044.3
[110]   validation_0-rmse:1033.96
[111]   validation_0-rmse:1023.8
[112]   validation_0-rmse:1013.76
[113]   validation_0-rmse:1003.71
[114]   validation_0-rmse:993.851
[115]   validation_0-rmse:984.059
[116]   validation_0-rmse:974.413
[117]   validation_0-rmse:964.77
[118]   validation_0-rmse:955.268
[119]   validation_0-rmse:945.892
[120]   validation_0-rmse:936.615
[121]   validation_0-rmse:927.395
[122]   validation_0-rmse:918.31
[123]   validation_0-rmse:909.268
[124]   validation_0-rmse:900.36
[125]   validation_0-rmse:891.46
[126]   validation_0-rmse:882.744
[127]   validation_0-rmse:874.106
[128]   validation_0-rmse:865.504
[129]   validation_0-rmse:857.037
[130]   validation_0-rmse:848.609
[131]   validation_0-rmse:840.316
[132]   validation_0-rmse:832.053
[133]   validation_0-rmse:823.866
[134]   validation_0-rmse:815.818
[135]   validation_0-rmse:807.767
[136]   validation_0-rmse:799.868
[137]   validation_0-rmse:792.032
[138]   validation_0-rmse:784.174
[139]   validation_0-rmse:776.511
[140]   validation_0-rmse:768.879
[141]   validation_0-rmse:761.378
[142]   validation_0-rmse:753.934
[143]   validation_0-rmse:746.519
[144]   validation_0-rmse:739.236
[145]   validation_0-rmse:731.968
[146]   validation_0-rmse:724.823
```

```
[147]   validation_0-rmse:717.7
[148]   validation_0-rmse:710.647
[149]   validation_0-rmse:703.715
[150]   validation_0-rmse:696.789
[151]   validation_0-rmse:689.937
[152]   validation_0-rmse:683.216
[153]   validation_0-rmse:676.532
[154]   validation_0-rmse:669.841
[155]   validation_0-rmse:663.316
[156]   validation_0-rmse:656.832
[157]   validation_0-rmse:650.419
[158]   validation_0-rmse:644.033
[159]   validation_0-rmse:637.77
[160]   validation_0-rmse:631.529
[161]   validation_0-rmse:625.327
[162]   validation_0-rmse:619.234
[163]   validation_0-rmse:613.161
[164]   validation_0-rmse:607.205
[165]   validation_0-rmse:601.256
[166]   validation_0-rmse:595.38
[167]   validation_0-rmse:589.548
[168]   validation_0-rmse:583.781
[169]   validation_0-rmse:578.117
[170]   validation_0-rmse:572.458
[171]   validation_0-rmse:566.881
[172]   validation_0-rmse:561.32
[173]   validation_0-rmse:555.875
[174]   validation_0-rmse:550.489
[175]   validation_0-rmse:545.101
[176]   validation_0-rmse:539.78
[177]   validation_0-rmse:534.591
[178]   validation_0-rmse:529.409
[179]   validation_0-rmse:524.266
[180]   validation_0-rmse:519.175
[181]   validation_0-rmse:514.165
[182]   validation_0-rmse:509.128
[183]   validation_0-rmse:504.221
[184]   validation_0-rmse:499.306
[185]   validation_0-rmse:494.442
[186]   validation_0-rmse:489.672
[187]   validation_0-rmse:484.866
[188]   validation_0-rmse:480.173
[189]   validation_0-rmse:475.493
[190]   validation_0-rmse:470.863
[191]   validation_0-rmse:466.335
[192]   validation_0-rmse:461.823
[193]   validation_0-rmse:457.336
[194]   validation_0-rmse:452.886
```

```
[195]   validation_0-rmse:448.483
[196]   validation_0-rmse:444.151
[197]   validation_0-rmse:439.865
[198]   validation_0-rmse:435.554
[199]   validation_0-rmse:431.342
[200]   validation_0-rmse:427.207
[201]   validation_0-rmse:423.034
[202]   validation_0-rmse:418.989
[203]   validation_0-rmse:414.952
[204]   validation_0-rmse:410.959
[205]   validation_0-rmse:406.941
[206]   validation_0-rmse:403.034
[207]   validation_0-rmse:399.105
[208]   validation_0-rmse:395.253
[209]   validation_0-rmse:391.457
[210]   validation_0-rmse:387.645
[211]   validation_0-rmse:383.925
[212]   validation_0-rmse:380.246
[213]   validation_0-rmse:376.538
[214]   validation_0-rmse:372.921
[215]   validation_0-rmse:369.348
[216]   validation_0-rmse:365.805
[217]   validation_0-rmse:362.264
[218]   validation_0-rmse:358.759
[219]   validation_0-rmse:355.268
[220]   validation_0-rmse:351.849
[221]   validation_0-rmse:348.485
[222]   validation_0-rmse:345.117
[223]   validation_0-rmse:341.848
[224]   validation_0-rmse:338.548
[225]   validation_0-rmse:335.297
[226]   validation_0-rmse:332.101
[227]   validation_0-rmse:328.96
[228]   validation_0-rmse:325.791
[229]   validation_0-rmse:322.678
[230]   validation_0-rmse:319.57
[231]   validation_0-rmse:316.528
[232]   validation_0-rmse:313.543
[233]   validation_0-rmse:310.527
[234]   validation_0-rmse:307.578
[235]   validation_0-rmse:304.613
[236]   validation_0-rmse:301.737
[237]   validation_0-rmse:298.918
[238]   validation_0-rmse:296.118
[239]   validation_0-rmse:293.31
[240]   validation_0-rmse:290.549
[241]   validation_0-rmse:287.846
[242]   validation_0-rmse:285.124
```

```
[243]   validation_0-rmse:282.415
[244]   validation_0-rmse:279.791
[245]   validation_0-rmse:277.151
[246]   validation_0-rmse:274.523
[247]   validation_0-rmse:271.991
[248]   validation_0-rmse:269.456
[249]   validation_0-rmse:266.911
[250]   validation_0-rmse:264.455
[251]   validation_0-rmse:261.97
[252]   validation_0-rmse:259.487
[253]   validation_0-rmse:257.105
[254]   validation_0-rmse:254.696
[255]   validation_0-rmse:252.287
[256]   validation_0-rmse:249.972
[257]   validation_0-rmse:247.624
[258]   validation_0-rmse:245.286
[259]   validation_0-rmse:242.967
[260]   validation_0-rmse:240.697
[261]   validation_0-rmse:238.423
[262]   validation_0-rmse:236.245
[263]   validation_0-rmse:234.098
[264]   validation_0-rmse:231.922
[265]   validation_0-rmse:229.741
[266]   validation_0-rmse:227.577
[267]   validation_0-rmse:225.463
[268]   validation_0-rmse:223.371
[269]   validation_0-rmse:221.272
[270]   validation_0-rmse:219.195
[271]   validation_0-rmse:217.168
[272]   validation_0-rmse:215.132
[273]   validation_0-rmse:213.13
[274]   validation_0-rmse:211.139
[275]   validation_0-rmse:209.211
[276]   validation_0-rmse:207.26
[277]   validation_0-rmse:205.329
[278]   validation_0-rmse:203.452
[279]   validation_0-rmse:201.56
[280]   validation_0-rmse:199.688
[281]   validation_0-rmse:197.898
[282]   validation_0-rmse:196.071
[283]   validation_0-rmse:194.291
[284]   validation_0-rmse:192.493
[285]   validation_0-rmse:190.714
[286]   validation_0-rmse:189.003
[287]   validation_0-rmse:187.256
[288]   validation_0-rmse:185.531
[289]   validation_0-rmse:183.879
[290]   validation_0-rmse:182.221
```

```
[291]   validation_0-rmse:180.572
[292]   validation_0-rmse:178.939
[293]   validation_0-rmse:177.354
[294]   validation_0-rmse:175.768
[295]   validation_0-rmse:174.18
[296]   validation_0-rmse:172.626
[297]   validation_0-rmse:171.074
[298]   validation_0-rmse:169.54
[299]   validation_0-rmse:168.05
[300]   validation_0-rmse:166.529
[301]   validation_0-rmse:165.054
[302]   validation_0-rmse:163.58
[303]   validation_0-rmse:162.147
[304]   validation_0-rmse:160.706
[305]   validation_0-rmse:159.307
[306]   validation_0-rmse:157.911
[307]   validation_0-rmse:156.499
[308]   validation_0-rmse:155.124
[309]   validation_0-rmse:153.736
[310]   validation_0-rmse:152.404
[311]   validation_0-rmse:151.078
[312]   validation_0-rmse:149.751
[313]   validation_0-rmse:148.4
[314]   validation_0-rmse:147.063
[315]   validation_0-rmse:145.778
[316]   validation_0-rmse:144.513
[317]   validation_0-rmse:143.246
[318]   validation_0-rmse:141.998
[319]   validation_0-rmse:140.727
[320]   validation_0-rmse:139.483
[321]   validation_0-rmse:138.243
[322]   validation_0-rmse:136.987
[323]   validation_0-rmse:135.796
[324]   validation_0-rmse:134.621
[325]   validation_0-rmse:133.454
[326]   validation_0-rmse:132.282
[327]   validation_0-rmse:131.109
[328]   validation_0-rmse:129.994
[329]   validation_0-rmse:128.858
[330]   validation_0-rmse:127.74
[331]   validation_0-rmse:126.626
[332]   validation_0-rmse:125.528
[333]   validation_0-rmse:124.426
[334]   validation_0-rmse:123.362
[335]   validation_0-rmse:122.306
[336]   validation_0-rmse:121.248
[337]   validation_0-rmse:120.202
[338]   validation_0-rmse:119.155
```

```
[339]   validation_0-rmse:118.169
[340]   validation_0-rmse:117.15
[341]   validation_0-rmse:116.141
[342]   validation_0-rmse:115.122
[343]   validation_0-rmse:114.114
[344]   validation_0-rmse:113.116
[345]   validation_0-rmse:112.136
[346]   validation_0-rmse:111.182
[347]   validation_0-rmse:110.246
[348]   validation_0-rmse:109.289
[349]   validation_0-rmse:108.354
[350]   validation_0-rmse:107.439
[351]   validation_0-rmse:106.527
[352]   validation_0-rmse:105.636
[353]   validation_0-rmse:104.75
[354]   validation_0-rmse:103.879
[355]   validation_0-rmse:103.018
[356]   validation_0-rmse:102.153
[357]   validation_0-rmse:101.304
[358]   validation_0-rmse:100.46
[359]   validation_0-rmse:99.6339
[360]   validation_0-rmse:98.8213
[361]   validation_0-rmse:98.0125
[362]   validation_0-rmse:97.203
[363]   validation_0-rmse:96.4023
[364]   validation_0-rmse:95.6069
[365]   validation_0-rmse:94.8248
[366]   validation_0-rmse:94.0462
[367]   validation_0-rmse:93.2873
[368]   validation_0-rmse:92.5367
[369]   validation_0-rmse:91.788
[370]   validation_0-rmse:91.0377
[371]   validation_0-rmse:90.2957
[372]   validation_0-rmse:89.6022
[373]   validation_0-rmse:88.876
[374]   validation_0-rmse:88.1804
[375]   validation_0-rmse:87.5071
[376]   validation_0-rmse:86.8503
[377]   validation_0-rmse:86.1554
[378]   validation_0-rmse:85.4664
[379]   validation_0-rmse:84.7903
[380]   validation_0-rmse:84.1532
[381]   validation_0-rmse:83.4864
[382]   validation_0-rmse:82.8325
[383]   validation_0-rmse:82.1822
[384]   validation_0-rmse:81.5359
[385]   validation_0-rmse:80.9381
[386]   validation_0-rmse:80.3282
```

```
[387]   validation_0-rmse:79.7084
[388]   validation_0-rmse:79.0968
[389]   validation_0-rmse:78.4854
[390]   validation_0-rmse:77.9144
[391]   validation_0-rmse:77.3213
[392]   validation_0-rmse:76.735
[393]   validation_0-rmse:76.1443
[394]   validation_0-rmse:75.5708
[395]   validation_0-rmse:75.0125
[396]   validation_0-rmse:74.4668
[397]   validation_0-rmse:73.9332
[398]   validation_0-rmse:73.3789
[399]   validation_0-rmse:72.8655
[400]   validation_0-rmse:72.3288
[401]   validation_0-rmse:71.8517
[402]   validation_0-rmse:71.3354
[403]   validation_0-rmse:70.8251
[404]   validation_0-rmse:70.3318
[405]   validation_0-rmse:69.8329
[406]   validation_0-rmse:69.3761
[407]   validation_0-rmse:68.8988
[408]   validation_0-rmse:68.4202
[409]   validation_0-rmse:67.9339
[410]   validation_0-rmse:67.4622
[411]   validation_0-rmse:66.9999
[412]   validation_0-rmse:66.5482
[413]   validation_0-rmse:66.1023
[414]   validation_0-rmse:65.6604
[415]   validation_0-rmse:65.264
[416]   validation_0-rmse:64.8125
[417]   validation_0-rmse:64.3666
[418]   validation_0-rmse:63.931
[419]   validation_0-rmse:63.5062
[420]   validation_0-rmse:63.0932
[421]   validation_0-rmse:62.6762
[422]   validation_0-rmse:62.3123
[423]   validation_0-rmse:61.9613
[424]   validation_0-rmse:61.5542
[425]   validation_0-rmse:61.1371
[426]   validation_0-rmse:60.7505
[427]   validation_0-rmse:60.3438
[428]   validation_0-rmse:59.9678
[429]   validation_0-rmse:59.5799
[430]   validation_0-rmse:59.2235
[431]   validation_0-rmse:58.8616
[432]   validation_0-rmse:58.4873
[433]   validation_0-rmse:58.1282
[434]   validation_0-rmse:57.781
```

```
[435]   validation_0-rmse:57.4286
[436]   validation_0-rmse:57.0894
[437]   validation_0-rmse:56.745
[438]   validation_0-rmse:56.4086
[439]   validation_0-rmse:56.0809
[440]   validation_0-rmse:55.7499
[441]   validation_0-rmse:55.4033
[442]   validation_0-rmse:55.0738
[443]   validation_0-rmse:54.7551
[444]   validation_0-rmse:54.4347
[445]   validation_0-rmse:54.1518
[446]   validation_0-rmse:53.8466
[447]   validation_0-rmse:53.5425
[448]   validation_0-rmse:53.242
[449]   validation_0-rmse:52.9174
[450]   validation_0-rmse:52.6259
[451]   validation_0-rmse:52.3338
[452]   validation_0-rmse:52.0459
[453]   validation_0-rmse:51.7422
[454]   validation_0-rmse:51.4642
[455]   validation_0-rmse:51.1963
[456]   validation_0-rmse:50.9229
[457]   validation_0-rmse:50.672
[458]   validation_0-rmse:50.4069
[459]   validation_0-rmse:50.1385
[460]   validation_0-rmse:49.8955
[461]   validation_0-rmse:49.6324
[462]   validation_0-rmse:49.3899
[463]   validation_0-rmse:49.1433
[464]   validation_0-rmse:48.8939
[465]   validation_0-rmse:48.6351
[466]   validation_0-rmse:48.3946
[467]   validation_0-rmse:48.1532
[468]   validation_0-rmse:47.897
[469]   validation_0-rmse:47.666
[470]   validation_0-rmse:47.4344
[471]   validation_0-rmse:47.2121
[472]   validation_0-rmse:46.9859
[473]   validation_0-rmse:46.7846
[474]   validation_0-rmse:46.5666
[475]   validation_0-rmse:46.3428
[476]   validation_0-rmse:46.1438
[477]   validation_0-rmse:45.9361
[478]   validation_0-rmse:45.7684
[479]   validation_0-rmse:45.5551
[480]   validation_0-rmse:45.3557
[481]   validation_0-rmse:45.1546
[482]   validation_0-rmse:44.9647
```

```
[483]   validation_0-rmse:44.809
[484]   validation_0-rmse:44.6241
[485]   validation_0-rmse:44.4324
[486]   validation_0-rmse:44.2363
[487]   validation_0-rmse:44.0582
[488]   validation_0-rmse:43.9139
[489]   validation_0-rmse:43.7253
[490]   validation_0-rmse:43.5497
[491]   validation_0-rmse:43.3686
[492]   validation_0-rmse:43.1995
[493]   validation_0-rmse:43.0228
[494]   validation_0-rmse:42.8572
[495]   validation_0-rmse:42.684
[496]   validation_0-rmse:42.5561
[497]   validation_0-rmse:42.3879
[498]   validation_0-rmse:42.2332
[499]   validation_0-rmse:42.0681
```

[121]:
```
XGBRegressor(base_score=0.5, booster='gbtree', colsample_bylevel=1,
             colsample_bynode=1, colsample_bytree=1, gamma=0,
             importance_type='gain', learning_rate=0.01, max_delta_step=0,
             max_depth=3, min_child_weight=1, missing=None, n_estimators=500,
             n_jobs=1, nthread=None, objective='reg:linear', random_state=0,
             reg_alpha=0, reg_lambda=1, scale_pos_weight=1, seed=None,
             silent=None, subsample=1, verbosity=1)
```

[122]:
```
pred5 = model5.predict(X_test_1)
score5 = mean_absolute_error(y_test_1,pred5)
score5
```

[122]:
```
31.894299362182426
```

[123]:
```
model5.score(X_test_1,y_test_1)
```

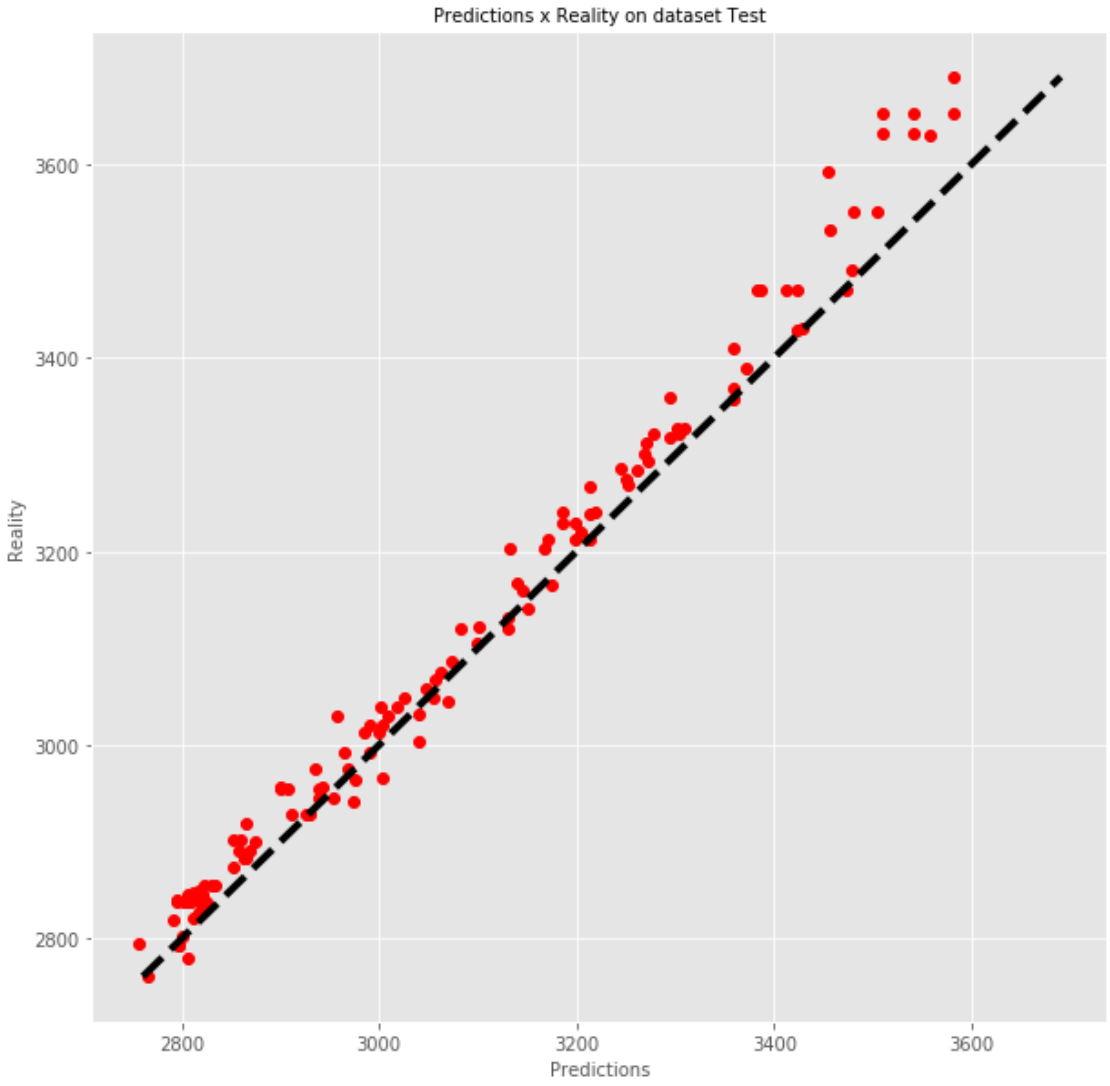
[123]:
```
0.9715032410711822
```

[126]:
```
pred5 = model5.predict(X_test_1)
plt.style.use('ggplot')

matplotlib.rc('xtick', labelsize=10)
matplotlib.rc('ytick', labelsize=10)

fig, ax = plt.subplots(figsize=(10, 10))
plt.plot(pred5, y_test_1, 'ro')
plt.xlabel('Predictions', fontsize = 10)
plt.ylabel('Reality', fontsize=10)
plt.title('Predictions x Reality on dataset Test', fontsize = 10)
```

```
ax.plot([y_test_1.min(), y_test_1.max()], [y_test_1.min(), y_test_1.max()],␣
 ↪'k--', lw=4)
plt.show()
```



[ ]: