InsuranceCostLR.py

April 5, 2019

1 Health Insurance Cost Estimation Using Linear Regression

1.1 By MiMoTrixZ

1.1.1 Import Libraries

```
In [85]: import pandas as pd
         import numpy as np
         import matplotlib.pyplot as plt
         from matplotlib.ticker import FuncFormatter
         import seaborn as sns
         from scipy.stats import norm
         %matplotlib inline
         from sklearn.model_selection import cross_val_score, KFold
         from sklearn import model_selection
         from sklearn import linear_model
         from sklearn.metrics import mean_squared_error,mean_absolute_error
```

2 A

2.0.1 Load Data and See the Shape

```
In [86]: df = pd.read_csv("insurance.csv")
         print(df.shape)
         df.info()
```

```
(1338, 7)
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1338 entries, 0 to 1337
Data columns (total 7 columns):
age         1338 non-null int64
sex         1338 non-null object
bmi         1338 non-null float64
children    1338 non-null int64
smoker      1338 non-null object
region      1338 non-null object
charges     1338 non-null float64
dtypes: float64(2), int64(2), object(3)
```

```
memory usage: 73.2+ KB
```

2.0.2 Map Categorical Data to Numerical Ones

```
In [148]: catColumns = ['sex', 'smoker', 'region']
          insurance_dum = pd.get_dummies(df, columns = catColumns, drop_first=True)
          insurance_dum.head()
```

Out[148]:

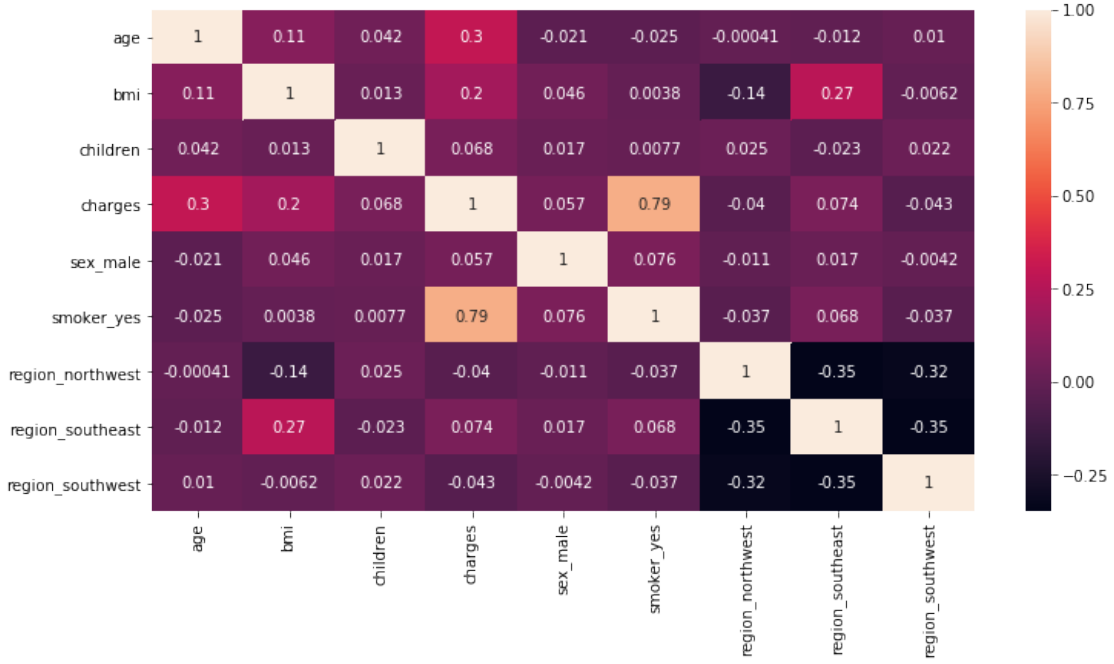
	age	bmi	children	charges	sex_male	smoker_yes	region_northwest	region_southeast	region_southwest
0	19	27.900	0	16884.92400	0	1	0	0	1
1	18	33.770	1	1725.55230	1	0	0	1	0
2	28	33.000	3	4449.46200	1	0	0	1	0
3	33	22.705	0	21984.47061	1	0	1	0	0
4	32	28.880	0	3866.85520	1	0	1	0	0

3 B

3.0.1 Correlation Plot

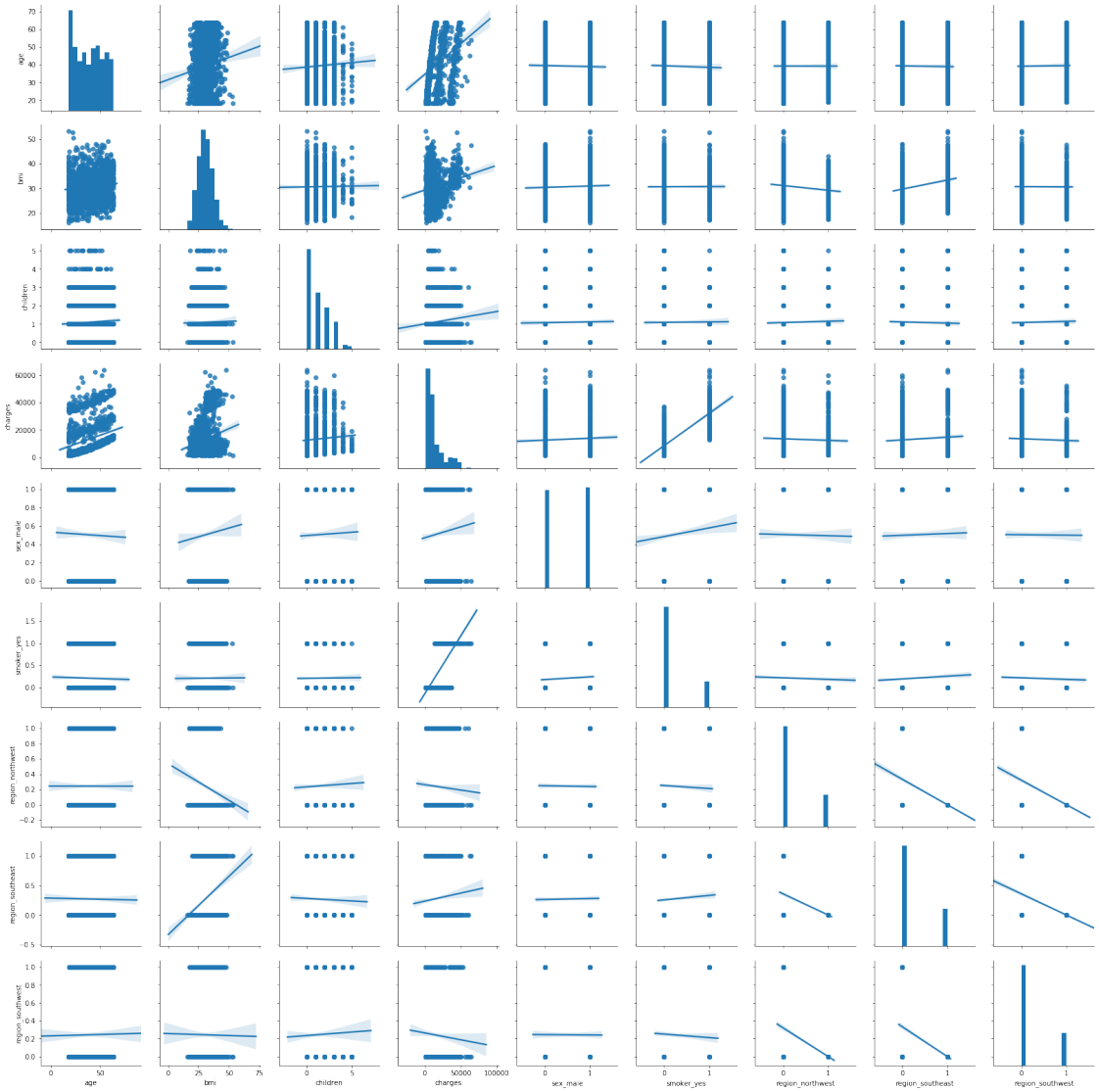
```
In [147]: fig = plt.figure(figsize=(12,6))
          sns.heatmap(insurance_dum.corr(), annot=True)
```

```
Out[147]: <matplotlib.axes._subplots.AxesSubplot at 0x130a13f28>
```



In [149]: `sns.pairplot(insurance_dum, kind='reg')`

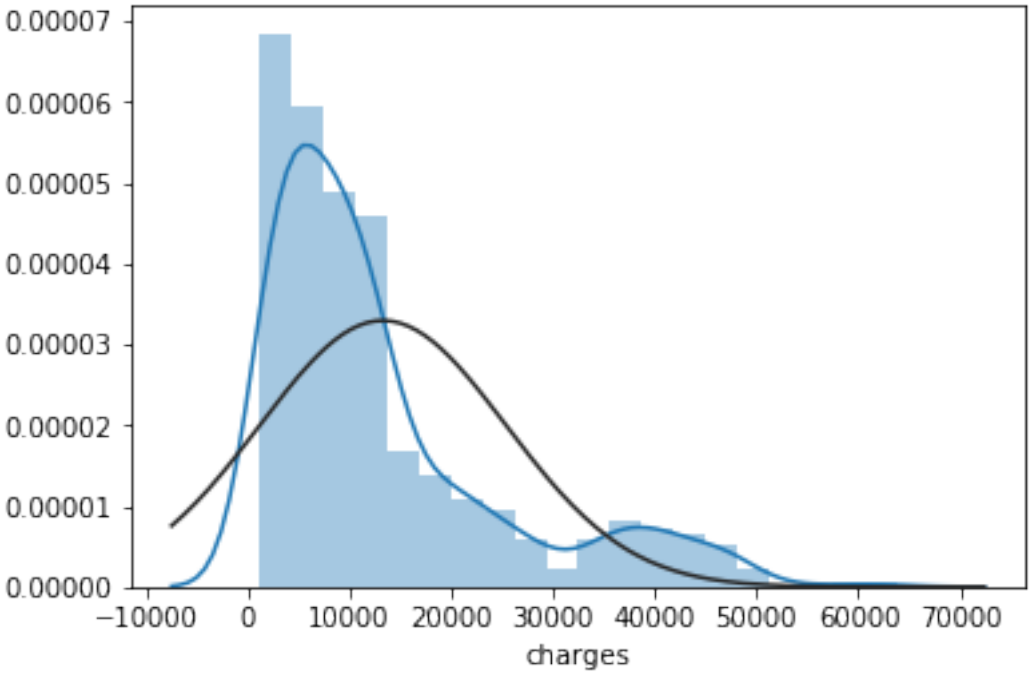
Out[149]: `<seaborn.axisgrid.PairGrid at 0x130ddcf98>`



4 C

4.0.1 Costs Distributions Due to Features

```
In [91]: sns.distplot(df["charges"], bins=20, fit=norm)
         plt.show()
```

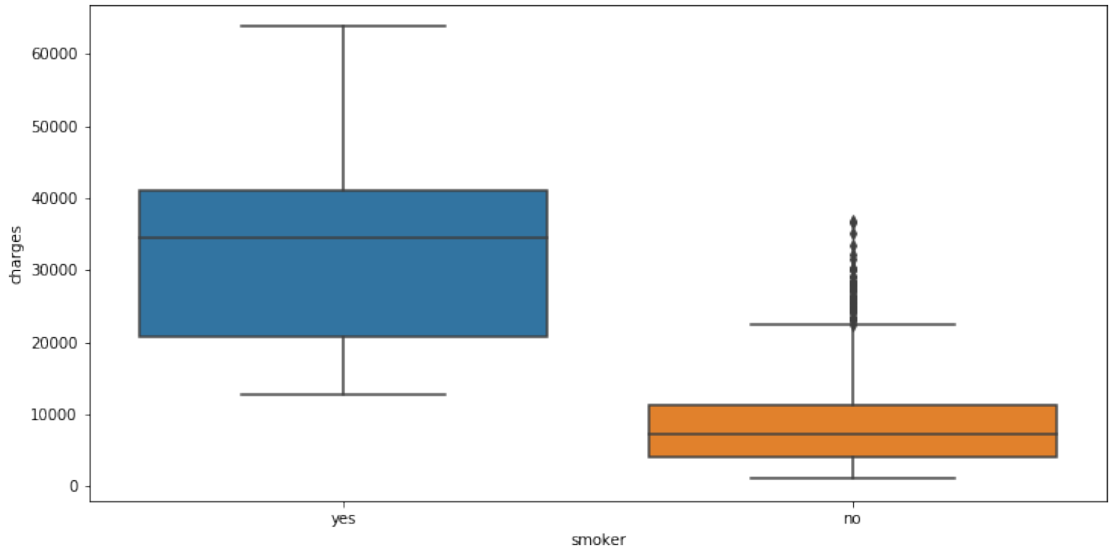


5 D

5.0.1 Smokers, Non Smokers / Insurance Costs

```
In [92]: plt.figure(figsize=(12,6))
         sns.boxplot(x='smoker', y = 'charges', data = df)
```

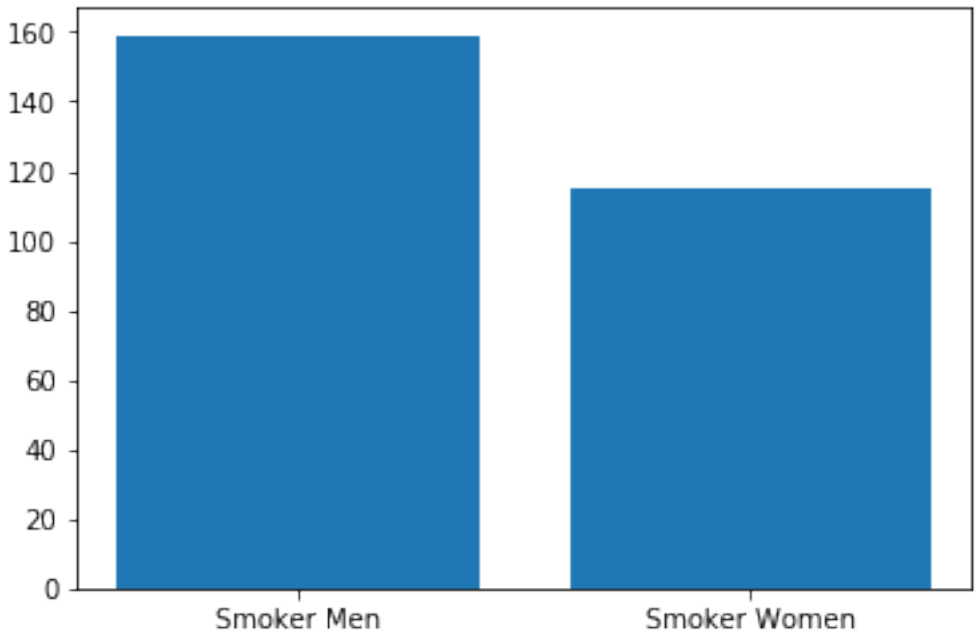
```
Out[92]: <matplotlib.axes._subplots.AxesSubplot at 0x12e4c4198>
```



6 E

6.0.1 Females, Males / Smokers

In [93]:
```
smoker_men = 0
smoker_women = 0
for items in range(len(df)):
    if insurance_dum['sex_male'][items]==0 and insurance_dum['smoker_yes'][items]==1:
        smoker_women = smoker_women + 1
    if insurance_dum['sex_male'][items]==1 and insurance_dum['smoker_yes'][items]==1:
        smoker_men = smoker_men + 1
smokers = ['Smoker Males','Smoker Females']
y = [smoker_men, smoker_women]
x = np.arange(2)
fig, ax = plt.subplots()
plt.bar(x, y)
plt.xticks(x, ('Smoker Men', 'Smoker Women'))
plt.show()
```



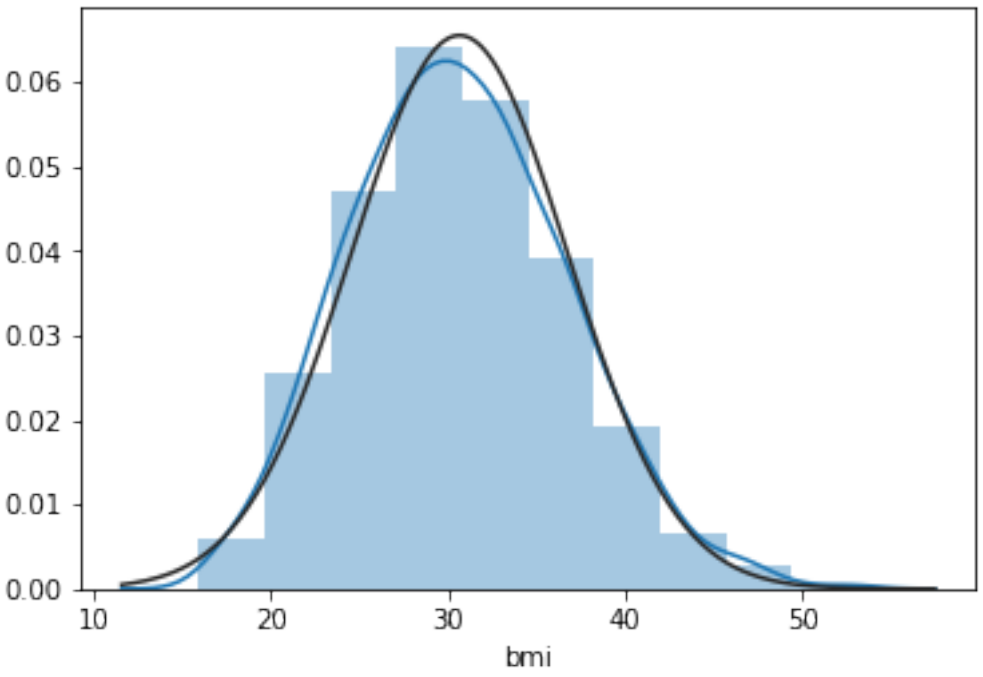
7 F

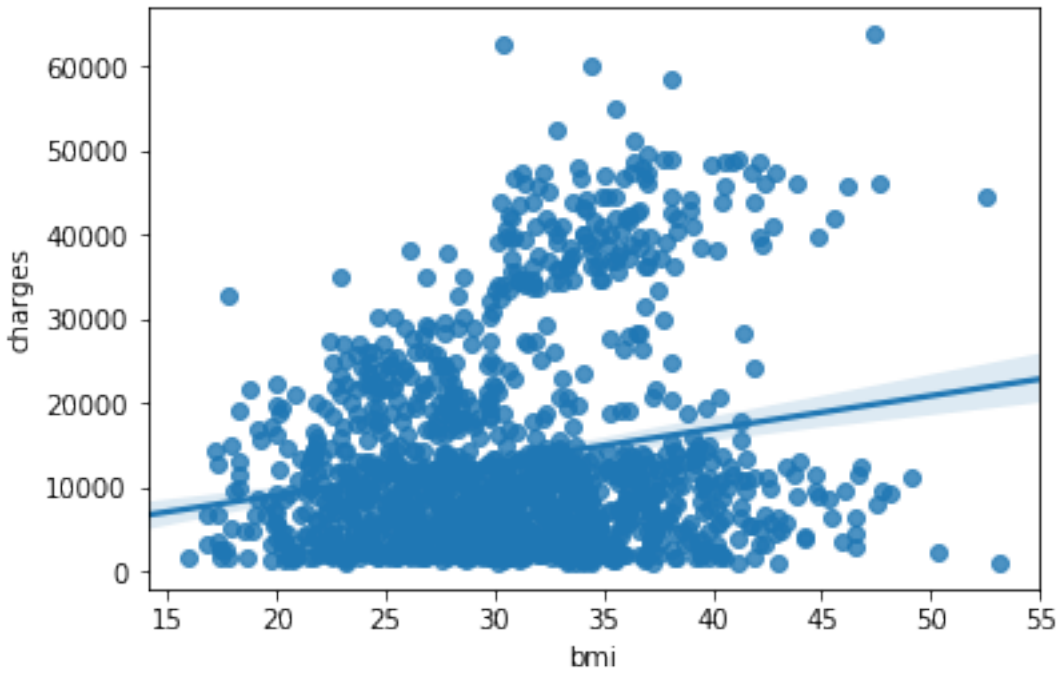
7.0.1 BMI vs. Charges

```
In [94]: df["bmi"].describe()
```

```
Out[94]: count    1338.000000
         mean       30.663397
         std         6.098187
         min        15.960000
         25%        26.296250
         50%        30.400000
         75%        34.693750
         max        53.130000
         Name: bmi, dtype: float64
```

```
In [95]: sns.distplot(df["bmi"], bins=10, fit=norm)
         plt.show()
         sns.regplot(x="bmi", y="charges", data=df);
         plt.show()
```





8 E and F

8.0.1 Creating Model Using K-Fold Cross Validation (Splitting Data to Train and Test Using SKLearn)

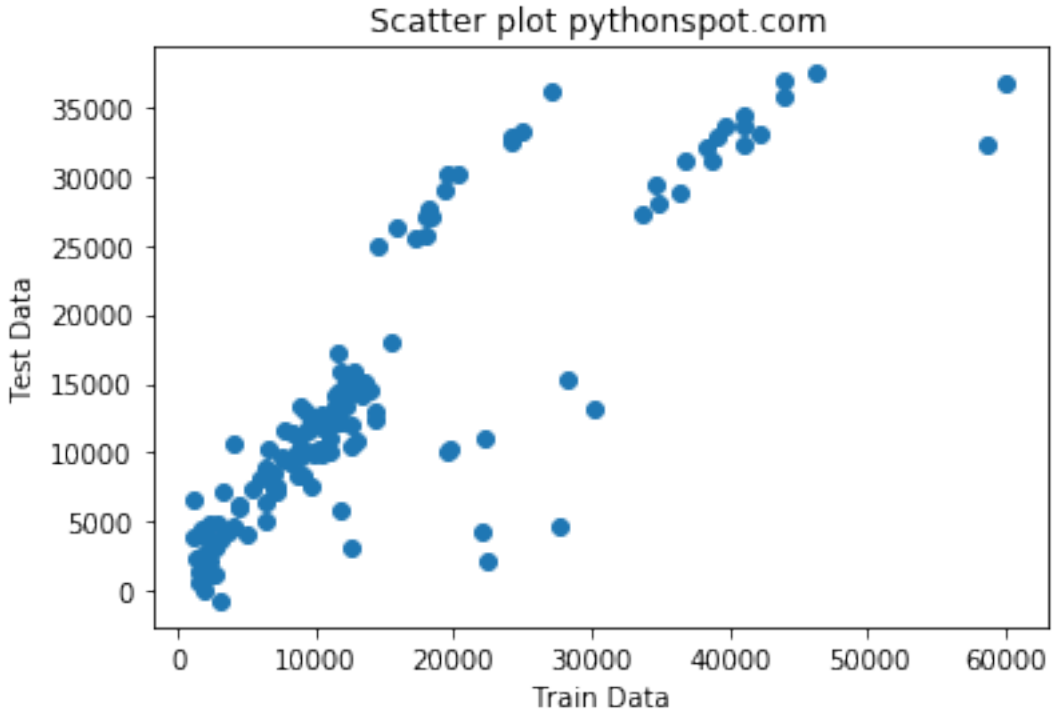
In [143]:
```
cols_not_reg3=['age', 'bmi', 'smoker_yes']

kf=KFold(n_splits=10, random_state=1, shuffle=True)
intercepts=[]
mses=[]
coefs=[]
i = 1
for train_index, test_index in kf.split(insurance_dum[cols_not_reg3]):
    lr=linear_model.LinearRegression()
    lr.fit(insurance_dum[cols_not_reg3].iloc[train_index],
           insurance_dum["charges"].iloc[train_index])
    lr_predictions=lr.predict(insurance_dum[cols_not_reg3].iloc[test_index])
    lr_mse=mean_squared_error(insurance_dum["charges"].iloc[test_index],lr_predictio
    print("Mean Squared Error When ", i, "th Fold is Trained: ", lr_mse)
    intercepts.append(lr.intercept_)
    coefs.append(lr.coef_)
    mses.append(lr_mse)
    i = i+1
    plt.figure()
```

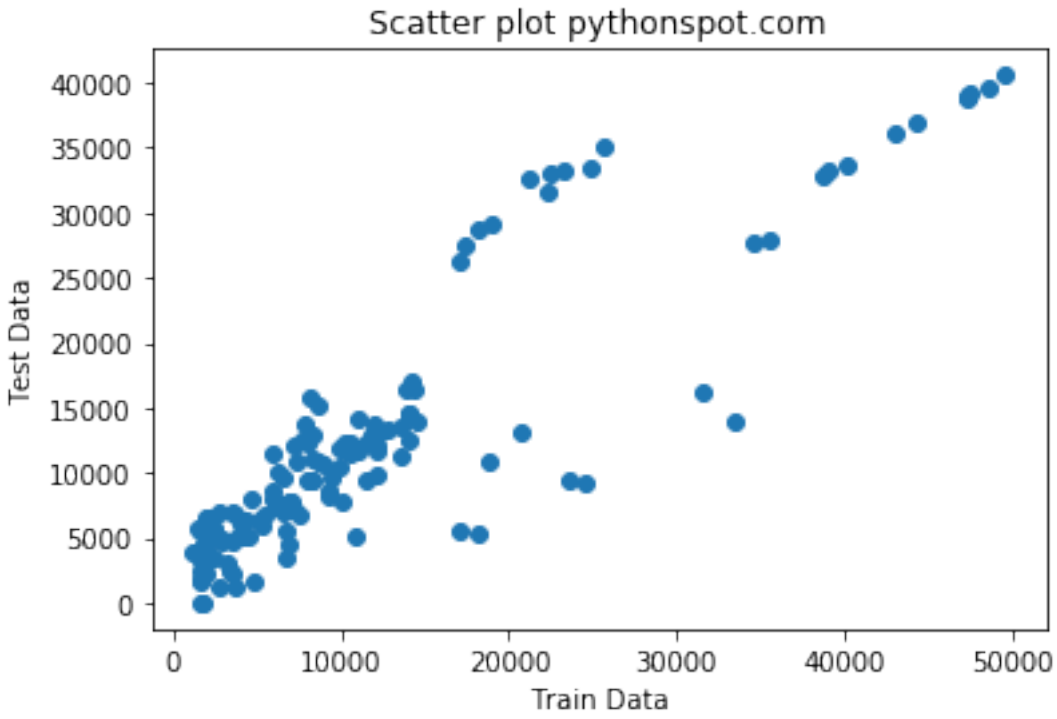
```
        y_pred1 = lr_predictions
        plt.scatter(insurance_dum["charges"].iloc[test_index], y_pred1)
        plt.title('Scatter plot pythonspot.com')
        plt.xlabel('Train Data')
        plt.ylabel('Test Data')
        plt.show()

    rmses=[x**.5 for x in mses]
    avg_rmse=np.mean(rmses)
    print("Total Training Error Average: ", lr_mse)
    avg_intercept=np.mean(intercepts)
    age_coefs=[]
    bmi_coefs=[]
    smoking_coefs=[]
    for vals in coefs:
        #print vals[0]
        age_coefs.append(vals[0])
        bmi_coefs.append(vals[1])
        smoking_coefs.append(vals[2])
    age_coef=np.mean(age_coefs)
    bmi_coef=np.mean(bmi_coefs)
    smoking_coef=np.mean(smoking_coefs)
    print("Age Coefficient: ",age_coef,"\nBMI Coefficient: ",bmi_coef,
          "\nSmoker_Yes Coefficient: ",smoking_coef,"\nAverage Intercept: ",avg_intercept
```

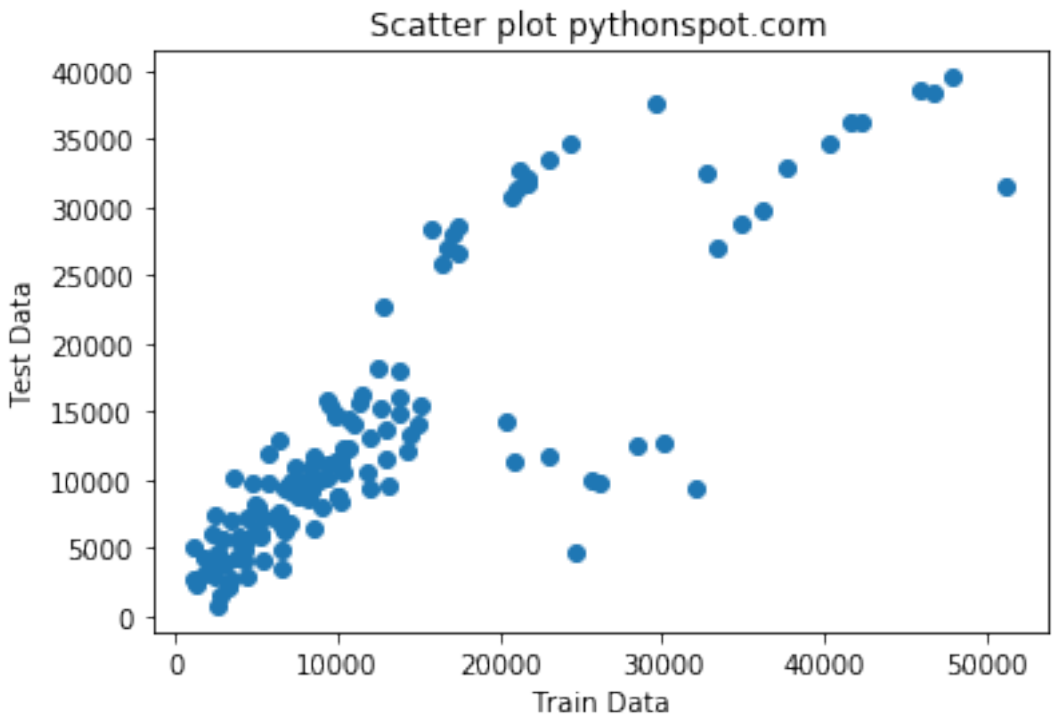
```
Mean Squared Error When  1 th Fold is Trained:  43807430.46611558
```



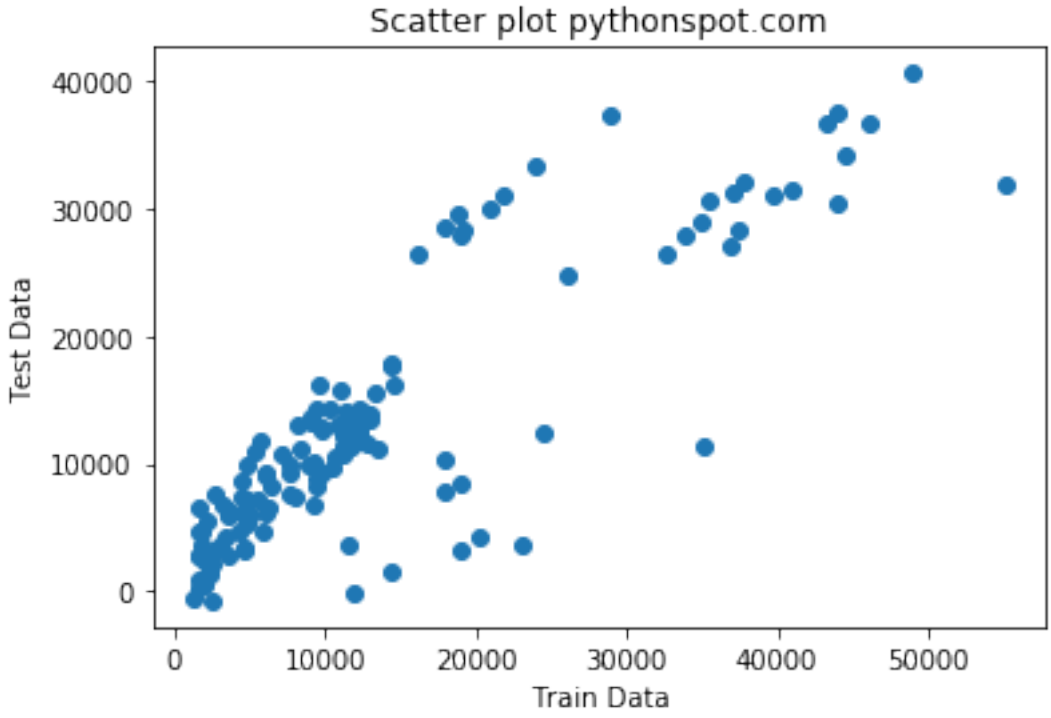
```
Mean Squared Error When  2 th Fold is Trained:  28819695.679591242
```



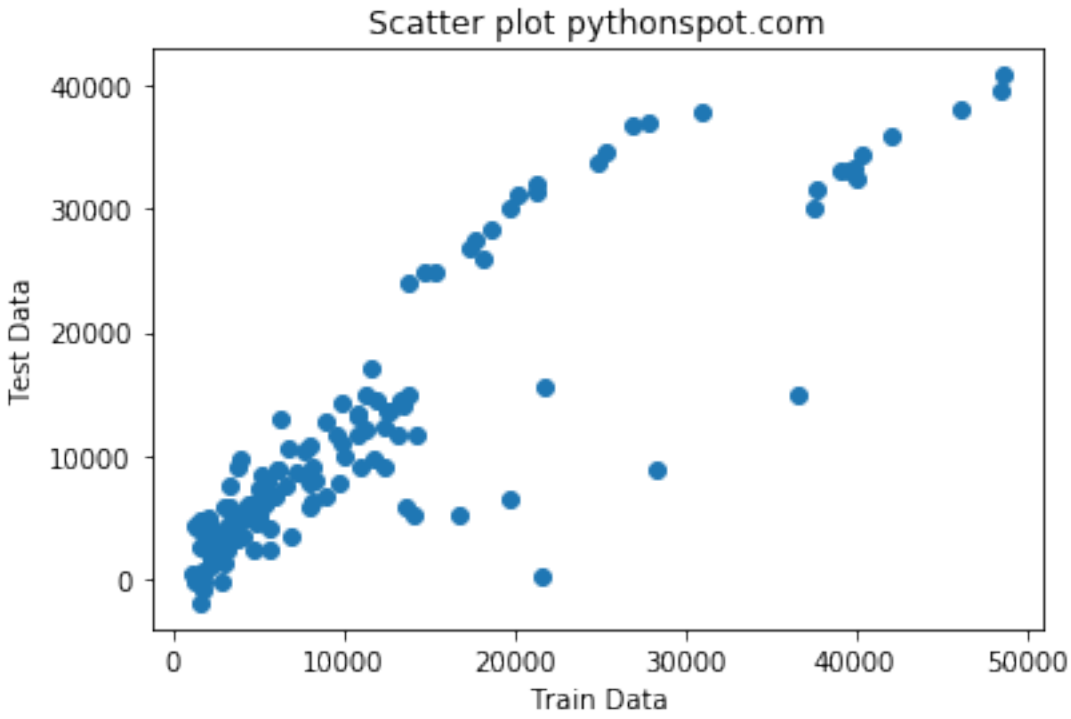

```
Mean Squared Error When  3 th Fold is Trained:  40130484.27718843
```



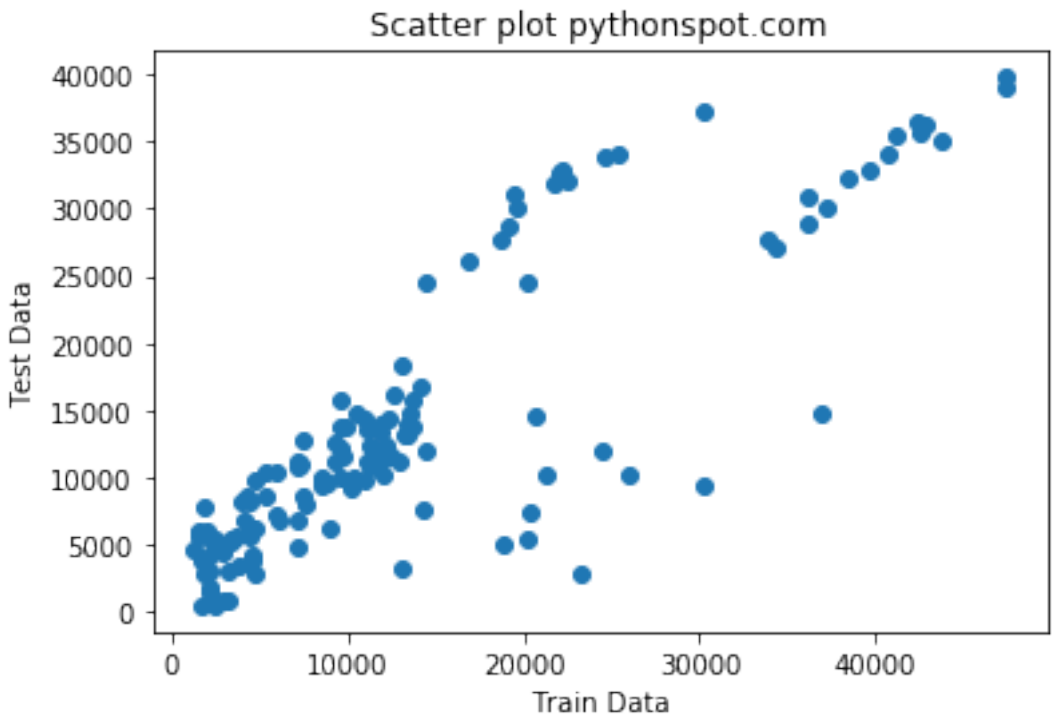

```
Mean Squared Error When  4 th Fold is Trained:  39222308.91249657
```



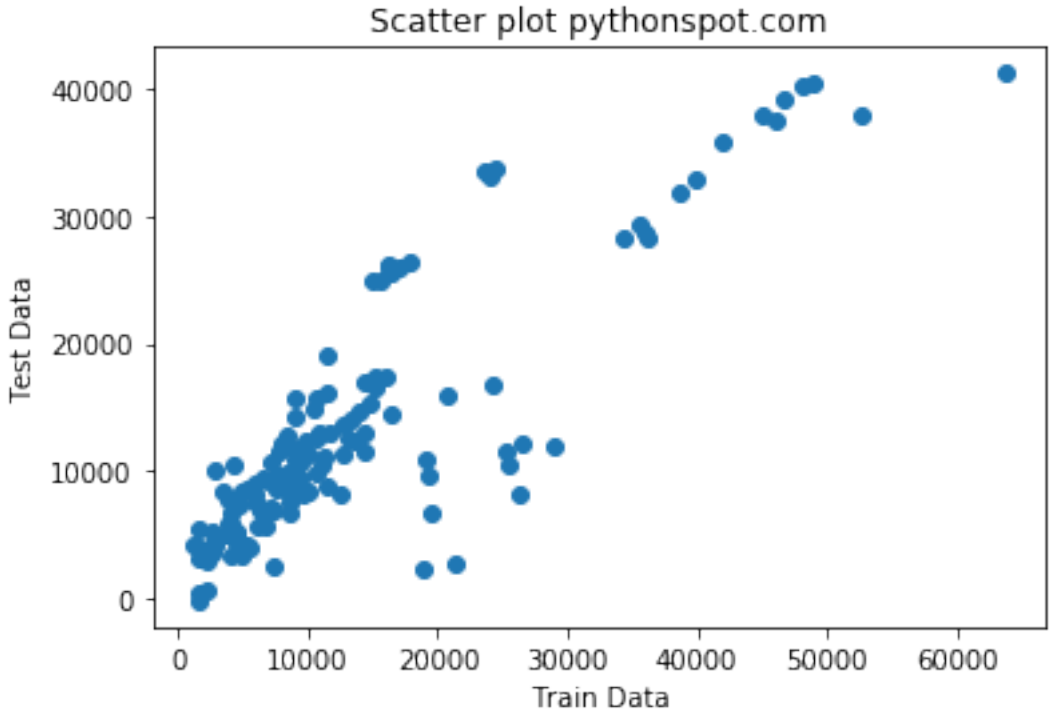
```
Mean Squared Error When  5 th Fold is Trained:  32262291.40598369
```



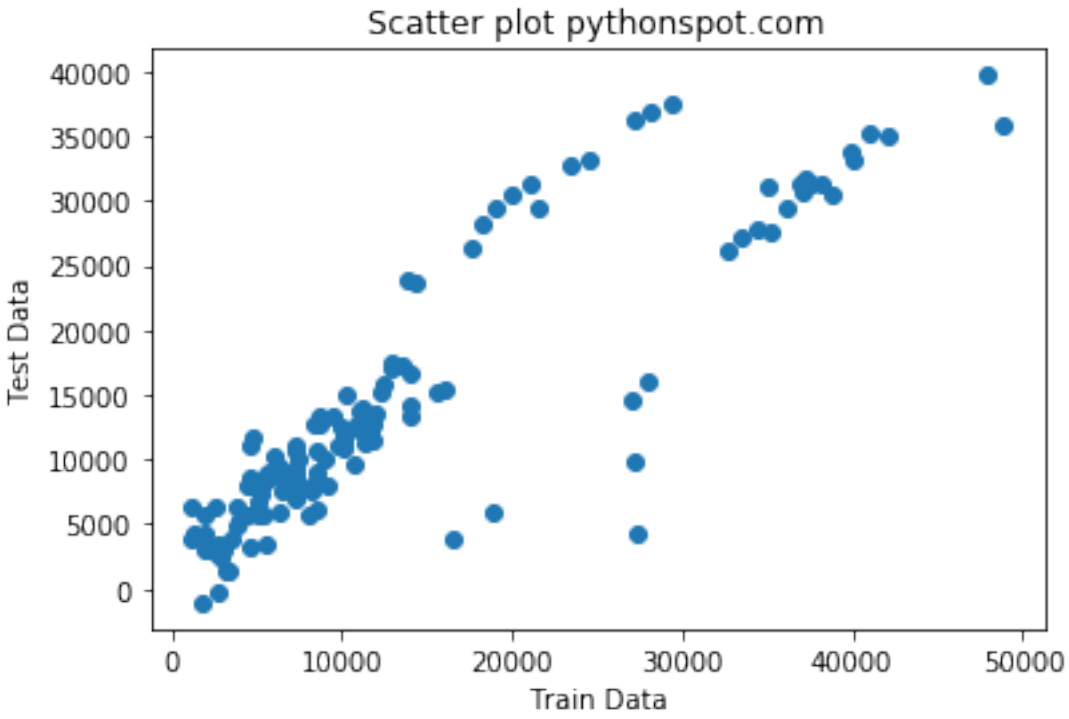

```
Mean Squared Error When  6 th Fold is Trained:  38861142.89703826
```



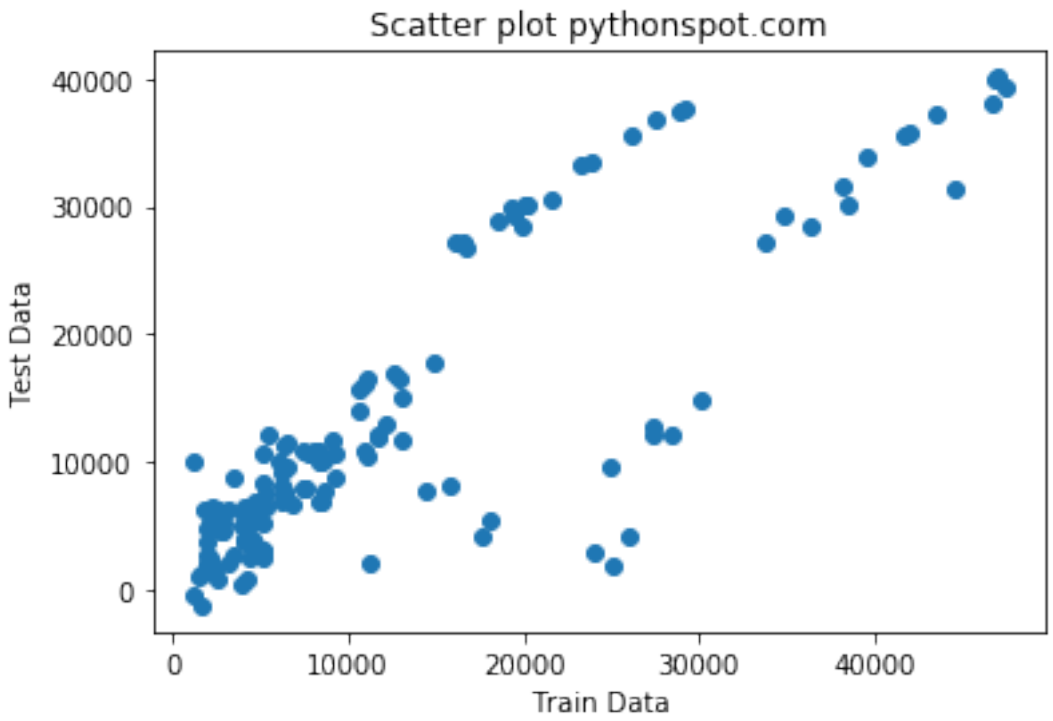

```
Mean Squared Error When  7 th Fold is Trained:  38549367.555600055
```



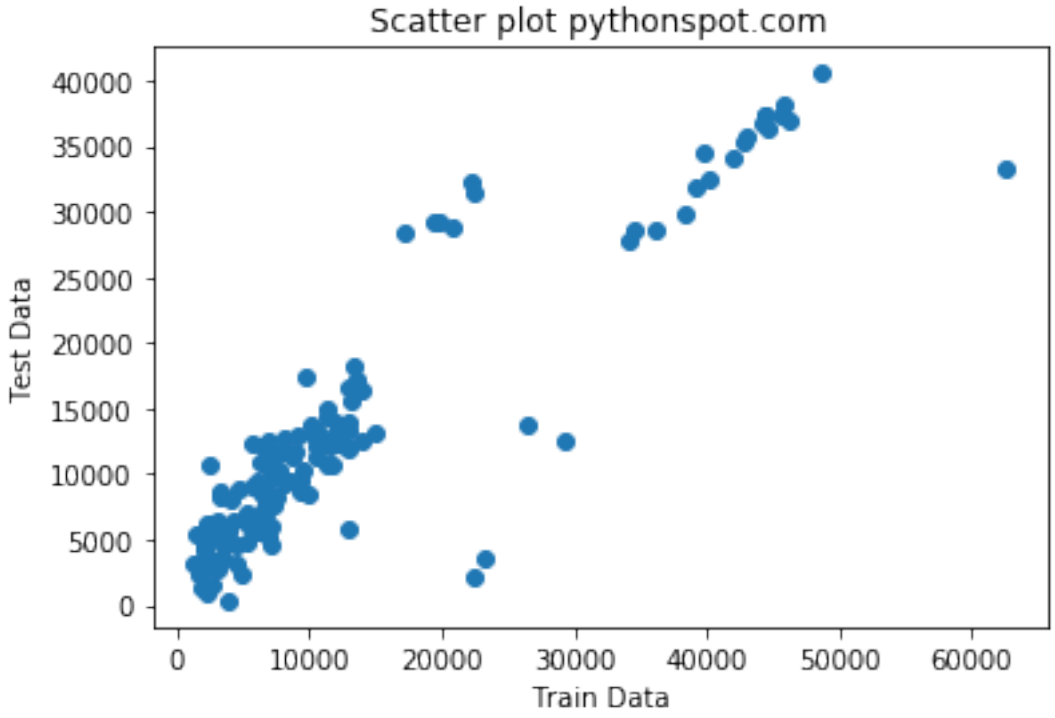
```
Mean Squared Error When  8 th Fold is Trained:  31015631.637245115
```




```
Mean Squared Error When  9 th Fold is Trained:  46408406.030766316
```




```
Mean Squared Error When  10 th Fold is Trained:  34036719.61720482
```



```
Total Training Error Average:  34036719.61720482
Age Coefficient:  259.5694426874053
BMI Coefficient:  322.502715139757
Smoker_Yes Coefficient:  23823.42350100766
Average Intercept:  -11674.352092391951
```

8.0.2 Predictor Function (Final Output :))

```
In [145]: def calculate_insurance(age,bmi,smoking):
              y=(age_coef*age)+(bmi_coef*bmi)+(smoking_coef*smoking)+avg_intercept
              return y
          # For example 19 Year Old Individual with BMI 27.9 Who Smokes
          print(calculate_insurance(19,27.9,1))
```

```
26078.71657207563
```