In [1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib as mpl
import matplotlib.pyplot as plt
import matplotlib.ticker as mtick
import plotly
import plotly.express as px
import plotly.graph_objects as go
import plotly.offline as pyo

from IPython.display import display
from plotly.graph_objs.scatter.marker import Line

%matplotlib inline
```

California Housing Price Prediction

In [2]:
```
houseData = pd.read_csv("housing.csv")
```

In [3]:
```
houseData
```

Out[3]:

	longitude	latitude	housing_median_age	total_rooms	total_bedrooms	population	househo
0	-122.23	37.88	41	880	129.0	322	1
1	-122.22	37.86	21	7099	1106.0	2401	11
2	-122.24	37.85	52	1467	190.0	496	1
3	-122.25	37.85	52	1274	235.0	558	2
4	-122.25	37.85	52	1627	280.0	565	2
...	...	...	...	...	...	...	
20635	-121.09	39.48	25	1665	374.0	845	3
20636	-121.21	39.49	18	697	150.0	356	1
20637	-121.22	39.43	17	2254	485.0	1007	4
20638	-121.32	39.43	18	1860	409.0	741	3
20639	-121.24	39.37	16	2785	616.0	1387	5

20640 rows × 10 columns

- longitude (signed numeric - float) : Longitude value for the block in California, USA
- latitude (numeric - float) : Latitude value for the block in California, USA
- housing_median_age (numeric - int) : Median age of the house in the block
- total_rooms (numeric - int) : Count of the total number of rooms (excluding bedrooms) in all houses in the block
- total_bedrooms (numeric - float) : Count of the total number of bedrooms in all houses in the block
- population (numeric - int) : Count of the total number of population in the block
- households (numeric - int) : Count of the total number of households in the block
- median_income (numeric - float) : Median of the total household income of all the houses in the block

- ocean_proximity (numeric - categorical) : Type of the landscape of the block [Unique Values : 'NEAR BAY', '<1H OCEAN', 'INLAND', 'NEAR OCEAN', 'ISLAND']
- median_house_value (numeric - int) : Median of the household prices of all the houses in the block

In [4]:
```
houseData.describe()
```

Out[4]:

	longitude	latitude	housing_median_age	total_rooms	total_bedrooms	populatio
count	20640.000000	20640.000000	20640.000000	20640.000000	20433.000000	20640.00000
mean	-119.569704	35.631861	28.639486	2635.763081	537.870553	1425.47674
std	2.003532	2.135952	12.585558	2181.615252	421.385070	1132.46212
min	-124.350000	32.540000	1.000000	2.000000	1.000000	3.00000
25%	-121.800000	33.930000	18.000000	1447.750000	296.000000	787.00000
50%	-118.490000	34.260000	29.000000	2127.000000	435.000000	1166.00000
75%	-118.010000	37.710000	37.000000	3148.000000	647.000000	1725.00000
max	-114.310000	41.950000	52.000000	39320.000000	6445.000000	35682.00000

In [5]:
```
houseData.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 20640 entries, 0 to 20639
Data columns (total 10 columns):
 #   Column              Non-Null Count  Dtype  
---  ------              --------------  -----  
 0   longitude           20640 non-null  float64
 1   latitude            20640 non-null  float64
 2   housing_median_age  20640 non-null  int64  
 3   total_rooms         20640 non-null  int64  
 4   total_bedrooms      20433 non-null  float64
 5   population          20640 non-null  int64  
 6   households          20640 non-null  int64  
 7   median_income       20640 non-null  float64
 8   ocean_proximity     20640 non-null  object 
 9   median_house_value  20640 non-null  int64  
dtypes: float64(4), int64(5), object(1)
memory usage: 1.6+ MB
```

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

Out[6]:
```
(20640, 10)
```

In [7]:
```
houseData.head(10)
```

Out[7]:

	longitude	latitude	housing_median_age	total_rooms	total_bedrooms	population	households
0	-122.23	37.88	41	880	129.0	322	126
1	-122.22	37.86	21	7099	1106.0	2401	1138
2	-122.24	37.85	52	1467	190.0	496	177
3	-122.25	37.85	52	1274	235.0	558	219
4	-122.25	37.85	52	1627	280.0	565	259
5	-122.25	37.85	52	919	213.0	413	193
6	-122.25	37.84	52	2535	489.0	1094	514
7	-122.25	37.84	52	3104	687.0	1157	647

	longitude	latitude	housing_median_age	total_rooms	total_bedrooms	population	households
8	-122.26	37.84	42	2555	665.0	1206	595
9	-122.25	37.84	52	3549	707.0	1551	714

In [8]:
```
X = houseData.iloc[:, :-1].values
y = houseData.iloc[:, [-1]].values
```

In [9]:
```
X.shape
```

Out[9]:
```
(20640, 9)
```

In [10]:
```
type(X)
```

Out[10]:
```
numpy.ndarray
```

In [11]:
```
X[0]
```

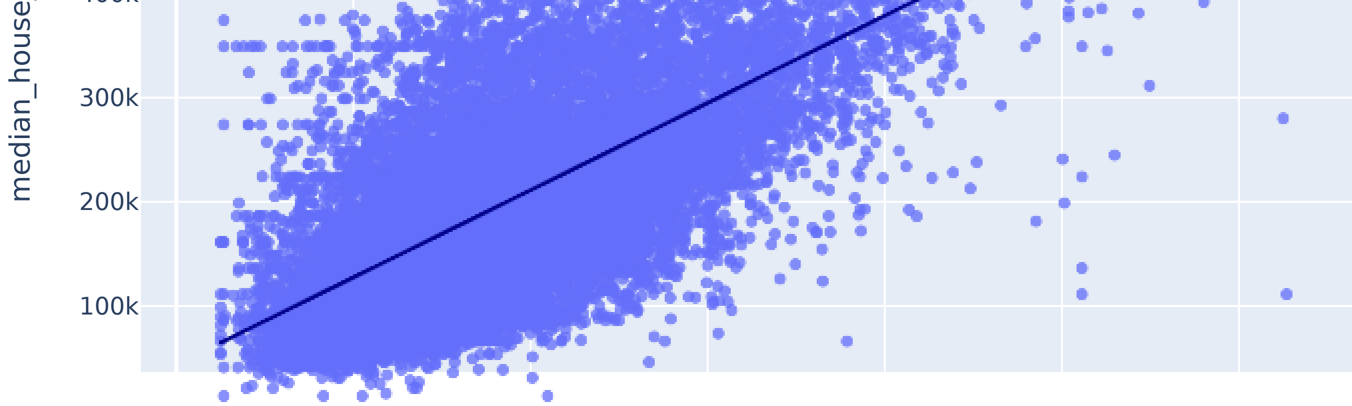
Out[11]:
```
array([-122.23, 37.88, 41, 880, 129.0, 322, 126, 8.3252, 'NEAR BAY'],
      dtype=object)
```

In [12]:
```
# Step3: Handle missing values:
# Fill the missing values with the mean of the respective column

from sklearn.impute import SimpleImputer

imputer = SimpleImputer(missing_values=np.nan, strategy='mean')

X[:, :-1] = imputer.fit_transform(X[:, :-1])
y =  imputer.fit_transform(y)
```

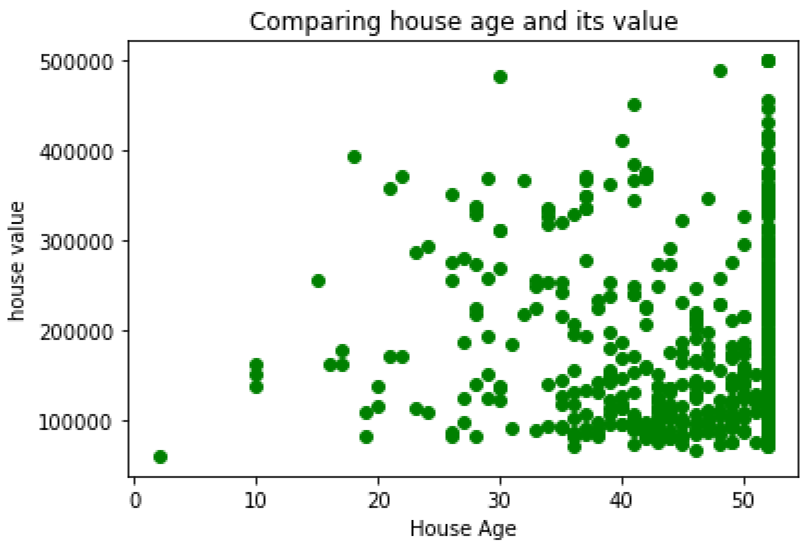
In [13]:
```
# Encode categorical data:
# Convert categorical column in the dataset to numerical data

from sklearn.preprocessing import LabelEncoder
X_labelencoder = LabelEncoder()
X[:, -1] = X_labelencoder.fit_transform(X[:, -1])
```

Visualization of the data

In [14]:
```
fig = px.scatter(
    houseData, x='median_income', y='median_house_value', opacity=0.76,
    trendline='ols', trendline_color_override='darkblue'
)
fig.show()
```




```
In [15]: plt.scatter(houseData.head(500)['housing_median_age'], houseData.head(500)['median_house_v
         plt.title('Comparing house age and its value')
         plt.xlabel('House Age')
         plt.ylabel('house value')
         plt.show()
```




```
In [ ]:
```

Creating a model

```
In [16]: from sklearn.model_selection import train_test_split
         X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, random_state =
```

```
In [17]: from sklearn.preprocessing import StandardScaler

         scaler = StandardScaler()
         X_train = scaler.fit_transform(X_train)
         X_test = scaler.transform(X_test)
         y_train = scaler.fit_transform(y_train)
         y_test = scaler.transform(y_test)
```

```
In [18]: from sklearn.linear_model import LinearRegression
```

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```
model = LinearRegression()
model.fit(X_train, y_train)
```

Out[18]: LinearRegression()

In [19]:
```
X_train.shape
```

Out[19]: (16512, 9)

In [20]:
```
X_test.shape
```

Out[20]: (4128, 9)

In [21]:
```
y_train.shape
```

Out[21]: (16512, 1)

In [22]:
```
y_test.shape
```

Out[22]: (4128, 1)

In [23]:
```
y_pred_test=model.predict(X_test)
```

In [24]:
```
y_pred_test[0]
```

Out[24]: array([0.03048331])

In [25]:
```
y_test[0]
```

Out[25]: array([-0.60810016])

Evaluating the model performance

In [26]:
```
plt.scatter(y_test,y_pred_test,color='green')
plt.title('Model performance')
plt.xlabel('True values for Y')
plt.ylabel('Predicted values for y')
```

Out[26]: Text(0, 0.5, 'Predicted values for y')

In [27]:
```
from sklearn.metrics import mean_squared_error,r2_score
```

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```
print('Root Mean Squared Error = %.4f'%(np.sqrt(mean_squared_error(y_test,y_pred_test))))
print('R-Squared = %.4f'%(r2_score(y_test,y_pred_test)))
```

```
Root Mean Squared Error = 0.6036
R-Squared = 0.6261
```

In [28]:
```
#Postprocessing
#display the coefficients

print('Slope = ',model.coef_[0][0])
```

```
Slope =  -0.7358310667577718
```

In [29]:
```
print('Intercept = ',model.intercept_[0])
```

```
Intercept =  -9.675685131184276e-14
```

In [30]:
```
X.shape
```

Out[30]:
```
(20640, 9)
```

In [31]:
```
seed = 1
numInstances = 20640
```

In [32]:
```
numTrain = 16512
numTest = numInstances - numTrain
```

In [33]:
```
np.random.seed(seed)
```

In [34]:
```
X2=0.5 * X + np.random.normal(0,0.04,size=numInstances).reshape(-1,1)
```

In [35]:
```
X2.shape
```

Out[35]:
```
(20640, 9)
```

In [36]:
```
X3 =0.5 * X2 + np.random.normal(0,0.01,size=numInstances).reshape(-1,1)
```

In [37]:
```
X4 = 0.5 * X3 + np.random.normal(0,0.01,size=numInstances).reshape(-1,1)
```

In [38]:
```
X5 = 0.5 * X4 + np.random.normal(0,0.01,size=numInstances).reshape(-1,1)
```

In [39]:
```
X6 = 0.5 * X5 + np.random.normal(0,0.01,size=numInstances).reshape(-1,1)
```

In [40]:
```
X7 = 0.5 * X6 + np.random.normal(0,0.01,size=numInstances).reshape(-1,1)
```

In [41]:
```
X8 = 0.5 * X7 + np.random.normal(0,0.01,size=numInstances).reshape(-1,1)
```

In [42]:
```
X9 = 0.5 * X8 + np.random.normal(0,0.01,size=numInstances).reshape(-1,1)
```

In [43]:
```
X8.shape
```

Out[43]:
```
(20640, 9)
```

In [44]:
```
fig,((ax1,ax2),(ax3,ax4),(ax5,ax6),(ax7,ax8))=plt.subplots(4,2,figsize=(14,20), dpi = 200
ax1.scatter(X,X2,color='green')
ax1.set_xlabel('X')
ax1.set_ylabel('X2')
c=np.corrcoef(np.column_stack((X[:-numTest],X2[:-numTest])).astype(float).T)
ation between X and X2 = %.4f'%(c[0,1])
```

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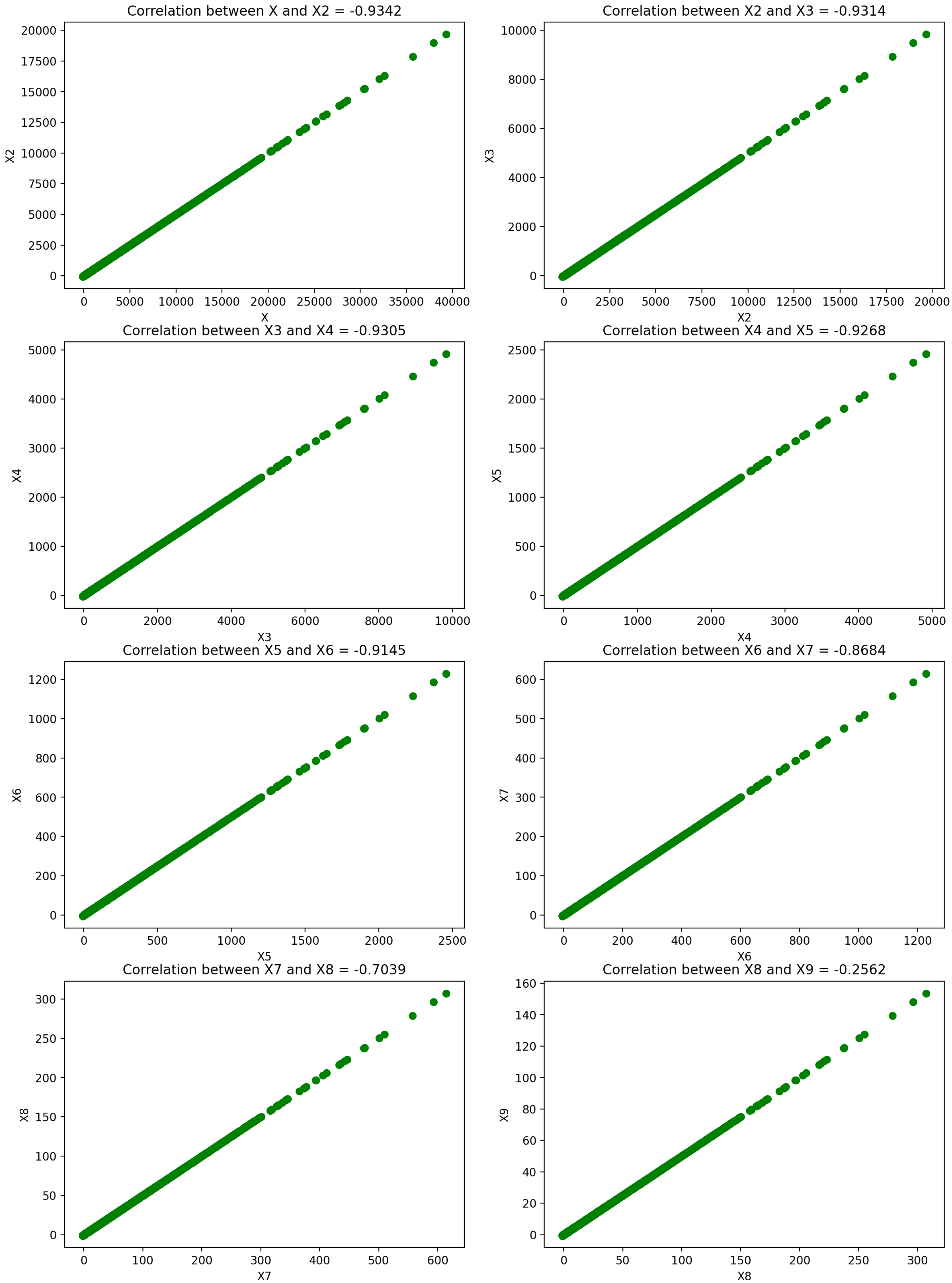
```python
ax1.set_title(titlestr)

ax2.scatter(X2,X3,color='green')
ax2.set_xlabel('X2')
ax2.set_ylabel('X3')
c=np.corrcoef(np.column_stack((X2[:-numTest],X3[:-numTest])).astype(float).T)
titlestr='Correlation between X2 and X3 = %.4f'%(c[0,1])
ax2.set_title(titlestr)

ax3.scatter(X3,X4,color='green')
ax3.set_xlabel('X3')
ax3.set_ylabel('X4')
c=np.corrcoef(np.column_stack((X3[:-numTest],X4[:-numTest])).astype(float).T)
titlestr='Correlation between X3 and X4 = %.4f'%(c[0,1])
ax3.set_title(titlestr)

ax4.scatter(X4,X5,color='green')
ax4.set_xlabel('X4')
ax4.set_ylabel('X5')
c=np.corrcoef(np.column_stack((X4[:-numTest],X5[:-numTest])).astype(float).T)
titlestr='Correlation between X4 and X5 = %.4f'%(c[0,1])
ax4.set_title(titlestr)

ax5.scatter(X5,X6,color='green')
ax5.set_xlabel('X5')
ax5.set_ylabel('X6')
c=np.corrcoef(np.column_stack((X5[:-numTest],X6[:-numTest])).astype(float).T)
titlestr='Correlation between X5 and X6 = %.4f'%(c[0,1])
ax5.set_title(titlestr)

ax6.scatter(X6,X7,color='green')
ax6.set_xlabel('X6')
ax6.set_ylabel('X7')
c=np.corrcoef(np.column_stack((X6[:-numTest],X7[:-numTest])).astype(float).T)
titlestr='Correlation between X6 and X7 = %.4f'%(c[0,1])
ax6.set_title(titlestr)

ax7.scatter(X7,X8,color='green')
ax7.set_xlabel('X7')
ax7.set_ylabel('X8')
c=np.corrcoef(np.column_stack((X7[:-numTest],X8[:-numTest])).astype(float).T)
titlestr='Correlation between X7 and X8 = %.4f'%(c[0,1])
ax7.set_title(titlestr)


ax8.scatter(X8,X9,color='green')
ax8.set_xlabel('X8')
ax8.set_ylabel('X9')
c=np.corrcoef(np.column_stack((X8[:-numTest],X9[:-numTest])).astype(float).T)
titlestr='Correlation between X8 and X9 = %.4f'%(c[0,1])
ax8.set_title(titlestr)
```

Out[44]:
```
Text(0.5, 1.0, 'Correlation between X8 and X9 = -0.2562')
```



In [45]:

```
X_train2=np.column_stack((X[:-numTest],X2[:-numTest]))
X_test2=np.column_stack((X[-numTest:],X2[-numTest:]))
```

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```
umn_stack((X[:-numTest],X2[:-numTest],X3[:-numTest]))
```

```
X_test3=np.column_stack((X[-numTest:],X2[-numTest:],X3[-numTest:]))
```

In [47]:
```
X_train4=np.column_stack((X[:-numTest],X2[:-numTest],X3[:-numTest],X4[:-numTest]))
X_test4=np.column_stack((X[-numTest:],X2[-numTest:],X3[-numTest:],X4[-numTest:]))
```

In [48]:
```
X_train5=np.column_stack((X[:-numTest],X2[:-numTest],X3[:-numTest],X4[:-numTest],X5[:-num
X_test5=np.column_stack((X[-numTest:],X2[-numTest:],X3[-numTest:],X4[-numTest:],X5[-numTe
```

In [49]:
```
X_train6=np.column_stack((X[:-numTest],X2[:-numTest],X3[:-numTest],X4[:-numTest],X5[:-num
X_test6=np.column_stack((X[-numTest:],X2[-numTest:],X3[-numTest:],X4[-numTest:],X5[-numTe
```

In [50]:
```
X_train7=np.column_stack((X[:-numTest],X2[:-numTest],X3[:-numTest],X4[:-numTest],X5[:-num
X_test7=np.column_stack((X[-numTest:],X2[-numTest:],X3[-numTest:],X4[-numTest:],X5[-numTe
```

In [51]:
```
X_train8=np.column_stack((X[:-numTest],X2[:-numTest],X3[:-numTest],X4[:-numTest],X5[:-num
X_test8=np.column_stack((X[-numTest:],X2[-numTest:],X3[-numTest:],X4[-numTest:],X5[-numTe
```

In [52]:
```
X_train9=np.column_stack((X[:-numTest],X2[:-numTest],X3[:-numTest],X4[:-numTest],X5[:-num
X_test9=np.column_stack((X[-numTest:],X2[-numTest:],X3[-numTest:],X4[-numTest:],X5[-numTe
```

In [53]:
```
X_train9.shape
```

Out[53]:
```
(16512, 81)
```

In [54]:
```
X_test9.shape
```

Out[54]:
```
(4128, 81)
```

In [55]:
```
X_train9[0]
```

Out[55]:
```
array([-122.23, 37.88, 41.0, 880.0, 129.0, 322.0, 126.0, 8.3252, 3,
       -61.050026185453476, 19.00497381454653, 20.56497381454653,
       440.06497381454653, 64.56497381454653, 161.06497381454653,
       63.064973814546526, 4.22757381454653, 1.5649738145465297,
       -30.52182080437767, 9.505679195622337, 10.285679195622336,
       220.03567919562235, 32.285679195622336, 80.53567919562234,
       31.535679195622333, 2.1169791956223354, 0.7856791956223353,
       -15.274169956252948, 4.739580043747054, 5.129580043747054,
       110.00458004374705, 16.129580043747055, 40.254580043747055,
       15.754580043747053, 1.0452300437470539, 0.3795800437470538,
       -7.653930333789659, 2.3529446662103424, 2.547944666210342,
       54.98544466621034, 8.047944666210343, 20.11044466621034,
       7.860444666210341, 0.5057696662103421, 0.17294466621034207,
       -3.8228654559536364, 1.1805720440463645, 1.2780720440463644,
       27.496822044046365, 4.028072044046365, 10.059322044046365,
       3.9343220440463638, 0.25698454404636434, 0.09057204404636429,
       -1.9089774485886017, 0.5927413014113987, 0.6414913014113987,
       13.7508663014114, 2.0164913014113988, 5.032116301411399,
       1.9696163014113983, 0.13094755141139866, 0.04774130141139864,
       -0.9638097309206792, 0.287049644079321, 0.3114246440793209,
       6.866112144079321, 0.998924644079321, 2.506737144079321,
       0.9754871440793208, 0.056152769079320944, 0.014549644079320932,
       -0.4662158511644028, 0.15921383633559733, 0.1714013363355973,
       3.4487450863355975, 0.5151513363355974, 1.2690575863355975,
       0.5034325863355973, 0.043765398835597731, 0.022963836335597305],
      dtype=object)
```

Test the 8 new regression model based on the 8 version of the training and test data

```
Loading [MathJax]/extensions/Safe.js egression()
```

```
model2.fit(X_train2,y_train)
```

Out[56]: LinearRegression()

In [57]:
```
model3 = LinearRegression()
model3.fit(X_train3,y_train)
```

Out[57]: LinearRegression()

In [58]:
```
model4 = LinearRegression()
model4.fit(X_train4,y_train)
```

Out[58]: LinearRegression()

In [59]:
```
model5 = LinearRegression()
model5.fit(X_train5,y_train)
```

Out[59]: LinearRegression()

In [60]:
```
model6 = LinearRegression()
model6.fit(X_train6,y_train)
```

Out[60]: LinearRegression()

In [61]:
```
model7 = LinearRegression()
model7.fit(X_train7,y_train)
```

Out[61]: LinearRegression()

In [62]:
```
model8 = LinearRegression()
model8.fit(X_train8,y_train)
```

Out[62]: LinearRegression()

In [63]:
```
model9 = LinearRegression()
model9.fit(X_train9,y_train)
```

Out[63]: LinearRegression()

In [64]:
```
y_pred_train= model.predict(X_train)
y_pred_test=model.predict(X_test)
```

In [65]:
```
y_pred_train2= model2.predict(X_train2)
y_pred_test2=model2.predict(X_test2)
```

In [66]:
```
y_pred_train3= model3.predict(X_train3)
y_pred_test3=model3.predict(X_test3)
```

In [67]:
```
y_pred_train4= model4.predict(X_train4)
y_pred_test4=model4.predict(X_test4)
```

In [68]:
```
y_pred_train5= model5.predict(X_train5)
y_pred_test5=model5.predict(X_test5)
```

In [69]:
```
y_pred_train6= model6.predict(X_train6)
y_pred_test6=model6.predict(X_test6)
```

In [70]:
```
y_pred_train7= model7.predict(X_train7)
el7.predict(X_test7)
```

In [71]:
```
y_pred_train8= model8.predict(X_train8)
y_pred_test8=model8.predict(X_test8)
```

In [72]:
```
y_pred_train9= model9.predict(X_train9)
y_pred_test9=model9.predict(X_test9)
```

In [73]:
```
columns=['Model','Train Error','Test Error','Sum of Absolute Weights']
```

In [74]:
```
model1 = "%.2f X + %.2f" % (model.coef_[0][0], model.intercept_[0])
values1 = [ model1, np.sqrt(mean_squared_error(y_train, y_pred_train)),
           np.sqrt(mean_squared_error(y_test, y_pred_test)),
           np.absolute(model.coef_[0]).sum() + np.absolute(model.intercept_[0])]
```

In [75]:
```
model_2 = "%.2f X + %.2f X2 + %.2f" % (model2.coef_[0][0], model2.coef_[0][1], model2.int
values2 = [ model_2, np.sqrt(mean_squared_error(y_train, y_pred_train2)),
           np.sqrt(mean_squared_error(y_test, y_pred_test2)),
           np.absolute(model2.coef_[0]).sum() + np.absolute(model2.intercept_[0])]
```

In [76]:
```
model_3 = "%.2f X + %.2f X2 + %.2f X3 + %.2f" % (model3.coef_[0][0], model3.coef_[0][1],
                                                 model3.coef_[0][2], model3.intercept_[0])
values3 = [ model_3, np.sqrt(mean_squared_error(y_train, y_pred_train3)),
           np.sqrt(mean_squared_error(y_test, y_pred_test3)),
           np.absolute(model3.coef_[0]).sum() + np.absolute(model3.intercept_[0])]
```

In [77]:
```
model_4 = "%.2f X + %.2f X2 + %.2f X3 + %.2f X4 + %.2f" % (model4.coef_[0][0], model4.coe
                                         model4.coef_[0][2], model4.coef_[0][3], model4.in
values4 = [ model_4, np.sqrt(mean_squared_error(y_train, y_pred_train4)),
           np.sqrt(mean_squared_error(y_test, y_pred_test4)),
           np.absolute(model4.coef_[0]).sum() + np.absolute(model4.intercept_[0])]
```

In [78]:
```
model_5 = "%.2f X + %.2f X2 + %.2f X3 + %.2f X4 + %.2f X5 + %.2f" % (model5.coef_[0][0],
                                         model5.coef_[0][1], model5.coef_[0][2],
                                         model5.coef_[0][3], model5.coef_[0][4], model5.in
values5 = [ model_5, np.sqrt(mean_squared_error(y_train, y_pred_train5)),
           np.sqrt(mean_squared_error(y_test, y_pred_test5)),
           np.absolute(model5.coef_[0]).sum() + np.absolute(model5.intercept_[0])]
```

In [79]:
```
model_6 = "%.2f X + %.2f X2 + %.2f X3 + %.2f X4 + %.2f X5 + %.2f X6 + %.2f" % (model6.coe
                                         model6.coef_[0][1], model6.coef_[0][2],
                                         model6.coef_[0][3], model6.coef_[0][4], model6.co
values6 = [ model_6, np.sqrt(mean_squared_error(y_train, y_pred_train6)),
           np.sqrt(mean_squared_error(y_test, y_pred_test6)),
           np.absolute(model6.coef_[0]).sum() + np.absolute(model6.intercept_[0])]
```

In [80]:
```
model_7 = "%.2f X + %.2f X2 + %.2f X3 + %.2f X4 + %.2f X5 + %.2f X6 + %.2f X7 + %.2f" % (
                                         model7.coef_[0][1], model7.coef_[0][2],
                                         model7.coef_[0][3], model7.coef_[0][4],
                                         model7.coef_[0][5], model7.coef_[0][6], model7.in
values7 = [ model_7, np.sqrt(mean_squared_error(y_train, y_pred_train7)),
           np.sqrt(mean_squared_error(y_test, y_pred_test7)),
           np.absolute(model7.coef_[0]).sum() + np.absolute(model7.intercept_[0])]
```

In [81]:
```
model_8 = "%.2f X + %.2f X2 + %.2f X3 + %.2f X4 + %.2f X5 + %.2f X6 + %.2f X7 + %.2f X8 +
                                         model8.coef_[0][1], model8.coef_[0][2],
                                         model8.coef_[0][3], model8.coef_[0][4],
                                         model8.coef_[0][5], model8.coef_[0][6], model8.co
values8 = [ model_8, np.sqrt(mean_squared_error(y_train, y_pred_train8)),
           np.sqrt(mean_squared_error(y_test, y_pred_test8)),
           np.absolute(model8.coef_[0]).sum() + np.absolute(model8.intercept_[0])]
```

In [82]:

```
model_9 = "%.2f X + %.2f X2 + %.2f X3 + %.2f X4 + %.2f X5 + %.2f X6 + %.2f X7 + %.2f X8 +
                                        model9.coef_[0][1], model9.coef_[0][2],
                                        model9.coef_[0][3], model9.coef_[0][4],
                                        model9.coef_[0][5], model9.coef_[0][6],
                                        model9.coef_[0][7], model9.coef_[0][8], model9.in
values9 = [ model_9, np.sqrt(mean_squared_error(y_train, y_pred_train9)),
           np.sqrt(mean_squared_error(y_test, y_pred_test9)),
           np.absolute(model9.coef_[0]).sum() + np.absolute(model9.intercept_[0])]
```

In [83]:

```
results=pd.DataFrame([values1,values2,values3,values4,values5,values6,values7,values8,val
```

In [84]:

```
results
```

Out[84]:

	Model	Train Error	Test Error	Sum of Absolute Weights
0	-0.74 X + -0.00	0.601750	0.603579	3.348947e+00
1	-0.00 X + -0.00 X2 + 0.16	0.999858	0.987093	1.954539e-01
2	-0.00 X + -0.00 X2 + -0.00 X3 + 0.17	0.999832	0.987282	1.287974e+00
3	132750114.58 X + 100354498.00 X2 + 99330012.13...	0.999814	0.987405	1.669149e+10
4	126263352.86 X + 91930778.39 X2 + 90841257.63 ...	0.999781	0.987222	1.682748e+10
5	126317355.74 X + 91072692.75 X2 + 89979584.19 ...	0.999763	0.987365	1.726918e+10
6	126108598.20 X + 90889407.62 X2 + 89782210.25 ...	0.999763	0.987391	1.732191e+10
7	125662523.80 X + 90555941.70 X2 + 89450085.54 ...	0.999751	0.987471	1.730092e+10
8	125662523.80 X + 89687555.72 X2 + 88593863.38 ...	0.999753	0.987443	1.716425e+10

In [85]:

```
#pd.options.display.float_format = '{:.4f}'.format
```

In [86]:

```
results["Sum of Absolute Weights"].values
```

Out[86]:

```
array([3.34894685e+00, 1.95453863e-01, 1.28797358e+00, 1.66914851e+10,
       1.68274769e+10, 1.72691847e+10, 1.73219078e+10, 1.73009199e+10,
       1.71642463e+10])
```

In [87]:

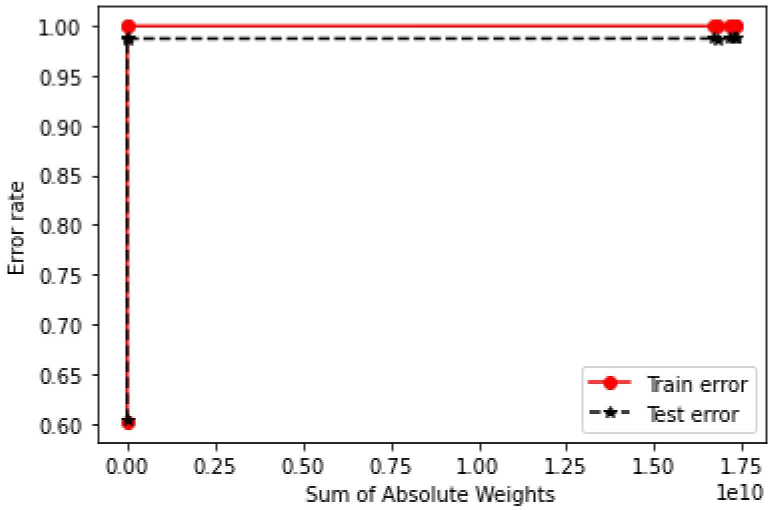
```
plt.plot(results['Sum of Absolute Weights'], results['Train Error'], 'ro-')
plt.plot(results['Sum of Absolute Weights'], results['Test Error'], 'k*--')
plt.legend(['Train error', 'Test error'])
plt.xlabel('Sum of Absolute Weights')
plt.ylabel('Error rate')

results
```

Out[87]:

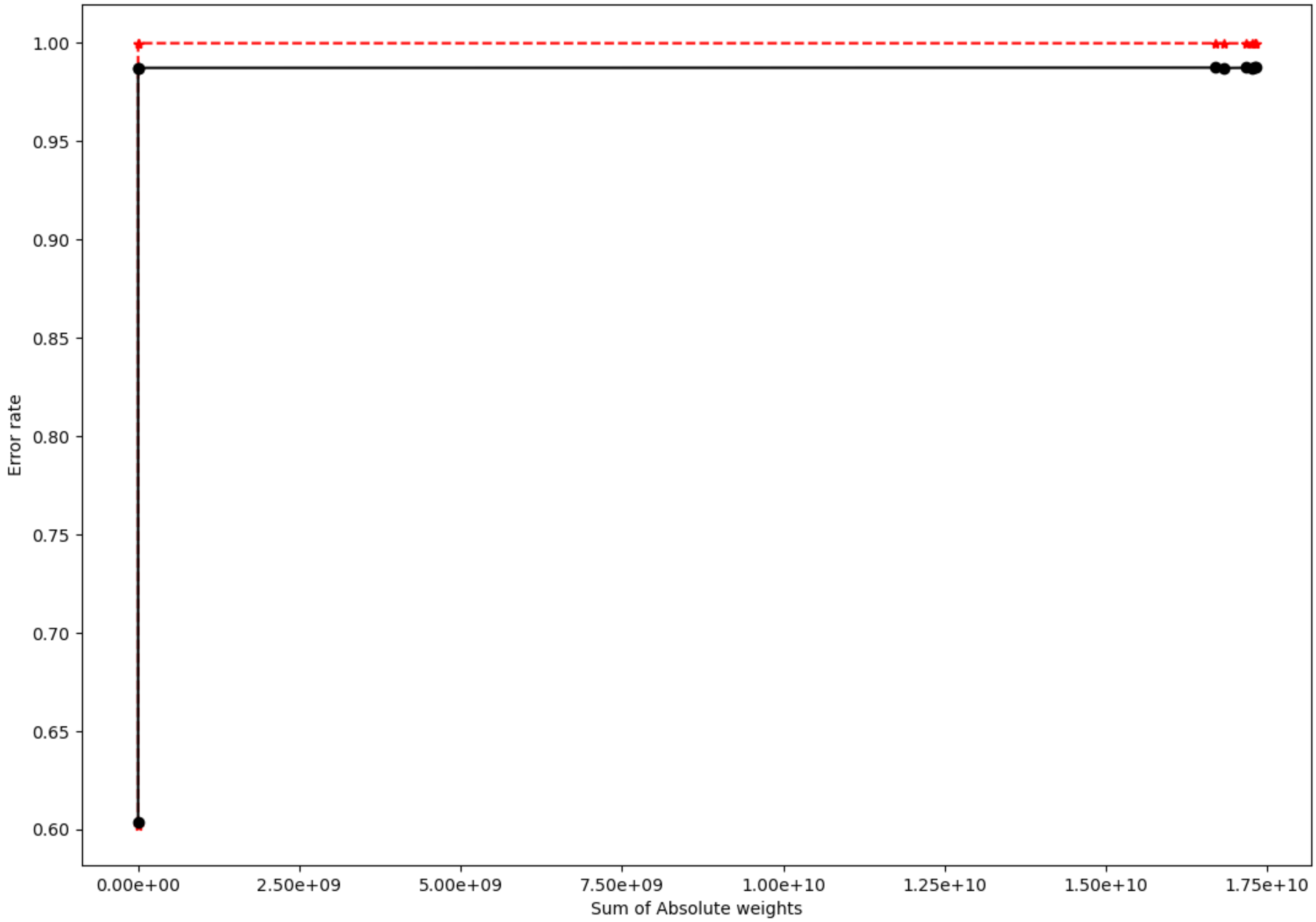
	Model	Train Error	Test Error	Sum of Absolute Weights
0	-0.74 X + -0.00	0.601750	0.603579	3.348947e+00
1	-0.00 X + -0.00 X2 + 0.16	0.999858	0.987093	1.954539e-01
2	-0.00 X + -0.00 X2 + -0.00 X3 + 0.17	0.999832	0.987282	1.287974e+00
3	132750114.58 X + 100354498.00 X2 + 99330012.13...	0.999814	0.987405	1.669149e+10

	Model	Train Error	Test Error	Sum of Absolute Weights
4	126263352.86 X + 91930778.39 X2 + 90841257.63 ...	0.999781	0.987222	1.682748e+10
5	126317355.74 X + 91072692.75 X2 + 89979584.19 ...	0.999763	0.987365	1.726918e+10
6	126108598.20 X + 90889407.62 X2 + 89782210.25 ...	0.999763	0.987391	1.732191e+10
7	125662523.80 X + 90555941.70 X2 + 89450085.54 ...	0.999751	0.987471	1.730092e+10
8	125662523.80 X + 89687555.72 X2 + 88593863.38 ...	0.999753	0.987443	1.716425e+10



In [88]:

```
fig = plt.figure(figsize=(10,7),dpi=100)
axes = fig.add_axes([0,0,1,1])
axes.plot(results['Sum of Absolute Weights'], results['Train Error'], ls = "--", color =
axes.plot(results['Sum of Absolute Weights'], results['Test Error'], ls = "-", color = "k
axes.set_title('')
axes.set_xlabel('Sum of Absolute weights')
axes.set_ylabel('Error rate')
axes.xaxis.set_major_formatter(mtick.FormatStrFormatter('%.2e'))
plt.show()
```



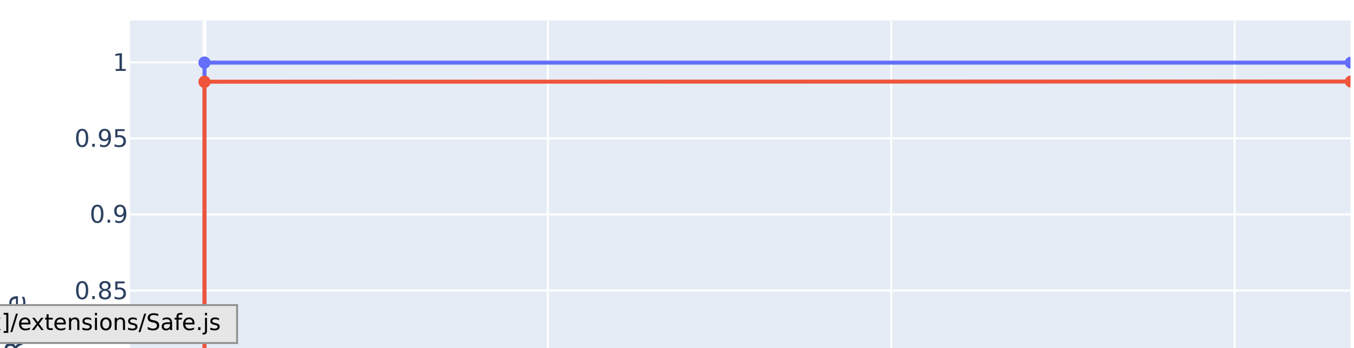
In [ ]:

In [89]:

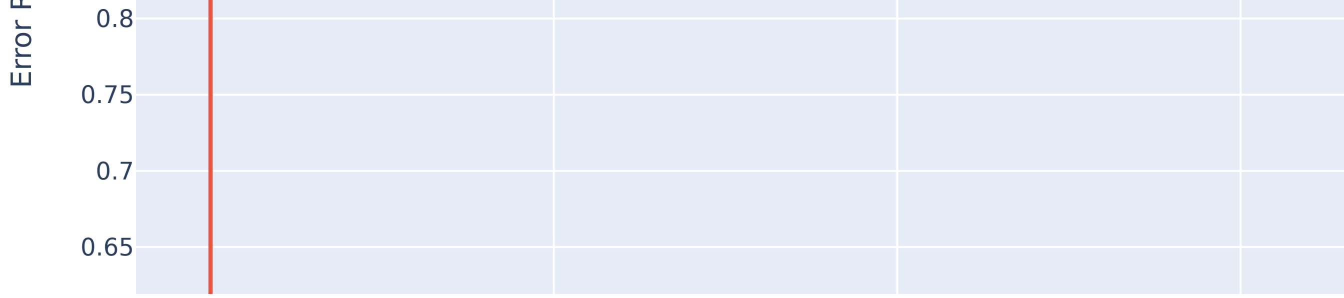
```
fig = go.Figure()
fig.add_trace(go.Line(x = results['Sum of Absolute Weights'], y = results['Train Error'],
fig.add_trace(go.Line(x = results['Sum of Absolute Weights'], y = results['Test Error'],
fig.update_layout(title='',xaxis=dict(title='Sum of Absolute Weights'), yaxis=dict(title=
```

```
C:\Users\Bill\anaconda3\lib\site-packages\plotly\graph_objs\_deprecations.py:378: Deprecat
ionWarning:

plotly.graph_objs.Line is deprecated.
Please replace it with one of the following more specific types
  - plotly.graph_objs.scatter.Line
  - plotly.graph_objs.layout.shape.Line
  - etc.
```



Loading [MathJax]/extensions/Safe.js



In [ ]:

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