HW_1

September 29, 2022

[779]:
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# Anthony Perales
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# Homework 1

# ======================================== 1a ========================================
import pandas as pd
import numpy as np
import matplotlib
import matplotlib.pyplot as plt
import sklearn.datasets as dt
from sklearn.model_selection import train_test_split
df = pandas.read_csv('Housing.csv', header = 0)

list_bm = ['mainroad', 'guestroom', 'basement', 'hotwaterheating',␣
 ↪'airconditioning','prefarea']

def binary_map(x):
    return x.map({'yes': 1, 'no': 0})

df[list_bm] = df[list_bm].apply(binary_map)

price = df['price']
area = df['area']
bedroom = df['bedrooms']
bathroom = df['bathrooms']
stories = df['stories']
mainroad = df['mainroad']
guestroom = df['guestroom']
basement = df['basement']
waterheating = df['hotwaterheating']
ac = df['airconditioning']
parking = df['parking']
prefarea = df['prefarea']
furnished = df['furnishingstatus']

theta_0 = 0
theta_1 = 0
a = 0.1
X = []
Y = df.values[:,0]
theta_old = []
theta_new = []
m = len(price)
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cost_history = []
loss = []
h_pred = []
h_pred2 = []
theta = []


for i in range(m):
    x_list = area[i] + bedroom[i] + bathroom[i] + stories[i] + parking[i]
    X.append(x_list)

for i in range(m):
    h = (X[i] * theta_1) + theta_0
    h_pred.append(h)
    errors = h_pred[i] - Y[i]
    sqrErrors = np.square(errors)
    j = np.sum(sqrErrors)
    loss.append(j/(2*m))

for j in range(m):
    pred = theta_0 + (theta_1 * loss[j])
    h_pred2.append(pred)
    theta_old.append(pred)
    errors = h_pred2[j] - (h_pred[j] + Y[j])
    sum_delta =  (theta_old[j] - errors)
    j_theta = theta_old - sum_delta
    theta.append(j_theta)
    cost = a * (np.square(errors))
    cost_history.append(cost/m)

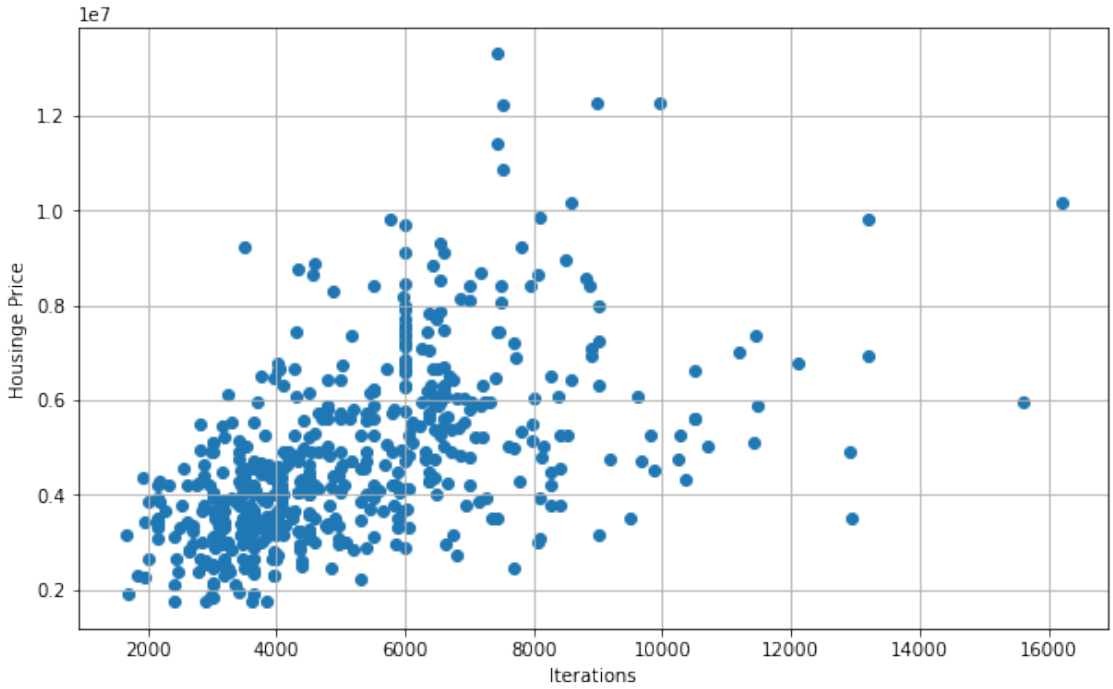
plt.rcParams["figure.figsize"] = (10,6)
plt.grid()
plt.scatter(X,Y)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

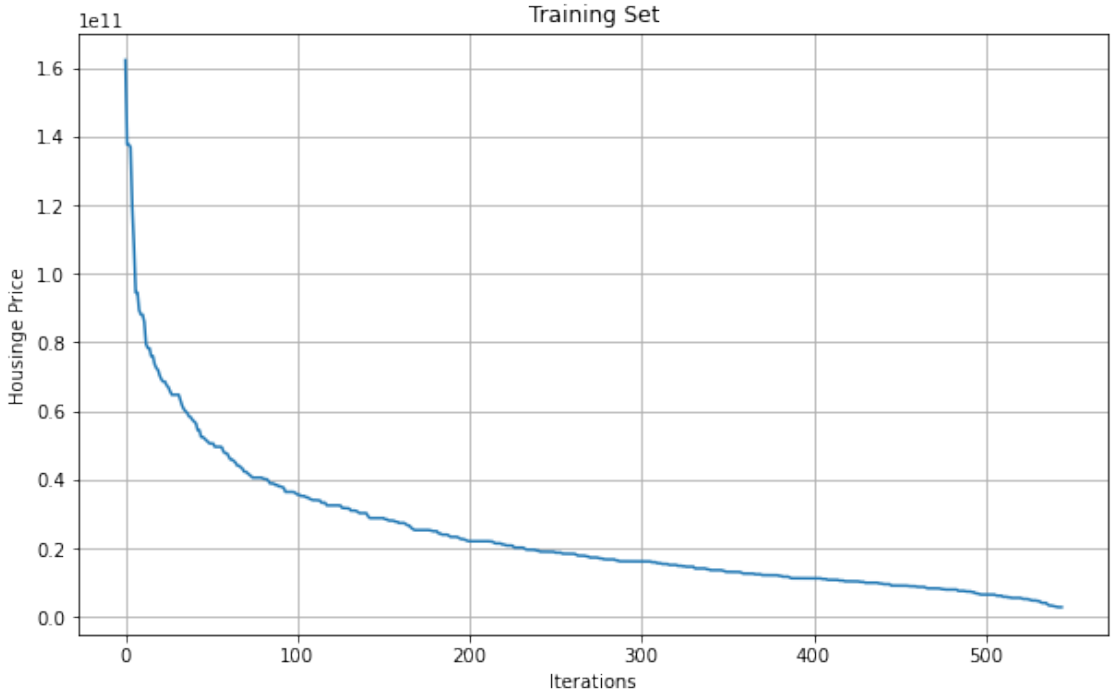
plt.grid()
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.title('Training Set')
plt.show()

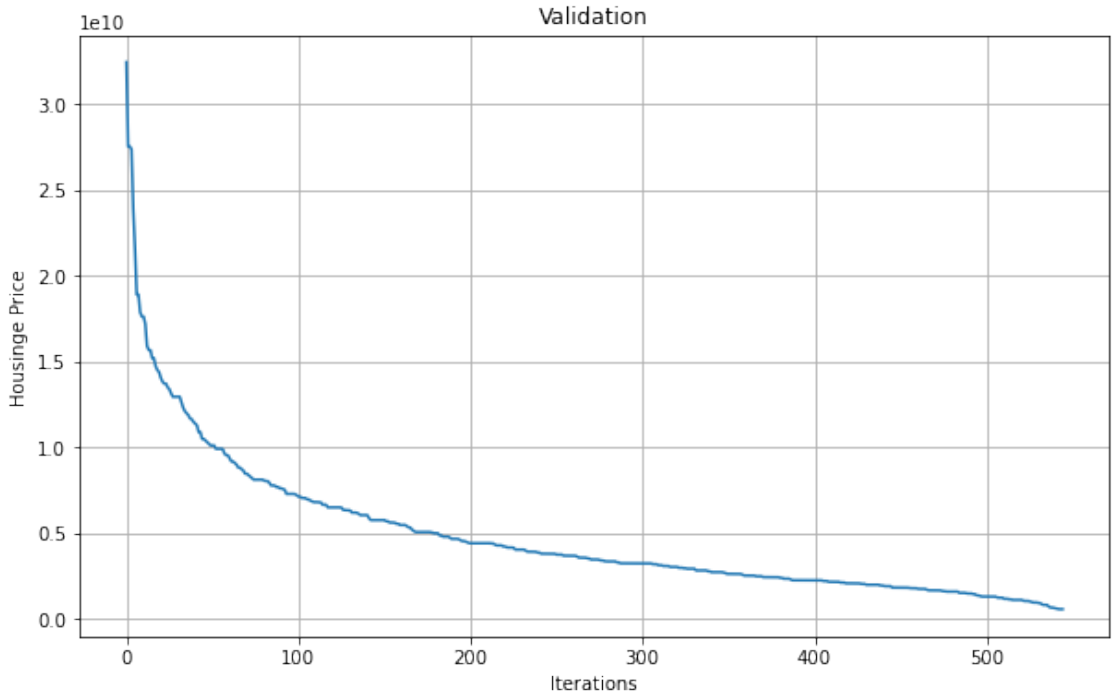
plt.grid()
plt.plot(cost_history)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.title('Validation')
plt.show()

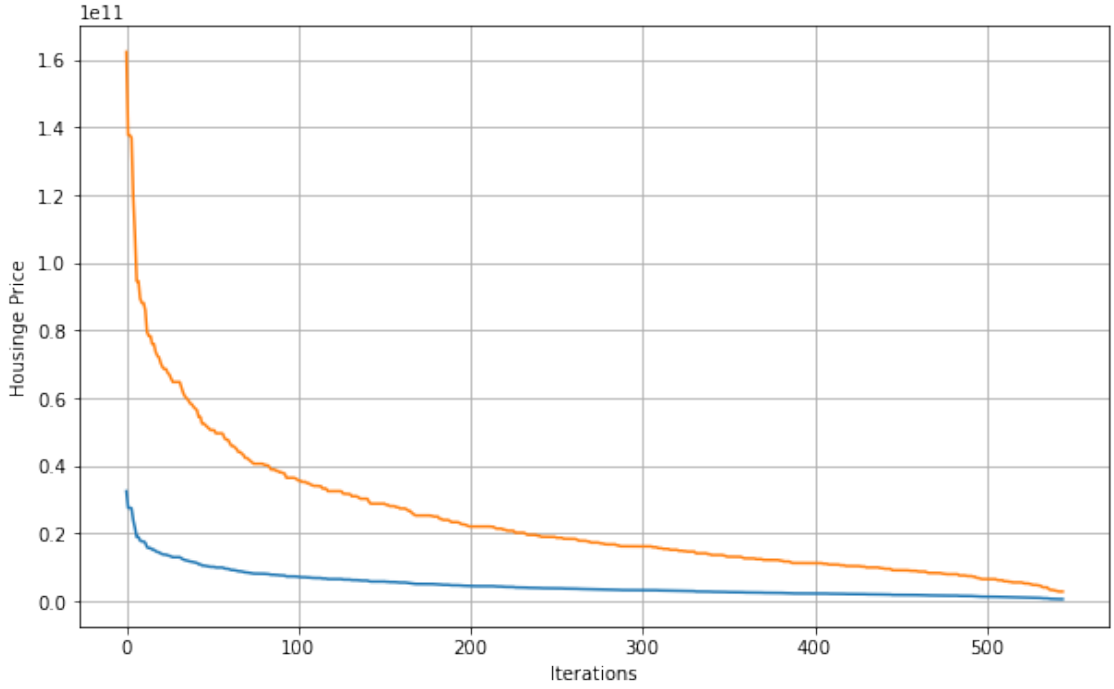

plt.grid()
```

```
plt.plot(cost_history)
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()
```






Validation
1e10
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Housinge Price
0
100
200
300
400
500
Iterations


1e11
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Housinge Price
0
100
200
300
400
500
Iterations

[792]:
```
# ======================================== 1b ========================================
import pandas as pd
import numpy as np
import matplotlib
import matplotlib.pyplot as plt
import sklearn.datasets as dt
from sklearn.model_selection import train_test_split
df = pandas.read_csv('Housing.csv', header = 0)

list_bm = ['mainroad', 'guestroom', 'basement', 'hotwaterheating',␣
↪'airconditioning','prefarea']

def binary_map(x):
    return x.map({'yes': 1, 'no': 0})

df[list_bm] = df[list_bm].apply(binary_map)

price = df['price']
area = df['area']
bedroom = df['bedrooms']
bathroom = df['bathrooms']
stories = df['stories']
mainroad = df['mainroad']
guestroom = df['guestroom']
basement = df['basement']
waterheating = df['hotwaterheating']
ac = df['airconditioning']
parking = df['parking']
prefarea = df['prefarea']
furnished = df['furnishingstatus']

theta_0 = 0
theta_1 = 0
a = 0.1
X = []
Y = df.values[:,0]
theta_old = 0
theta_new = 0
m = len(price)
cost_history = []
loss = []
h_pred = []
h_pred2 = []
theta = []


for i in range(m):
    x_list = ac[i] + prefarea[i] + waterheating[i] + area[i] + bedroom[i] +␣
↪bathroom[i] + stories[i] + parking[i] + mainroad[i] + guestroom[i] + basement[i]
    X.append(x_list)

for i in range(m):
    h = (X[i] * theta_1) + theta_0
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    h_pred.append(h)
    errors = h_pred[i] - Y[i]
    sqrErrors = np.square(errors)
    j = np.sum(sqrErrors)
    loss.append(j/(2*m))

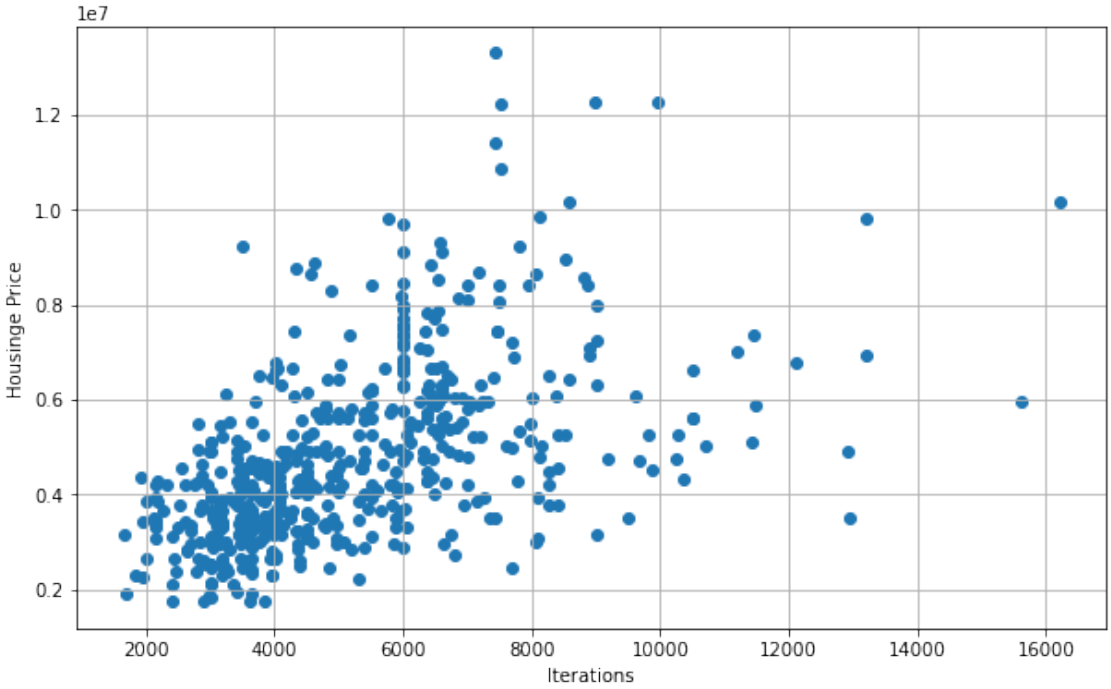
for j in range(m):
    pred = theta_0 + (theta_1 * loss[j])
    h_pred2.append(pred)
    errors = h_pred2[j] - (h_pred[j] + Y[j])
    sum_delta =  (pred - errors)
    theta_new = theta_old - sum_delta
    theta.append(theta_new)
    cost = a * (np.square(errors))
    cost_history.append(cost/m)

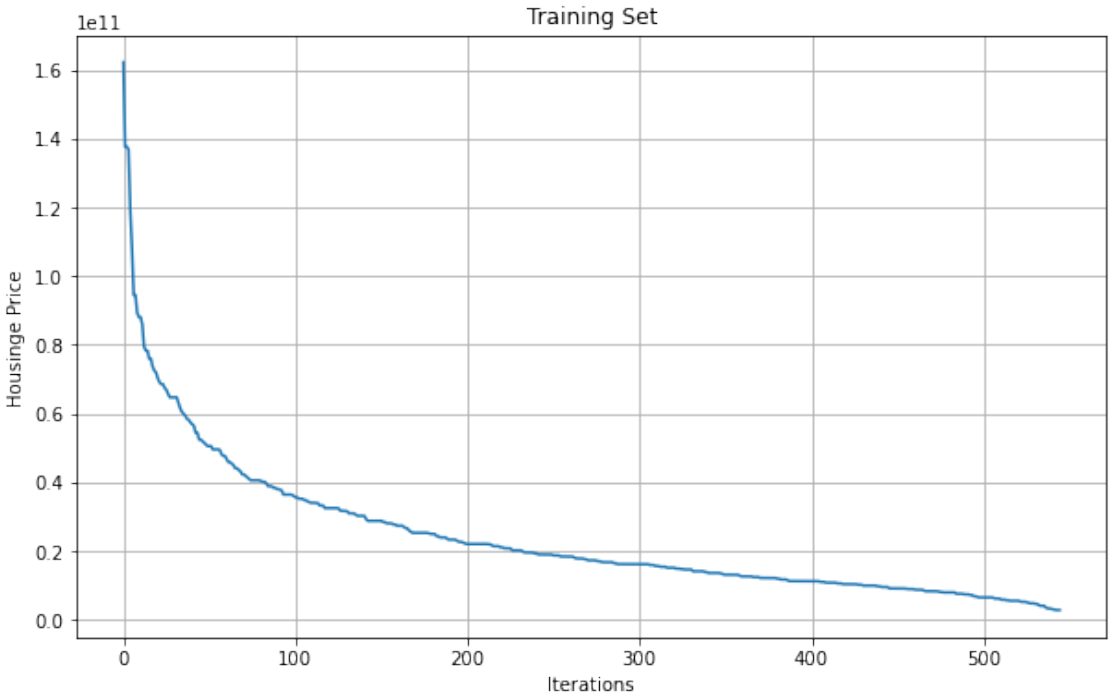
plt.rcParams["figure.figsize"] = (10,6)
plt.grid()
plt.scatter(X,Y)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

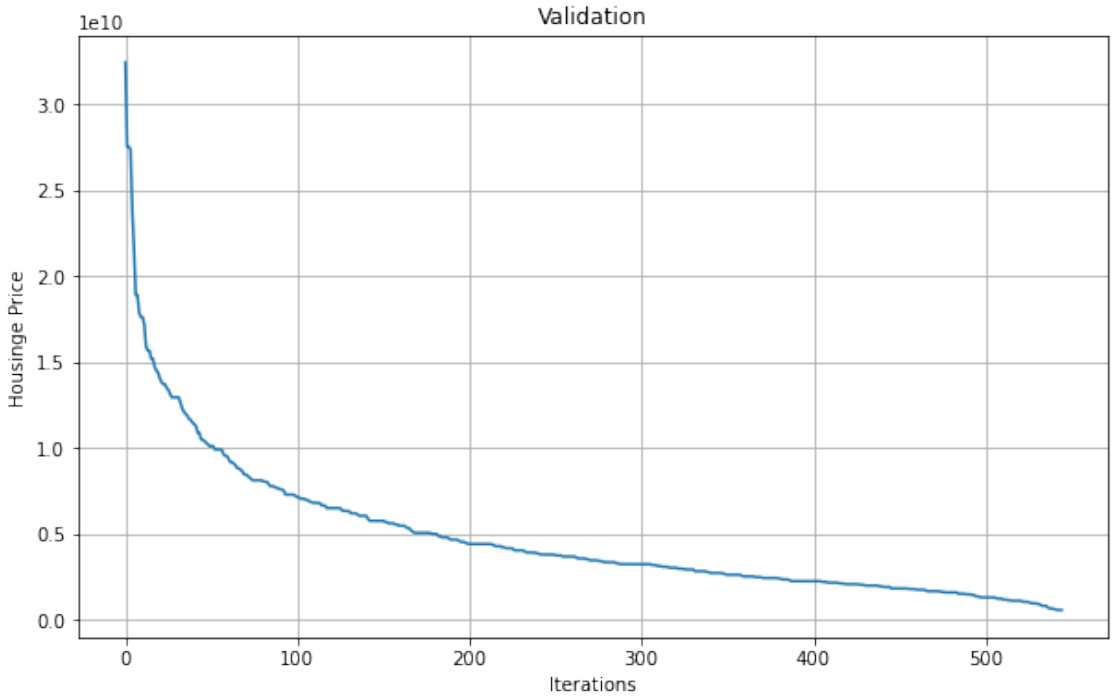
plt.grid()
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.title('Training Set')
plt.show()

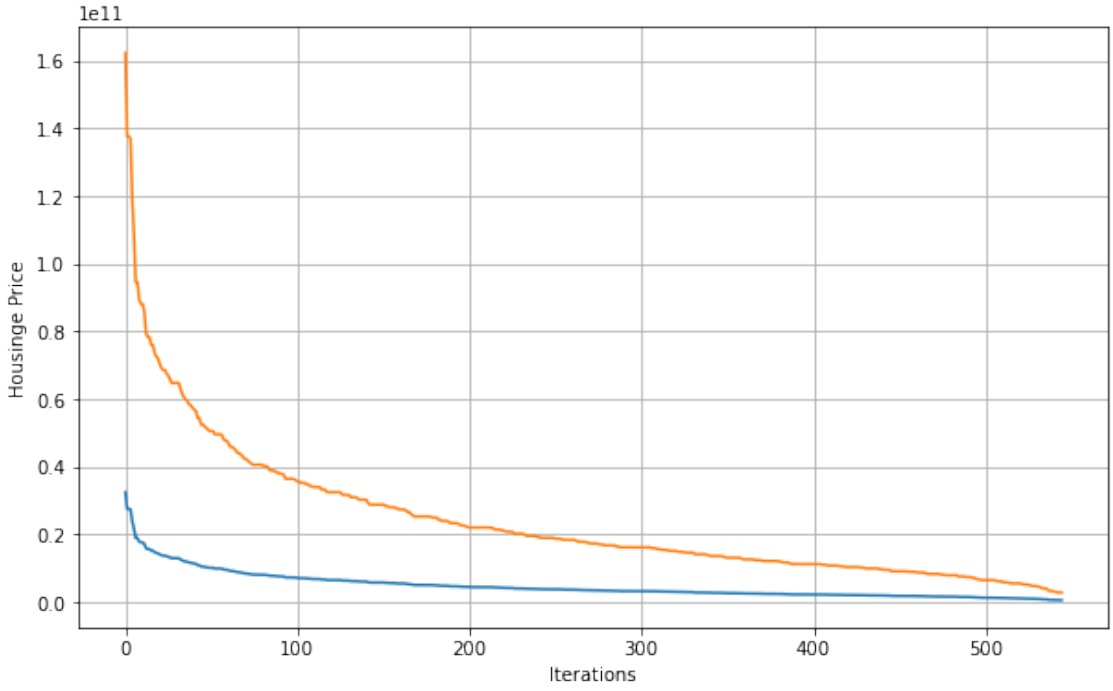
plt.grid()
plt.plot(cost_history)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.title('Validation')
plt.show()


plt.grid()
plt.plot(cost_history)
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()
```


1e7
1.2
1.0
0.8
0.6
0.4
0.2
Housinge Price
2000
4000
6000
8000
10000
12000
14000
16000
Iterations


Training Set
1e11
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Housinge Price
0
100
200
300
400
500
Iterations





[800]:
```
# ======================== 2a Normalization ========================
import pandas as pd
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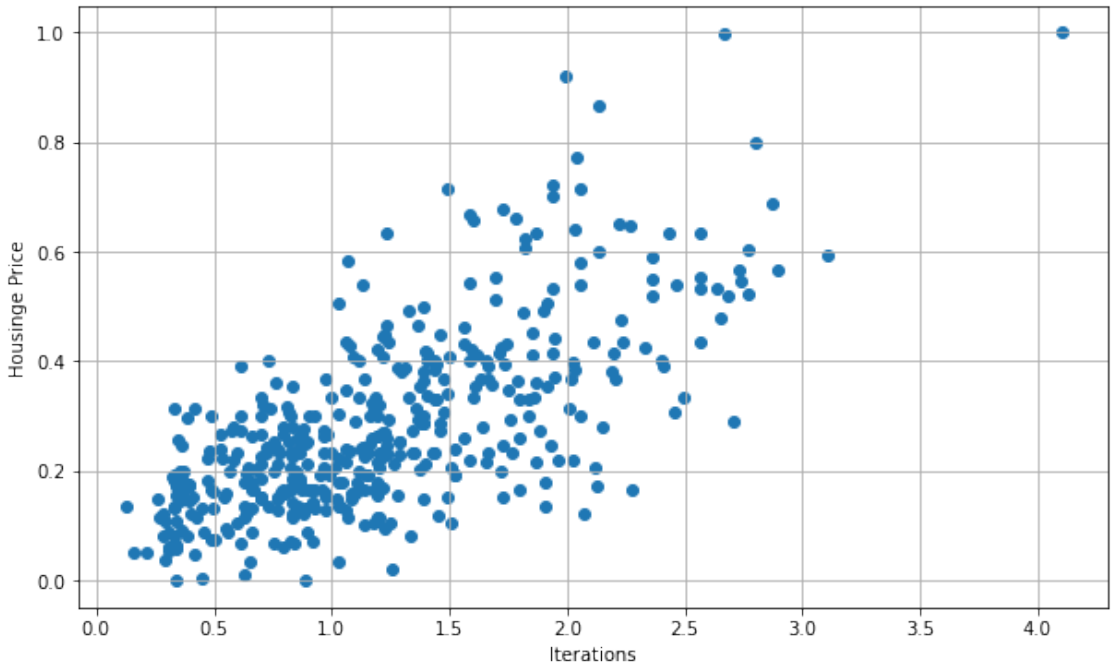
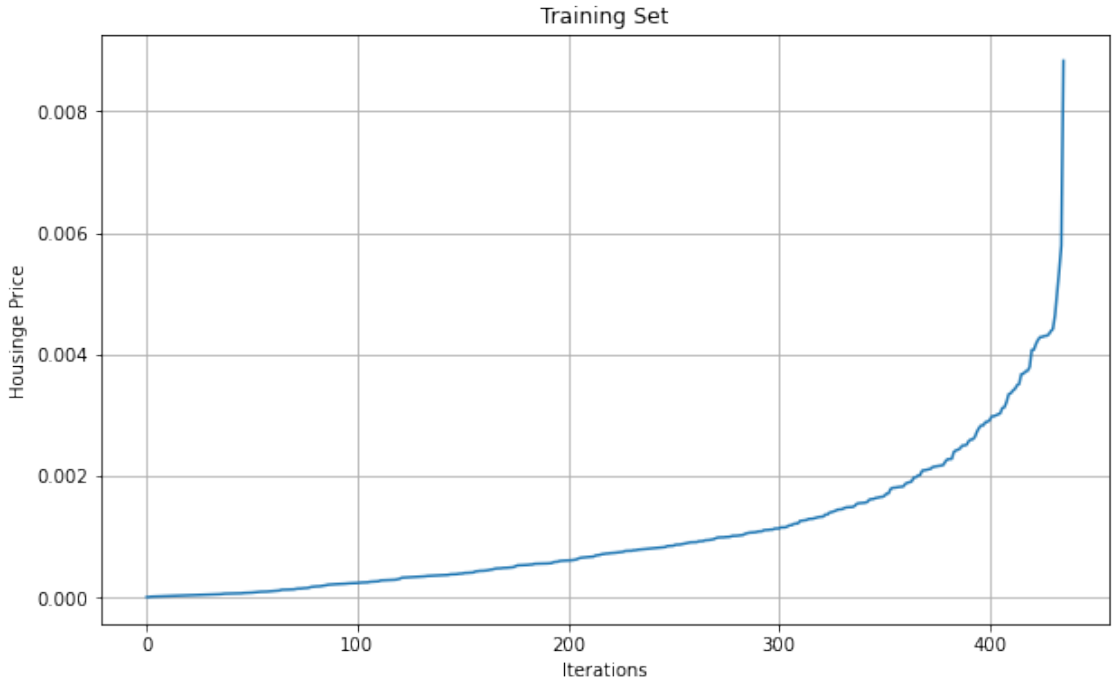
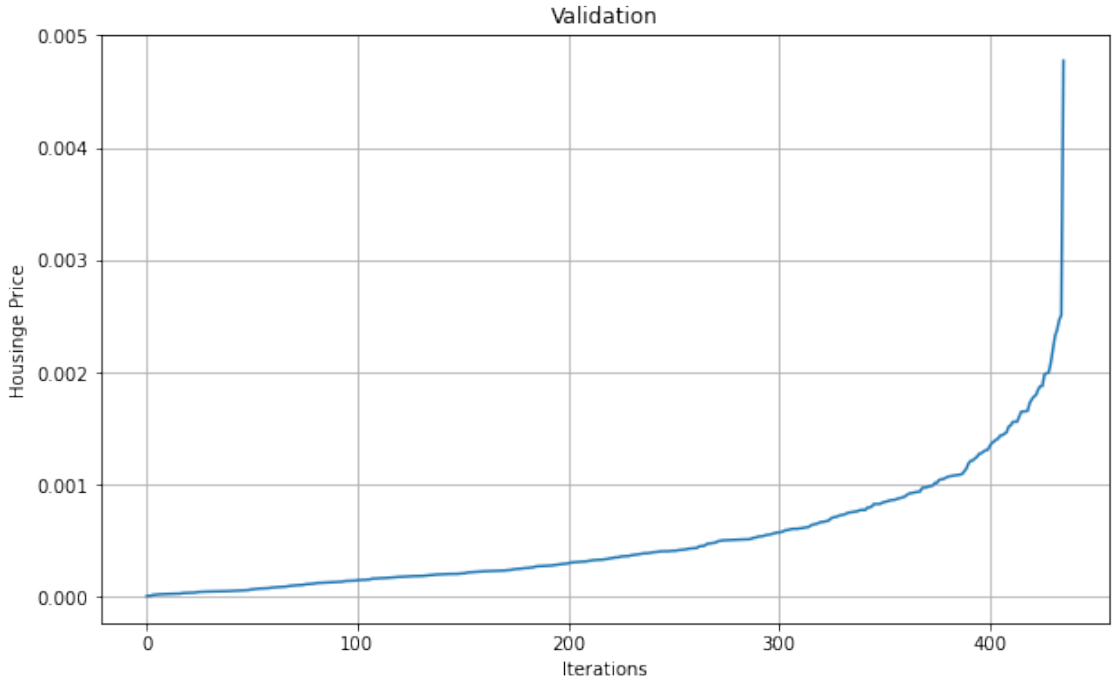
```
import numpy as np
import matplotlib
import matplotlib.pyplot as plt
import sklearn.datasets as dt
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler, StandardScaler
import warnings
warnings.filterwarnings('ignore')

df = pandas.read_csv('Housing.csv', header = 0)

list_bm = ['mainroad', 'guestroom', 'basement', 'hotwaterheating',␣
↪'airconditioning','prefarea']

def binary_map(x):
    return x.map({'yes': 1, 'no': 0})

df[list_bm] = df[list_bm].apply(binary_map)

price = df['price']
area = df['area']
bedroom = df['bedrooms']
bathroom = df['bathrooms']
stories = df['stories']
mainroad = df['mainroad']
guestroom = df['guestroom']
basement = df['basement']
waterheating = df['hotwaterheating']
ac = df['airconditioning']
parking = df['parking']
prefarea = df['prefarea']
furnished = df['furnishingstatus']

np.random.seed(0)
df_train, df_test = train_test_split(df, train_size = 0.8, test_size = 0.2,␣
↪random_state = 42)

num_vars = ['area', 'bedrooms', 'bathrooms', 'stories', 'parking', 'price']
df_newTrain = df_train[num_vars]
df_newTest = df_test[num_vars]

theta_0 = 0
theta_1 = 1
a = 0.1
theta_old = 0
theta_new = 0
cost_history = []
loss = []
h_pred = []
h_pred2 = []
theta = []
X = []
```

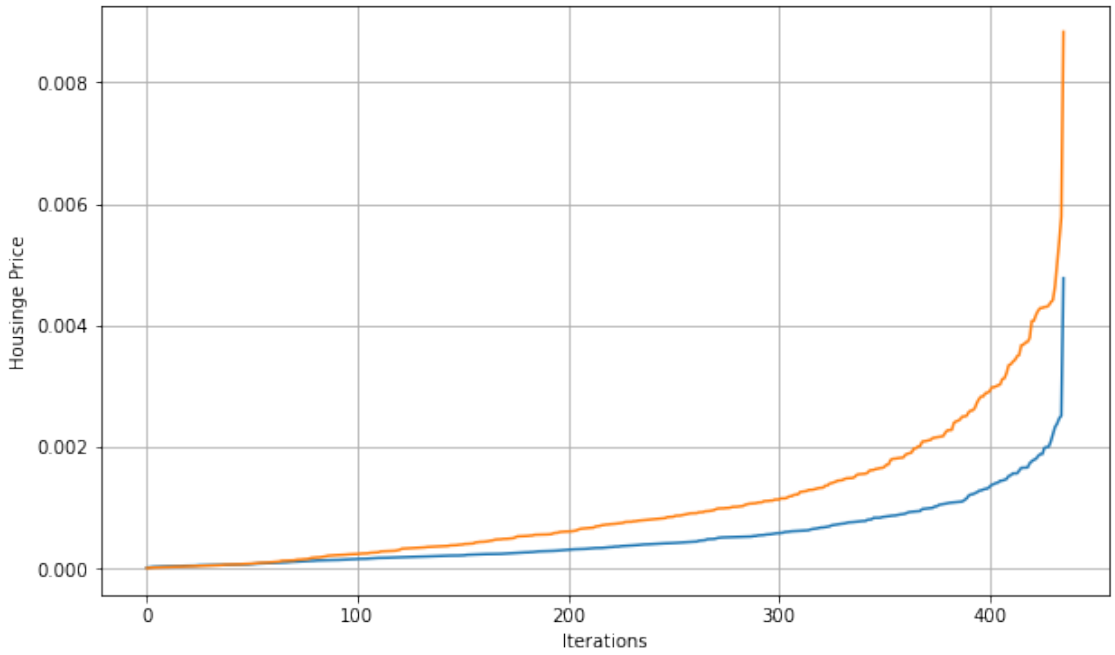
```
scaler = MinMaxScaler()
df_newTrain[num_vars]= scaler.fit_transform(df_newTrain[num_vars])
y_newTrain = df_newTrain.pop('price')
x_newTrain = df_newTrain
Y = y_newTrain.values

X_minmax = scaler.fit_transform(x_newTrain)

X0 = df_newTrain.values[:,0]
X1 = df_newTrain.values[:,1]
X2 = df_newTrain.values[:,2]
X3 = df_newTrain.values[:,3]
X4 = df_newTrain.values[:,4]

for i in range(len(X_minmax)):
    x_list = X0[i] + X1[i] + X2[i] + X3[i] + X4[i]
    X.append(x_list)

for i in range(len(X_minmax)):
    h = (X[i] * theta_1) + theta_0
    h_pred.append(h)
    errors = h_pred[i] - Y[i]
    sqrErrors = np.square(errors)
    j = np.sum(sqrErrors)
    loss.append(j/(2*m))

loss = sorted(loss)

for j in range(len(X_minmax)):
    pred = theta_0 + (theta_1 * loss[j])
    h_pred2.append(pred)
    errors = h_pred2[j] - (h_pred[j] + Y[j])
    sum_delta =  (pred - errors)
    theta_new = theta_old - sum_delta
    theta.append(theta_new)
    cost = a * (np.square(errors))
    cost_history.append(cost/m)

cost_history = sorted(cost_history)

plt.rcParams["figure.figsize"] = (10,6)
plt.grid()
plt.scatter(X,Y)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

plt.grid()
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.title('Training Set')
plt.show()
```

```
plt.grid()
plt.plot(cost_history)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.title('Validation')
plt.show()

plt.grid()
plt.plot(cost_history)
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()
```




Training Set
Housinge Price
0.008
0.006
0.004
0.002
0.000
0
100
200
300
400
Iterations

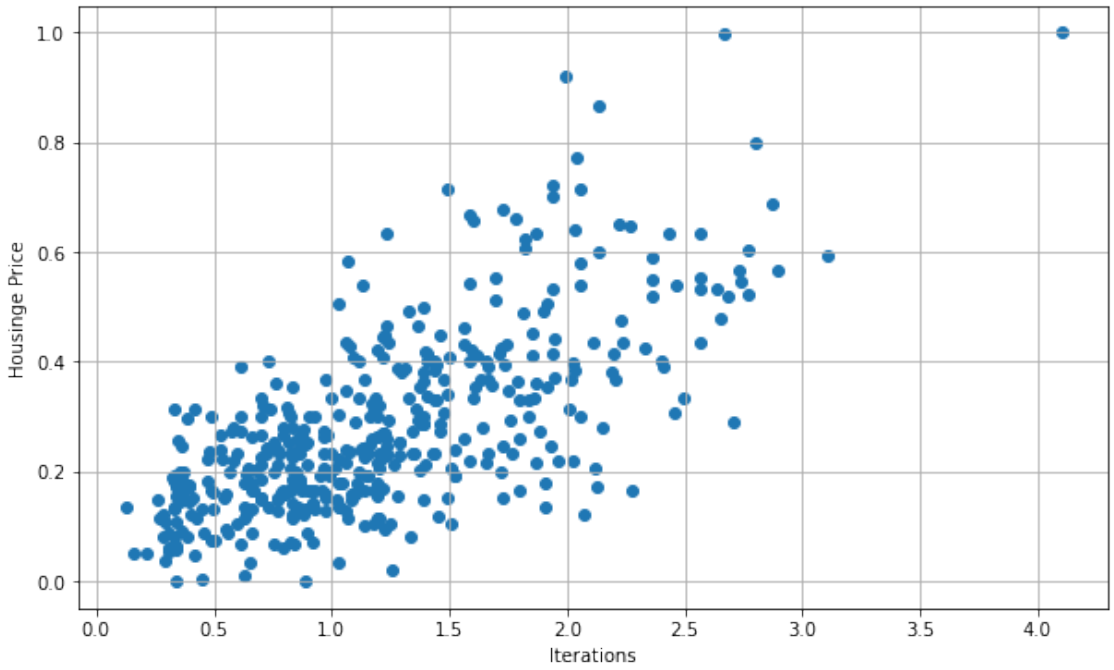

Validation
Housinge Price
0.005
0.004
0.003
0.002
0.001
0.000
0
100
200
300
400
Iterations

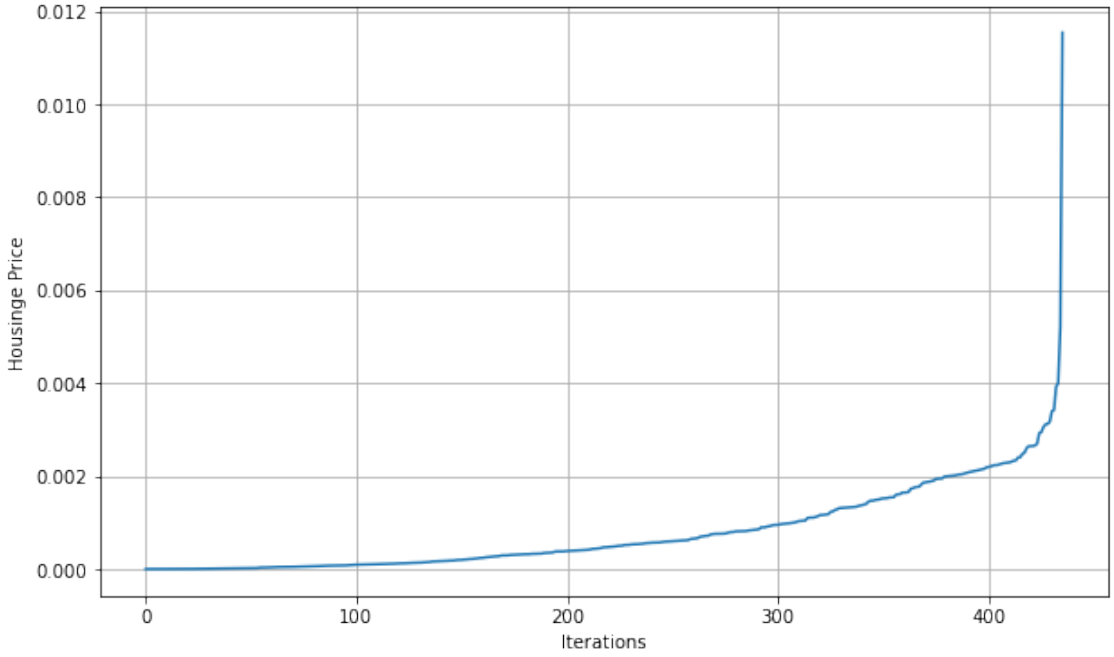


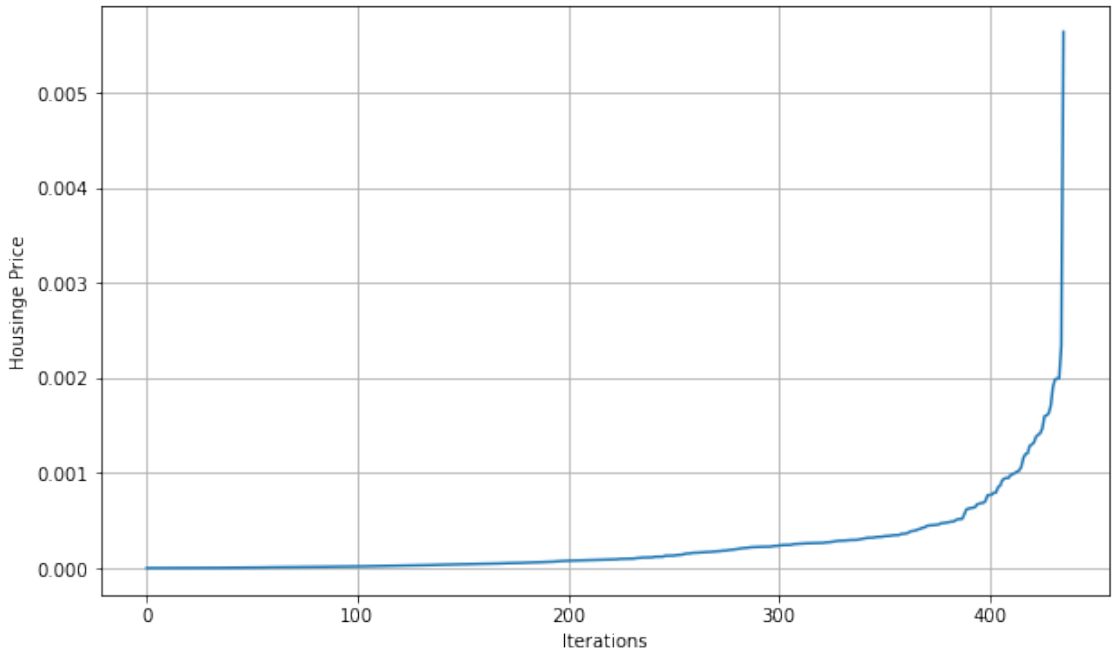
[795]:
```
# ======================== 2a Standardization ==========================
import pandas as pd
import numpy as np
import math
import statistics
import matplotlib
import matplotlib.pyplot as plt
import sklearn.datasets as dt
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler, StandardScaler
import warnings
warnings.filterwarnings('ignore')

df = pandas.read_csv('Housing.csv', header = 0)

list_bm = ['mainroad', 'guestroom', 'basement', 'hotwaterheating',␣
 ↪'airconditioning','prefarea']

def binary_map(x):
    return x.map({'yes': 1, 'no': 0})

def standard_deviation(x,mean,n):
    a = np.square(abs(x - mean))
    sd = math.sqrt(sum(a)/n)
    return sd

def standard_scale(x,mean,sd):
    std = (x - mean)/sd
    return std
```

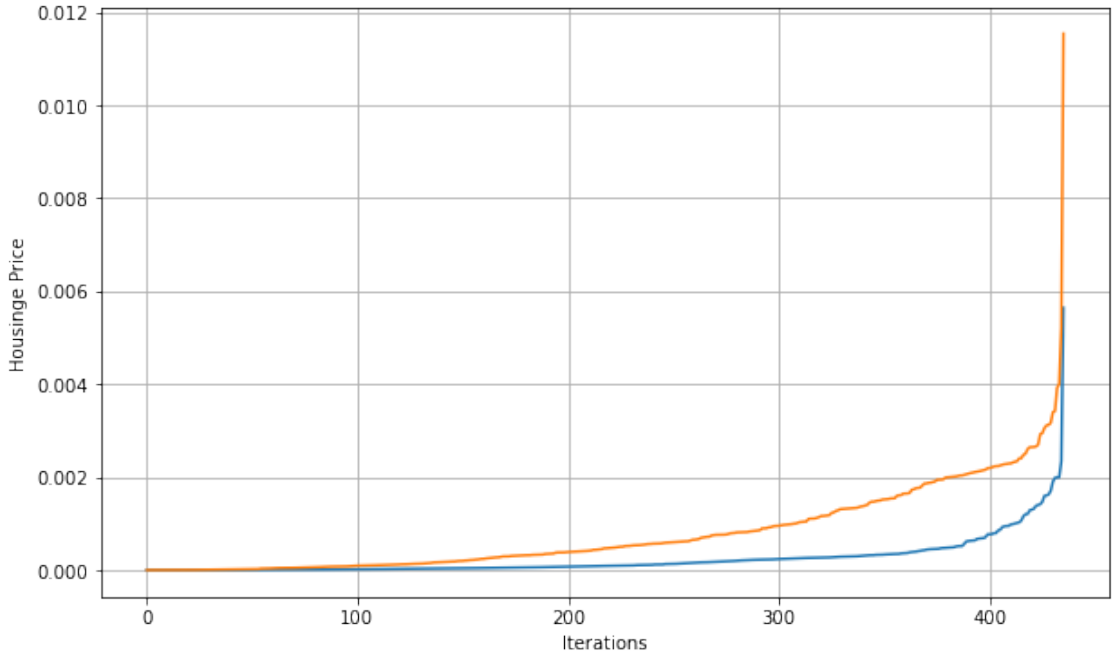
```
df[list_bm] = df[list_bm].apply(binary_map)

price = df['price']
area = df['area']
bedroom = df['bedrooms']
bathroom = df['bathrooms']
stories = df['stories']
mainroad = df['mainroad']
guestroom = df['guestroom']
basement = df['basement']
waterheating = df['hotwaterheating']
ac = df['airconditioning']
parking = df['parking']
prefarea = df['prefarea']
furnished = df['furnishingstatus']

np.random.seed(0)
df_train, df_test = train_test_split(df, train_size = 0.8, test_size = 0.2,␣
↪random_state = 42)

num_vars = ['area', 'bedrooms', 'bathrooms', 'stories', 'parking', 'price']
df_newTrain = df_train[num_vars]
df_newTest = df_test[num_vars]

theta_0 = 0
theta_1 = 1
a = 0.1
theta_old = 0
theta_new = 0
cost_history = []
loss = []
h_pred = []
h_pred2 = []
theta = []
X = []

df_newTrain[num_vars]= scaler.fit_transform(df_newTrain[num_vars])
y_newTrain = df_newTrain.pop('price')
x_newTrain = df_newTrain
Y = y_newTrain.values

X0 = df_newTrain.values[:,0]
X1 = df_newTrain.values[:,1]
X2 = df_newTrain.values[:,2]
X3 = df_newTrain.values[:,3]
X4 = df_newTrain.values[:,4]


for i in range(len(x_newTrain)):
    x_list = X0[i] + X1[i] + X2[i] + X3[i] + X4[i]
    X.append(x_list)
```

```
x_mean = statistics.mean(X)
sd = standard_deviation(X,x_mean,len(X))
std = standard_scale(X,x_mean,sd)

for i in range(len(X)):
    h = (std[i] * theta_1) + theta_0
    h_pred.append(h)
    errors = h_pred[i] - Y[i]
    sqrErrors = np.square(errors)
    j = np.sum(sqrErrors)
    loss.append(j/(2*m))

loss = sorted(loss)

for j in range(len(X)):
    pred = theta_0 + (theta_1 * loss[j])
    h_pred2.append(pred)
    errors = h_pred2[j] - (h_pred[j] + Y[j])
    sum_delta =  (pred - errors)
    theta_new = theta_old - sum_delta
    theta.append(theta_new)
    cost = a * (np.square(errors))
    cost_history.append(cost/m)

cost_history = sorted(cost_history)

plt.rcParams["figure.figsize"] = (10,6)
plt.grid()
plt.scatter(X,Y)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

plt.grid()
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

plt.grid()
plt.plot(cost_history)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

plt.grid()
plt.plot(cost_history)
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()
```


Housinge Price
Iterations
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0


Housinge Price
Iterations
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0
100
200
300
400



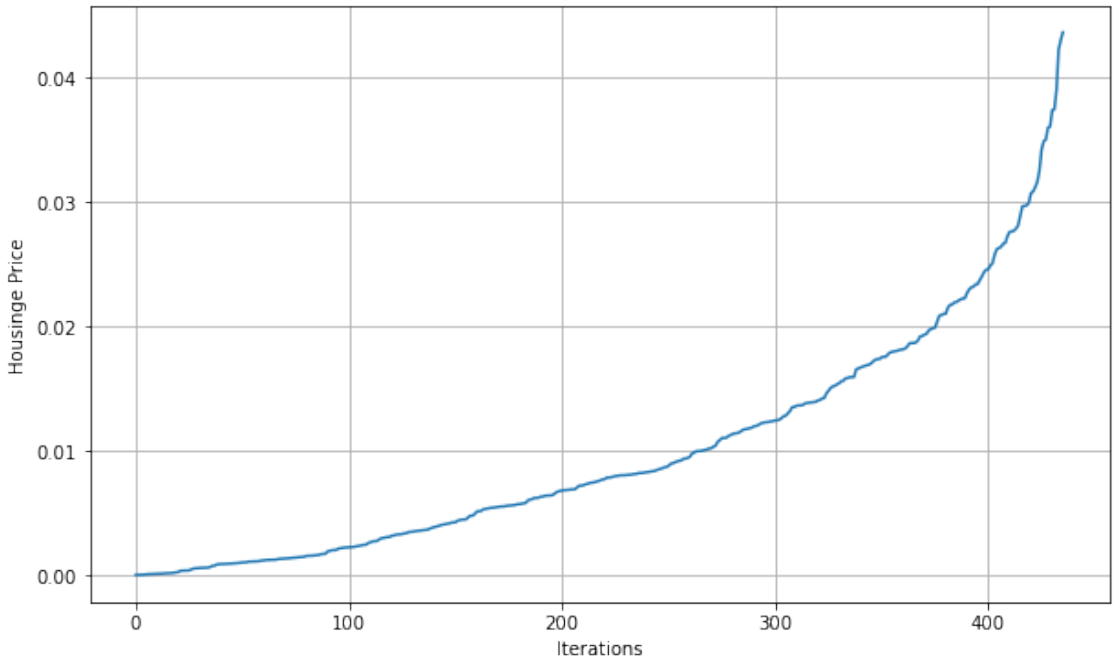


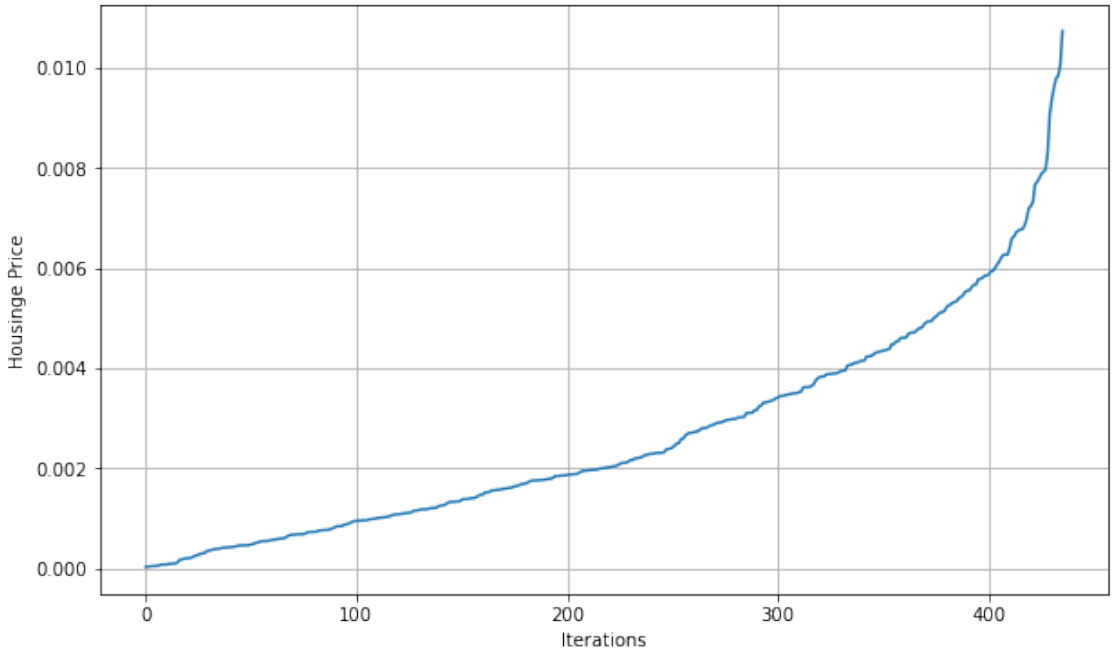
[802]:
```
# ======================== 2b Normalization ============================
import pandas as pd
import numpy as np
import matplotlib
import matplotlib.pyplot as plt
```

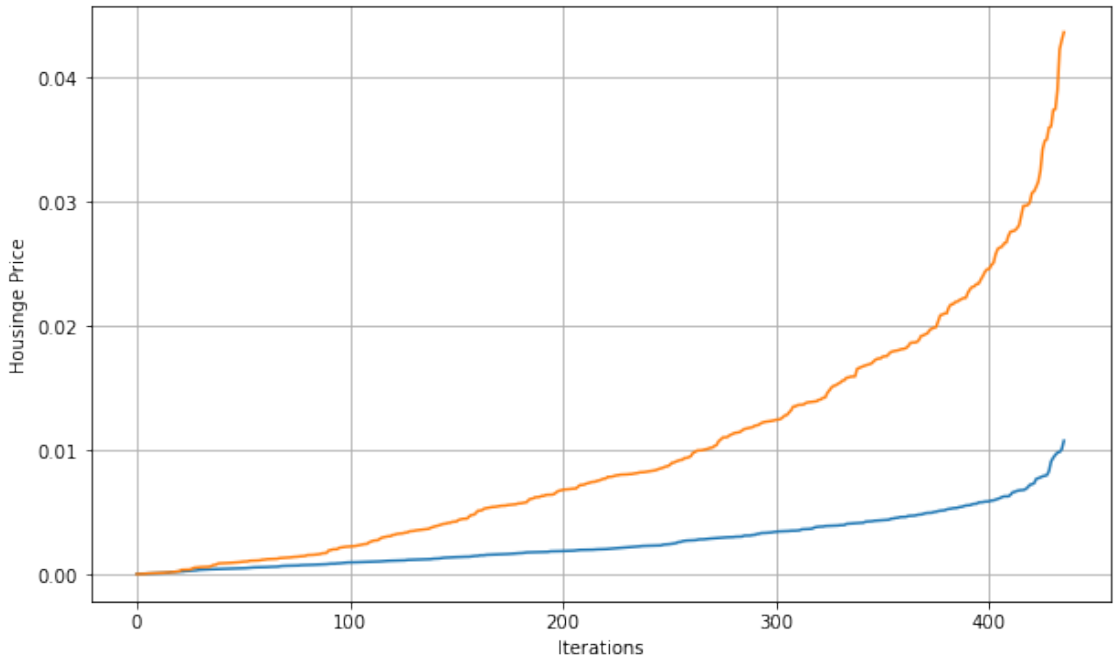
```
import sklearn.datasets as dt
from sklearn.model_selection import train_test_split
df = pandas.read_csv('Housing.csv', header = 0)

list_bm = ['mainroad', 'guestroom', 'basement', 'hotwaterheating',␣
↪'airconditioning','prefarea']

def binary_map(x):
    return x.map({'yes': 1, 'no': 0})

df[list_bm] = df[list_bm].apply(binary_map)

price = df['price']
area = df['area']
bedroom = df['bedrooms']
bathroom = df['bathrooms']
stories = df['stories']
mainroad = df['mainroad']
guestroom = df['guestroom']
basement = df['basement']
waterheating = df['hotwaterheating']
ac = df['airconditioning']
parking = df['parking']
prefarea = df['prefarea']
furnished = df['furnishingstatus']

np.random.seed(0)
df_train, df_test = train_test_split(df, train_size = 0.8, test_size = 0.2,␣
↪random_state = 42)

num_vars = ['airconditioning', 'bedrooms', 'bathrooms', 'stories', 'parking',␣
↪'mainroad', 'guestroom', 'basement', 'prefarea', 'hotwaterheating','area','price']
df_newTrain = df_train[num_vars]
df_newTest = df_test[num_vars]

theta_0 = 0
theta_1 = 1
a = 0.1
X = []
theta_old = 0
theta_new = 0
cost_history = []
loss = []
h_pred = []
h_pred2 = []
theta = []

scaler = MinMaxScaler()
df_newTrain[num_vars]= scaler.fit_transform(df_newTrain[num_vars])
y_newTrain = df_newTrain.pop('price')
x_newTrain = df_newTrain
Y = y_newTrain.values
```

```
X0 = df_newTrain.values[:,0]
X1 = df_newTrain.values[:,1]
X2 = df_newTrain.values[:,2]
X3 = df_newTrain.values[:,3]
X4 = df_newTrain.values[:,4]
X5 = df_newTrain.values[:,5]
X6 = df_newTrain.values[:,6]
X7 = df_newTrain.values[:,7]
X8 = df_newTrain.values[:,8]
X9 = df_newTrain.values[:,9]
X10 = df_newTrain.values[:,10]

for i in range(len(x_newTrain)):
    x_list = X0[i] + X1[i] + X2[i] + X3[i] + X4[i] + X5[i] + X6[i] + X7[i] + X8[i] +␣
 ↪X9[i] + X10[i]
    X.append(x_list)

X = sorted(X)

for i in range(len(X)):
    h = (X[i] * theta_1) + theta_0
    h_pred.append(h)
    errors = h_pred[i] - Y[i]
    sqrErrors = np.square(errors)
    j = np.sum(sqrErrors)
    loss.append(j/(2*m))

loss = sorted(loss)

for j in range(len(X)):
    pred = theta_0 + (theta_1 * loss[j])
    h_pred2.append(pred)
    errors = h_pred2[j] - (h_pred[j] + Y[j])
    sum_delta =  (h_pred2[j] - errors)
    theta_new = theta_old - sum_delta
    theta.append(theta_new)
    cost = a * (np.square(errors))
    cost_history.append(cost/m)

cost_history = sorted(cost_history)

plt.rcParams["figure.figsize"] = (10,6)
plt.grid()
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

plt.grid()
plt.plot(cost_history)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()
```

```
plt.grid()
plt.plot(cost_history)
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()
```





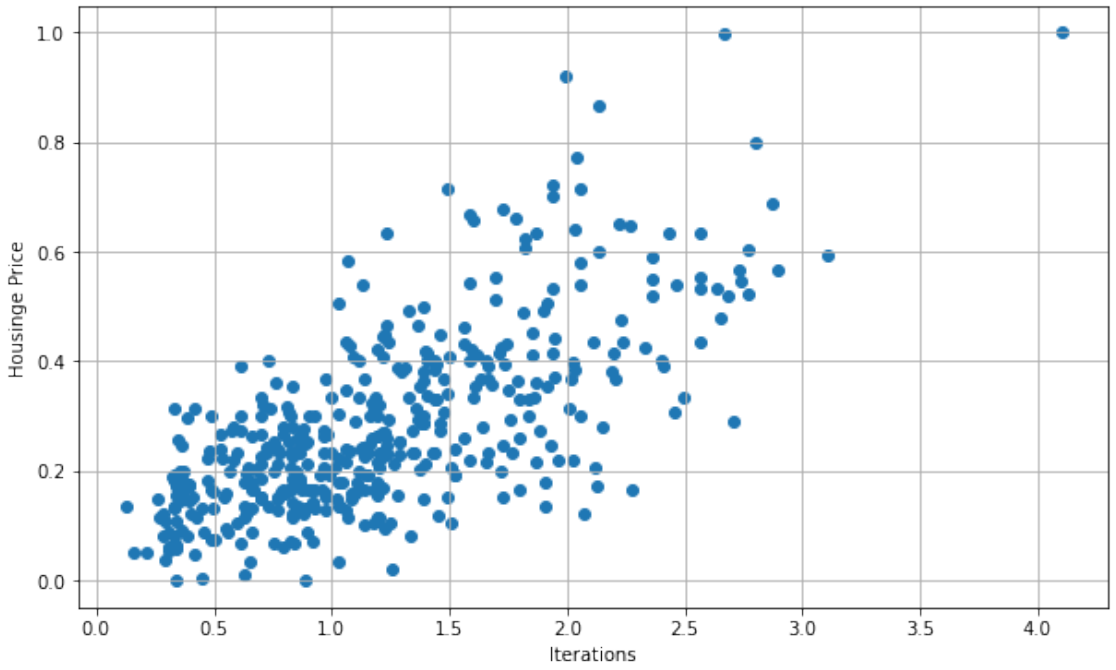


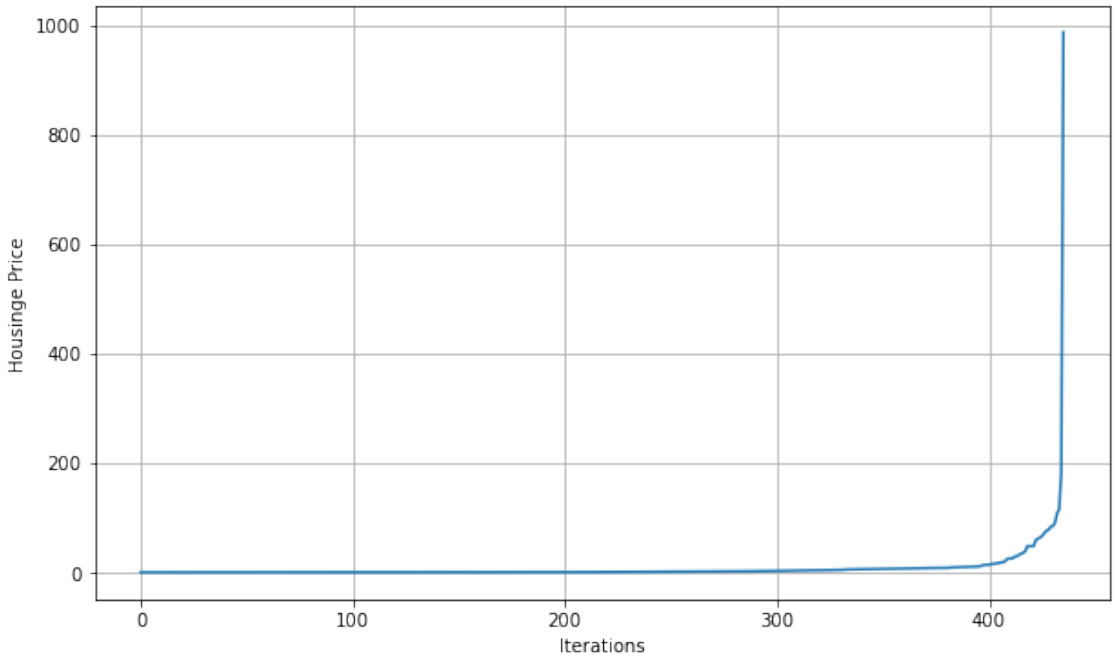
[835]:
```
# ======================== 3a Standardization ========================
import pandas as pd
import numpy as np
import math
import statistics
import matplotlib
import matplotlib.pyplot as plt
import sklearn.datasets as dt
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler, StandardScaler
import warnings
warnings.filterwarnings('ignore')

df = pandas.read_csv('Housing.csv', header = 0)

list_bm = ['mainroad', 'guestroom', 'basement', 'hotwaterheating',␣
 ↪'airconditioning','prefarea']

def binary_map(x):
    return x.map({'yes': 1, 'no': 0})

def standard_deviation(x,mean,n):
    a = np.square(abs(x - mean))
    sd = math.sqrt(sum(a)/n)
    return sd
```

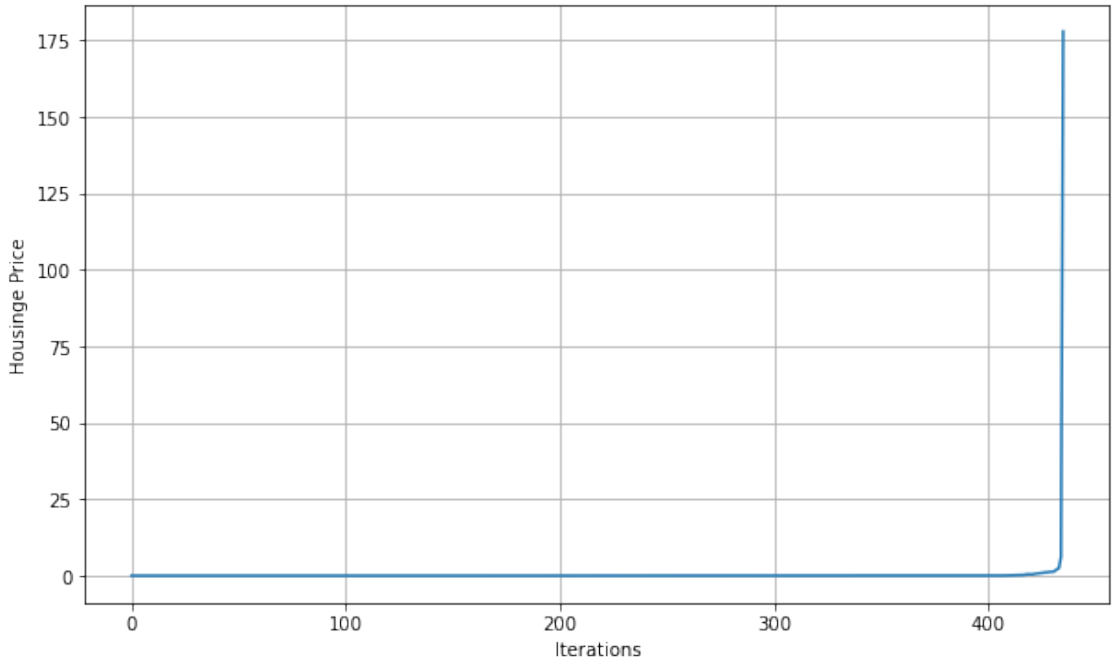
```
def standard_scale(x,mean,sd):
    std = (x - mean)/sd
    return std

df[list_bm] = df[list_bm].apply(binary_map)

price = df['price']
area = df['area']
bedroom = df['bedrooms']
bathroom = df['bathrooms']
stories = df['stories']
mainroad = df['mainroad']
guestroom = df['guestroom']
basement = df['basement']
waterheating = df['hotwaterheating']
ac = df['airconditioning']
parking = df['parking']
prefarea = df['prefarea']
furnished = df['furnishingstatus']

np.random.seed(0)
df_train, df_test = train_test_split(df, train_size = 0.8, test_size = 0.2,␣
↪random_state = 42)

num_vars = ['area', 'bedrooms', 'bathrooms', 'stories', 'parking', 'price']
df_newTrain = df_train[num_vars]
df_newTest = df_test[num_vars]

theta_0 = 0
theta_1 = 1
a = 0.1
theta_old = 0
theta_new = 0
cost_history = []
loss = []
h_pred = []
h_pred2 = []
theta = []
X = []
lamda = 50

df_newTrain[num_vars]= scaler.fit_transform(df_newTrain[num_vars])
y_newTrain = df_newTrain.pop('price')
x_newTrain = df_newTrain
Y = y_newTrain.values

X0 = df_newTrain.values[:,0]
X1 = df_newTrain.values[:,1]
X2 = df_newTrain.values[:,2]
X3 = df_newTrain.values[:,3]
X4 = df_newTrain.values[:,4]
```

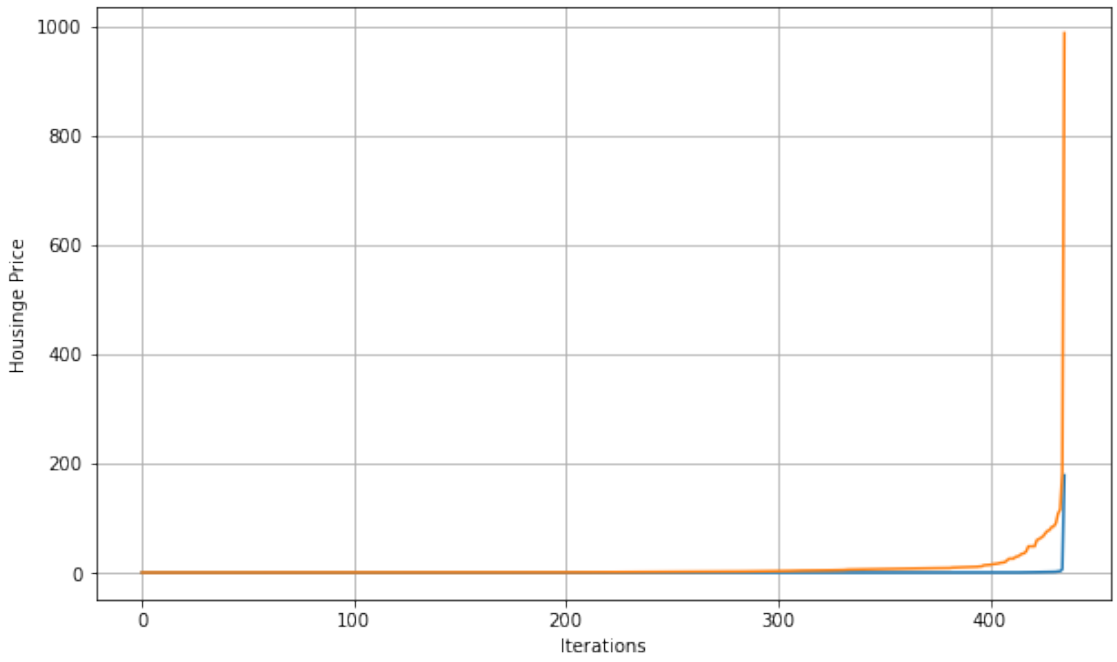
```
for i in range(len(x_newTrain)):
    x_list = X0[i] + X1[i] + X2[i] + X3[i] + X4[i]
    X.append(x_list)

x_sum = sum(X)
x_mean = statistics.mean(X)
sd = standard_deviation(X,x_mean,len(X))
std = standard_scale(X,x_mean,sd)

for i in range(len(X)):
    h = (std[i] * theta_1) + theta_0
    h_pred.append(h)
    reg = lamda * (h_pred[i])**2
    errors = h_pred[i] - Y[i] + reg
    sqrErrors = np.square(errors)
    j = np.sum(sqrErrors)
    loss.append(j/(2*m))

loss = sorted(loss)

for j in range(len(X)):
    pred = theta_0 + (theta_1 * loss[j])
    h_pred2.append(pred)
    errors = h_pred2[j] - (h_pred[j] + Y[j])
    sum_delta =  (pred - errors)
    theta_new = theta_old - sum_delta
    theta.append(theta_new)
    cost = a * (np.square(errors))
    cost_history.append(cost/m)


plt.rcParams["figure.figsize"] = (10,6)
plt.grid()
plt.scatter(X,Y)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

plt.grid()
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

plt.grid()
plt.plot(cost_history)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

plt.grid()
plt.plot(cost_history)
plt.plot(loss)
```

```
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()
```







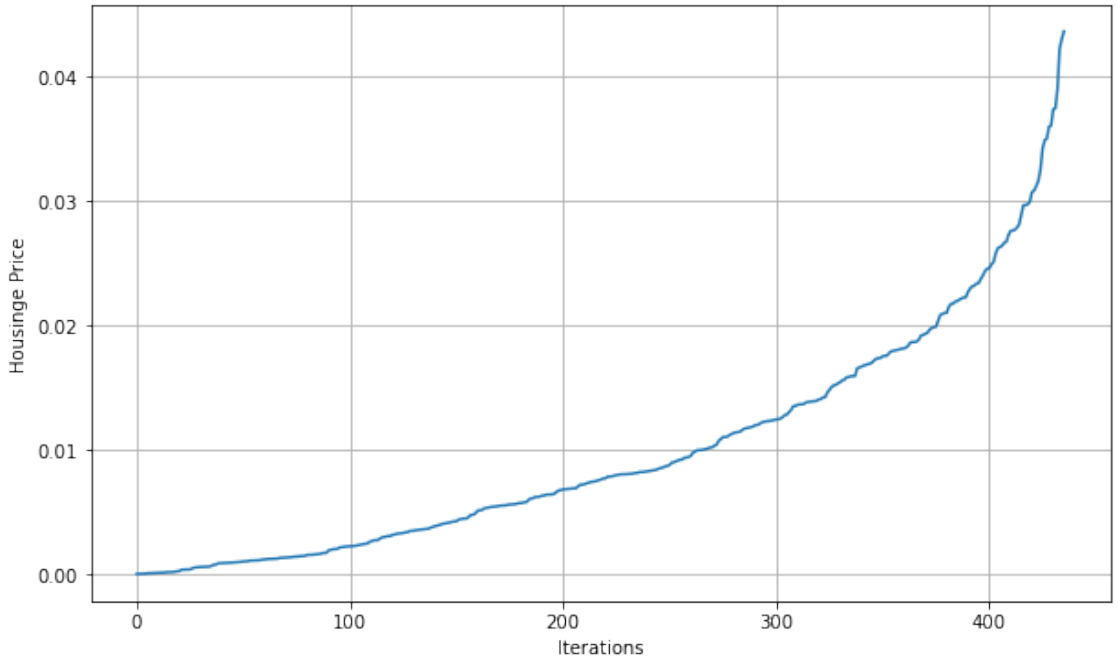


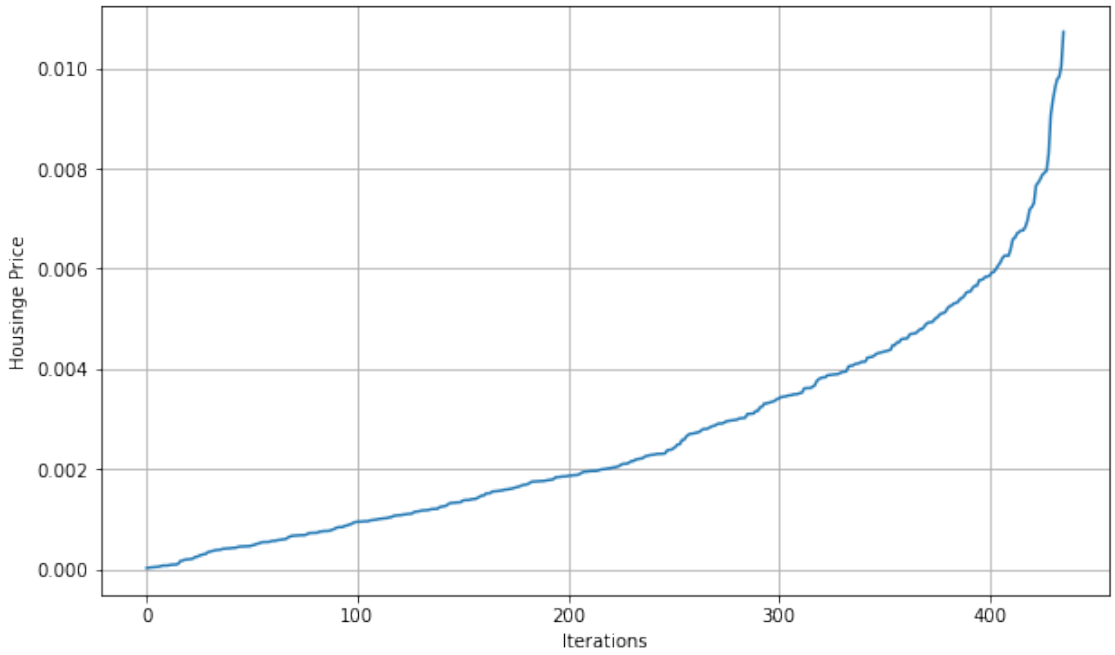
[823]:
```
# ======================== 3b Standardization ========================
import pandas as pd
import numpy as np
import matplotlib
```

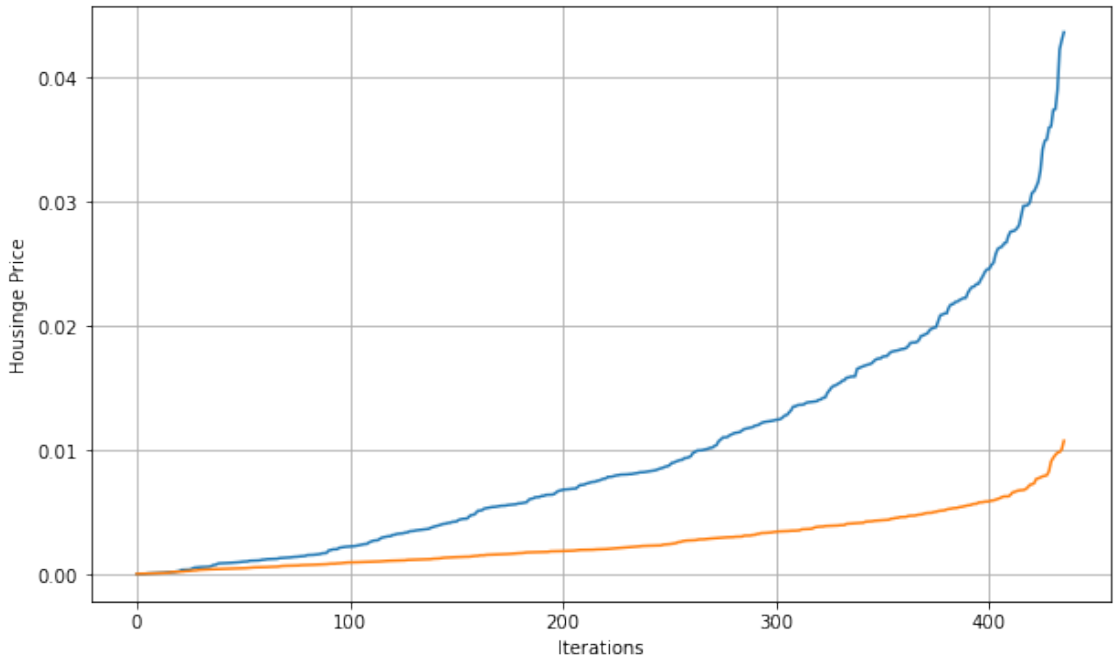
```
import matplotlib.pyplot as plt
import sklearn.datasets as dt
from sklearn.model_selection import train_test_split
df = pandas.read_csv('Housing.csv', header = 0)

list_bm = ['mainroad', 'guestroom', 'basement', 'hotwaterheating',␣
↪'airconditioning','prefarea']

def binary_map(x):
    return x.map({'yes': 1, 'no': 0})

df[list_bm] = df[list_bm].apply(binary_map)

price = df['price']
area = df['area']
bedroom = df['bedrooms']
bathroom = df['bathrooms']
stories = df['stories']
mainroad = df['mainroad']
guestroom = df['guestroom']
basement = df['basement']
waterheating = df['hotwaterheating']
ac = df['airconditioning']
parking = df['parking']
prefarea = df['prefarea']
furnished = df['furnishingstatus']

np.random.seed(0)
df_train, df_test = train_test_split(df, train_size = 0.8, test_size = 0.2,␣
↪random_state = 42)

num_vars = ['airconditioning', 'bedrooms', 'bathrooms', 'stories', 'parking',␣
↪'mainroad', 'guestroom', 'basement', 'prefarea', 'hotwaterheating','area','price']
df_newTrain = df_train[num_vars]
df_newTest = df_test[num_vars]

theta_0 = 0
theta_1 = 1
a = 0.1
X = []
theta_old = []
theta_new = []
cost_history = []
loss = []
h_pred = []
h_pred2 = []
theta = []
lamda = 0.0001

scaler = MinMaxScaler()
df_newTrain[num_vars]= scaler.fit_transform(df_newTrain[num_vars])
y_newTrain = df_newTrain.pop('price')
x_newTrain = df_newTrain
```

```
Y = y_newTrain.values

X0 = df_newTrain.values[:,0]
X1 = df_newTrain.values[:,1]
X2 = df_newTrain.values[:,2]
X3 = df_newTrain.values[:,3]
X4 = df_newTrain.values[:,4]
X5 = df_newTrain.values[:,5]
X6 = df_newTrain.values[:,6]
X7 = df_newTrain.values[:,7]
X8 = df_newTrain.values[:,8]
X9 = df_newTrain.values[:,9]
X10 = df_newTrain.values[:,10]

for i in range(len(x_newTrain)):
    x_list = X0[i] + X1[i] + X2[i] + X3[i] + X4[i] + X5[i] + X6[i] + X7[i] + X8[i] +␣
 ↪X9[i] + X10[i]
    X.append(x_list)

X = sorted(X)

for i in range(len(X)):
    h = (X[i] * theta_1) + theta_0
    h_pred.append(h)
    errors = (h_pred[i] - Y[i])
    sqrErrors = np.square(errors)
    j = np.sum(sqrErrors)
    loss.append(j/(2*m))

loss = sorted(loss)

for j in range(len(X)):
    pred = theta_0 + (theta_1 * loss[j])
    h_pred2.append(pred)
    theta_old.append(pred)
    r = sum(h_pred2)
    errors = h_pred2[j] - (h_pred[j] + Y[j]) + (lamda * (r)**2)
    sum_delta = (theta_old[j] - errors)
    theta_new.append(theta_old[j])
    j_theta = theta_new[j] - sum_delta
    cost = a * (np.square(errors))
    cost_history.append(cost/m)

cost_history = sorted(cost_history)

plt.rcParams["figure.figsize"] = (10,6)
plt.grid()
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

plt.grid()
```

```
plt.plot(cost_history)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

plt.grid()
plt.plot(loss)
plt.plot(cost_history)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()
```





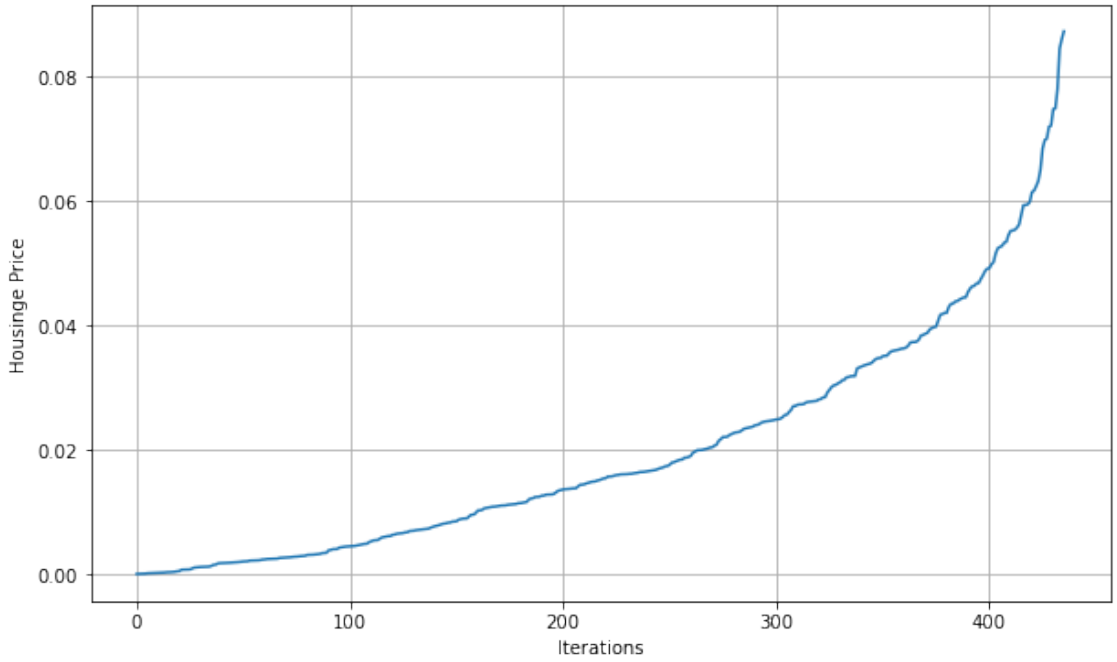


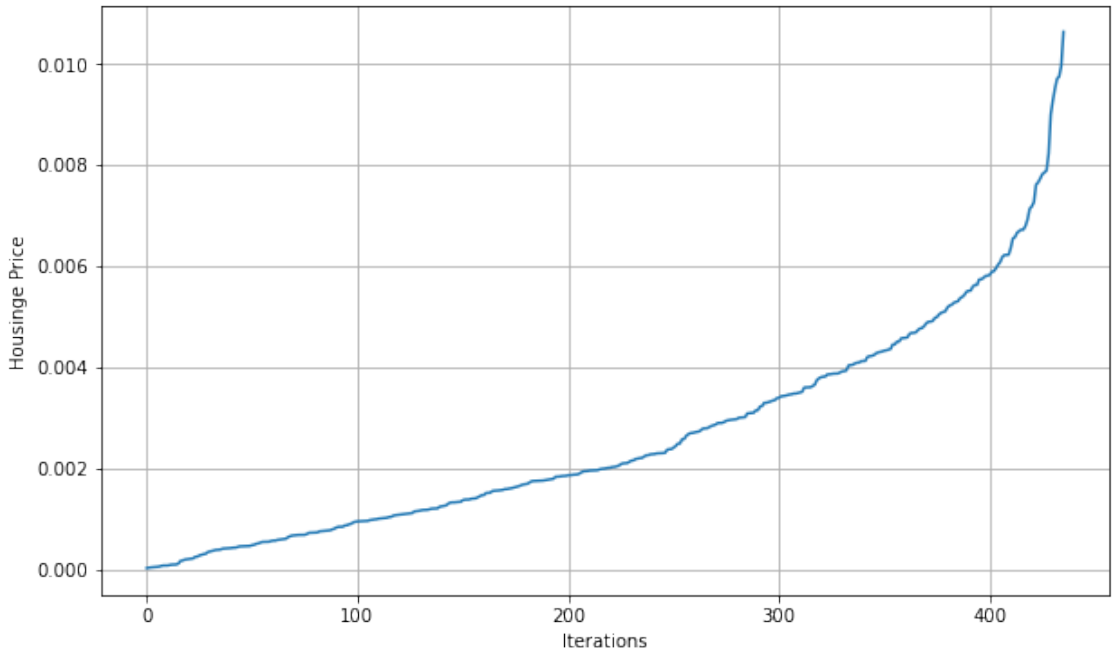
[839]:
```
# ====================== 3b Normalization ============================
import pandas as pd
import numpy as np
import matplotlib
import matplotlib.pyplot as plt
```

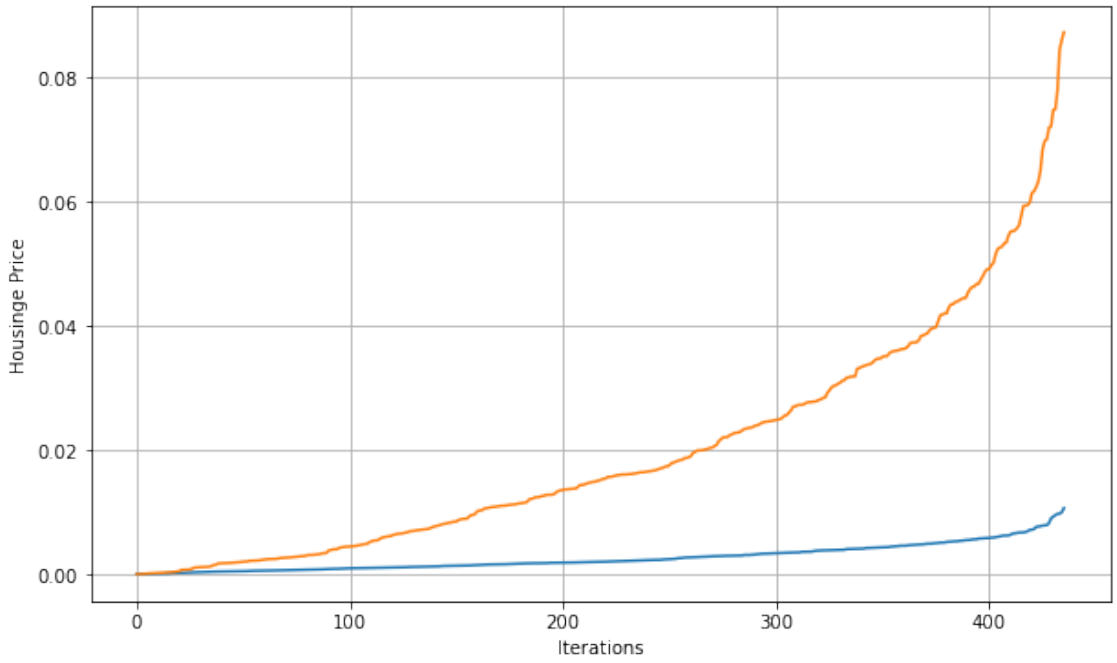
```
import sklearn.datasets as dt
from sklearn.model_selection import train_test_split
df = pandas.read_csv('Housing.csv', header = 0)

list_bm = ['mainroad', 'guestroom', 'basement', 'hotwaterheating',␣
↪'airconditioning','prefarea']

def binary_map(x):
    return x.map({'yes': 1, 'no': 0})

df[list_bm] = df[list_bm].apply(binary_map)

price = df['price']
area = df['area']
bedroom = df['bedrooms']
bathroom = df['bathrooms']
stories = df['stories']
mainroad = df['mainroad']
guestroom = df['guestroom']
basement = df['basement']
waterheating = df['hotwaterheating']
ac = df['airconditioning']
parking = df['parking']
prefarea = df['prefarea']
furnished = df['furnishingstatus']

np.random.seed(0)
df_train, df_test = train_test_split(df, train_size = 0.8, test_size = 0.2,␣
↪random_state = 42)

num_vars = ['airconditioning', 'bedrooms', 'bathrooms', 'stories', 'parking',␣
↪'mainroad', 'guestroom', 'basement', 'prefarea', 'hotwaterheating','area','price']
df_newTrain = df_train[num_vars]
df_newTest = df_test[num_vars]

theta_0 = 0
theta_1 = 1
a = 0.1
X = []
theta_old = 0
theta_new = 0
cost_history = []
loss = []
h_pred = []
h_pred2 = []
theta = []
lamda = 0.001

scaler = MinMaxScaler()
df_newTrain[num_vars]= scaler.fit_transform(df_newTrain[num_vars])
y_newTrain = df_newTrain.pop('price')
x_newTrain = df_newTrain
Y = y_newTrain.values
```

```
X0 = df_newTrain.values[:,0]
X1 = df_newTrain.values[:,1]
X2 = df_newTrain.values[:,2]
X3 = df_newTrain.values[:,3]
X4 = df_newTrain.values[:,4]
X5 = df_newTrain.values[:,5]
X6 = df_newTrain.values[:,6]
X7 = df_newTrain.values[:,7]
X8 = df_newTrain.values[:,8]
X9 = df_newTrain.values[:,9]
X10 = df_newTrain.values[:,10]

for i in range(len(x_newTrain)):
    x_list = X0[i] + X1[i] + X2[i] + X3[i] + X4[i] + X5[i] + X6[i] + X7[i] + X8[i] +␣
 ↪X9[i] + X10[i]
    X.append(x_list)

X = sorted(X)

for i in range(len(X)):
    h = (X[i] * theta_1) + theta_0
    h_pred.append(h)
    errors = (h_pred[i] - Y[i])
    sqrErrors = np.square(errors)
    j = np.sum(sqrErrors)
    loss.append(j/(m))

loss = sorted(loss)

for j in range(len(X)):
    pred = theta_0 + (theta_1 * loss[j])
    h_pred2.append(pred)
    r = sum(h_pred2)
    reg = r**2
    errors = (h_pred2[j] - (h_pred[j] + Y[j]))
    sum_delta = (h_pred2[j] - errors)
    theta_new = theta_old - sum_delta
    theta.append(theta_new)
    cost = a * (np.square(errors) + lamda * reg)
    cost_history.append(cost/m)

cost_history = sorted(cost_history)

plt.rcParams["figure.figsize"] = (10,6)
plt.grid()
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

plt.grid()
plt.plot(cost_history)
```

```
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()

plt.grid()
plt.plot(cost_history)
plt.plot(loss)
plt.xlabel('Iterations')
plt.ylabel('Housinge Price')
plt.show()
```




0.010
0.008
0.006
0.004
0.002
0.000
Housinge Price
0
100
200
300
400
Iterations


0.08
0.06
0.04
0.02
0.00
Housinge Price
0
100
200
300
400
Iterations

[ ]: