

Assignment -3
Python Programming

Assignment Date	6 October 2022
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Maximum Marks	2 Marks

Abalone Age Prediction

1. Download the dataset

```
#Dataset Downloaded
```

In [1]:

2. Load the Dataset

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
df = pd.read_csv('abalone.csv')
```

In [3]:

```
df.head()
```

In [4]:

Out[4]:

	Sex	Length	Diameter	Height	Whole weight	Shucked weight	Viscera weight	Shell weight	Rings
0	M	0.455	0.365	0.095	0.5140	0.2245	0.1010	0.150	15
1	M	0.350	0.265	0.090	0.2255	0.0995	0.0485	0.070	7
2	F	0.530	0.420	0.135	0.6770	0.2565	0.1415	0.210	9
3	M	0.440	0.365	0.125	0.5160	0.2155	0.1140	0.155	10
4	I	0.330	0.255	0.080	0.2050	0.0895	0.0395	0.055	7

In [5]:

```
#Modifying the given dataset
Age=1.5*df.Rings
df["Age"]=Age
```

```
df=df.rename(columns = {'Whole weight':'Whole_weight','Shucked weight':
'Shucked_weight','Viscera weight': 'Viscera_weight','Shell weight':
'Shell_weight'})
df=df.drop(columns=["Rings"],axis=1)
df.head()
```

Out[5]:

	Sex	Length	Diameter	Height	Whole_weight	Shucked_weight	Viscera_weight	Shell_weight	Age
0	M	0.455	0.365	0.095	0.5140	0.2245	0.1010	0.150	16.5
1	M	0.350	0.265	0.090	0.2255	0.0995	0.0485	0.070	8.5
2	F	0.530	0.420	0.135	0.6770	0.2565	0.1415	0.210	10.5
3	M	0.440	0.365	0.125	0.5160	0.2155	0.1140	0.155	11.5
4	I	0.330	0.255	0.080	0.2050	0.0895	0.0395	0.055	8.5

In [6]:

```
df.tail()
```

Out[6]:

	Sex	Length	Diameter	Height	Whole_weight	Shucked_weight	Viscera_weight	Shell_weight	Age
4172	F	0.565	0.450	0.165	0.8870	0.3700	0.2390	0.2490	12.5
4173	M	0.590	0.440	0.135	0.9660	0.4390	0.2145	0.2605	11.5
4174	M	0.600	0.475	0.205	1.1760	0.5255	0.2875	0.3080	10.5
4175	F	0.625	0.485	0.150	1.0945	0.5310	0.2610	0.2960	11.5
4176	M	0.710	0.555	0.195	1.9485	0.9455	0.3765	0.4950	13.5

In [7]:

```
df.shape
```

Out[7]:

```
(4177, 9)
```

In [8]:

```
df.info()
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4177 entries, 0 to 4176
Data columns (total 9 columns):
#   Column          Non-Null Count  Dtype
---  -
0   Sex              4177 non-null   object
1   Length           4177 non-null   float64
2   Diameter         4177 non-null   float64
3   Height           4177 non-null   float64
4   Whole_weight     4177 non-null   float64
5   Shucked_weight   4177 non-null   float64
6   Viscera_weight   4177 non-null   float64
7   Shell_weight     4177 non-null   float64
8   Age              4177 non-null   float64
dtypes: float64(8), object(1)
memory usage: 293.8+ KB
```

3. Perform Visualizations

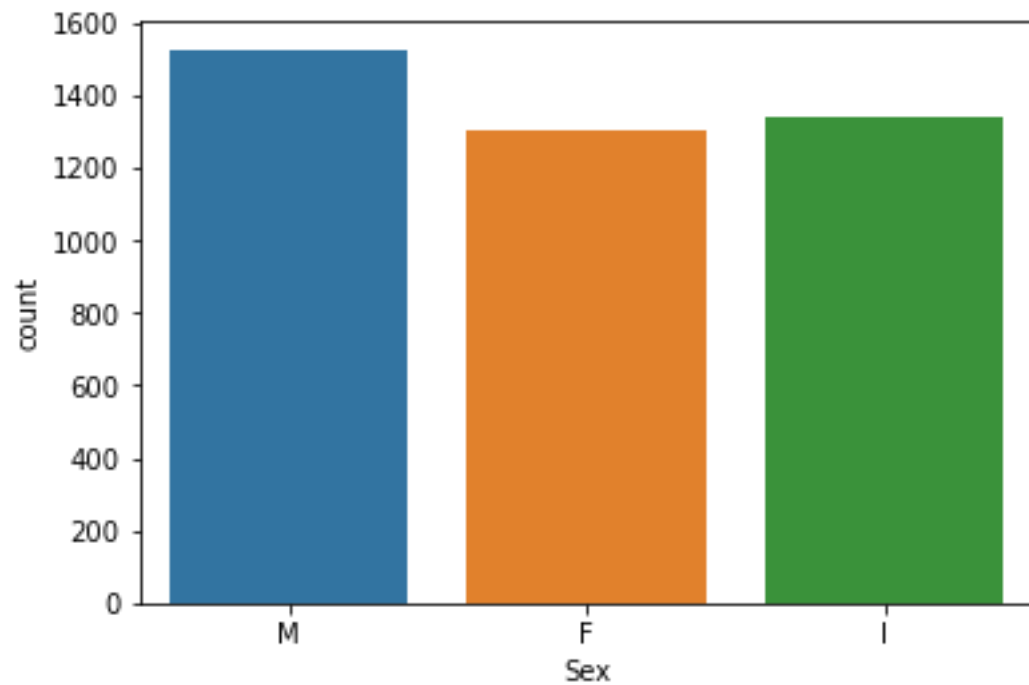
Univariate Analysis

```
sns.countplot(x='Sex',data=df)
```

In [10]:

```
<AxesSubplot:xlabel='Sex', ylabel='count'>
```

Out[10]:

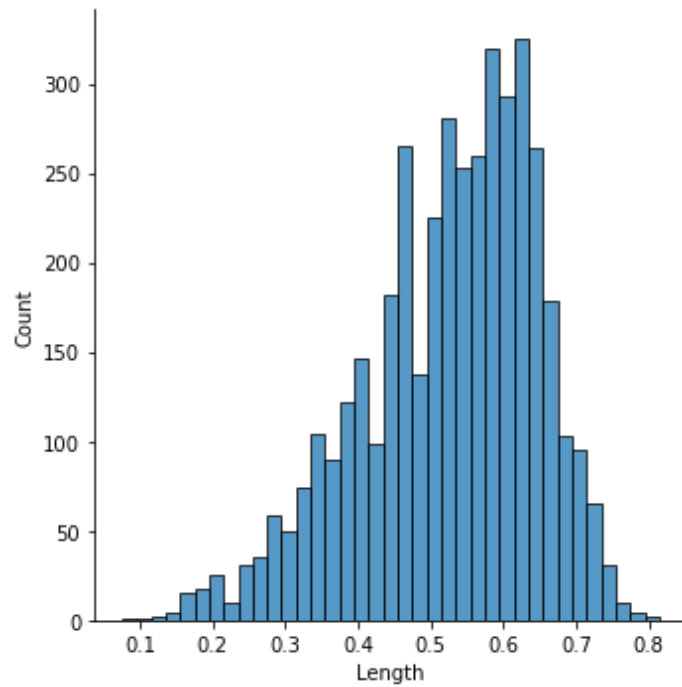


```
sns.displot(df["Length"])
```

In [12]:

```
<seaborn.axisgrid.FacetGrid at 0x2d750617c10>
```

Out[12]:

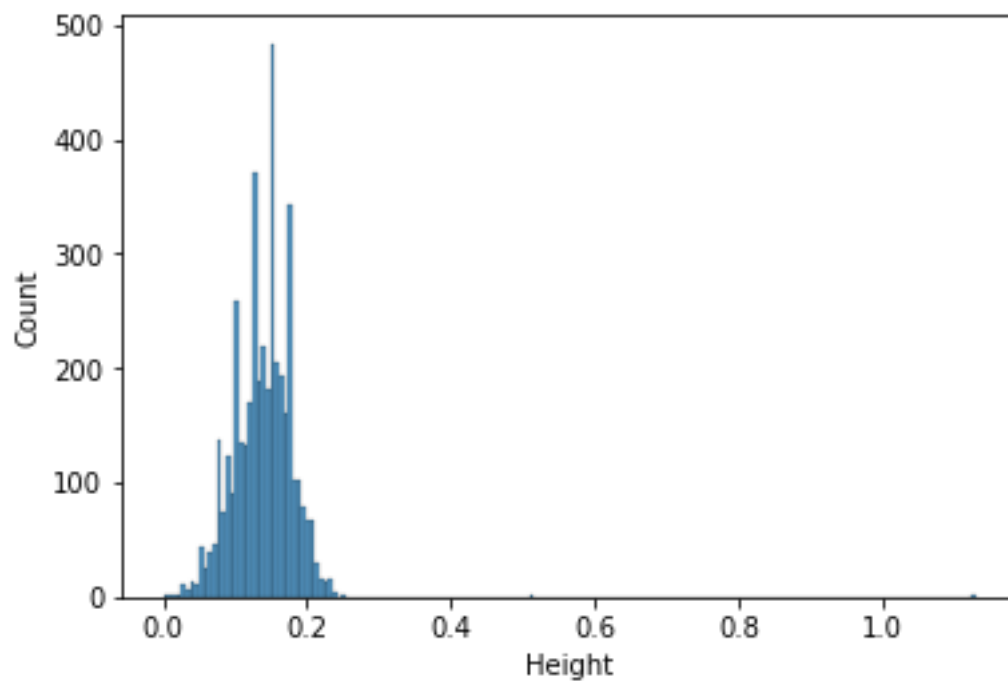


In [13]:

```
sns.histplot(x='Height',data=df)
```

Out[13]:

```
<AxesSubplot:xlabel='Height', ylabel='Count'>
```

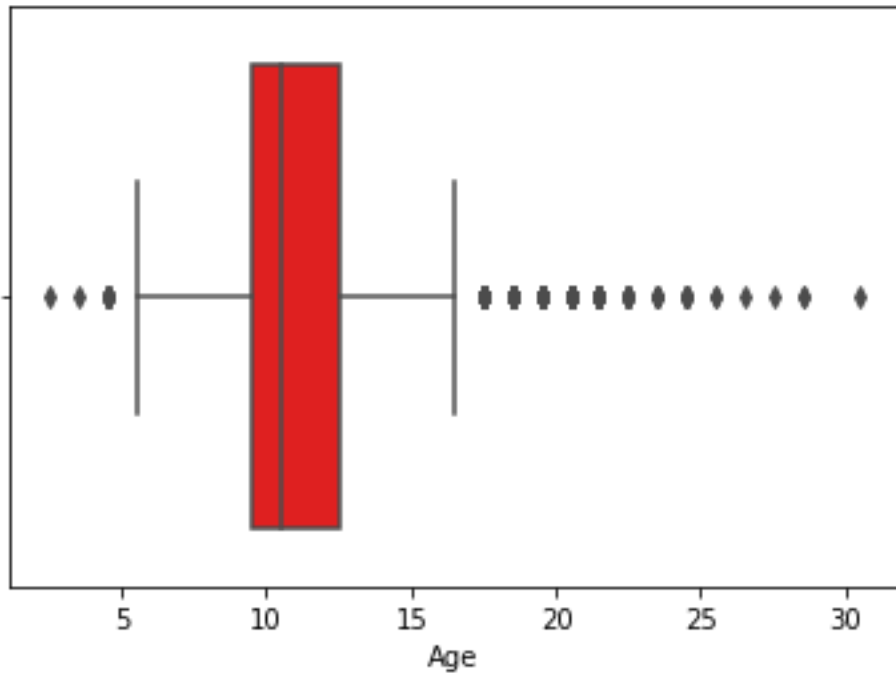


In [15]:

```
sns.boxplot(df["Age"],color='red')
```

Out[15]:

```
<AxesSubplot:xlabel='Age'>
```



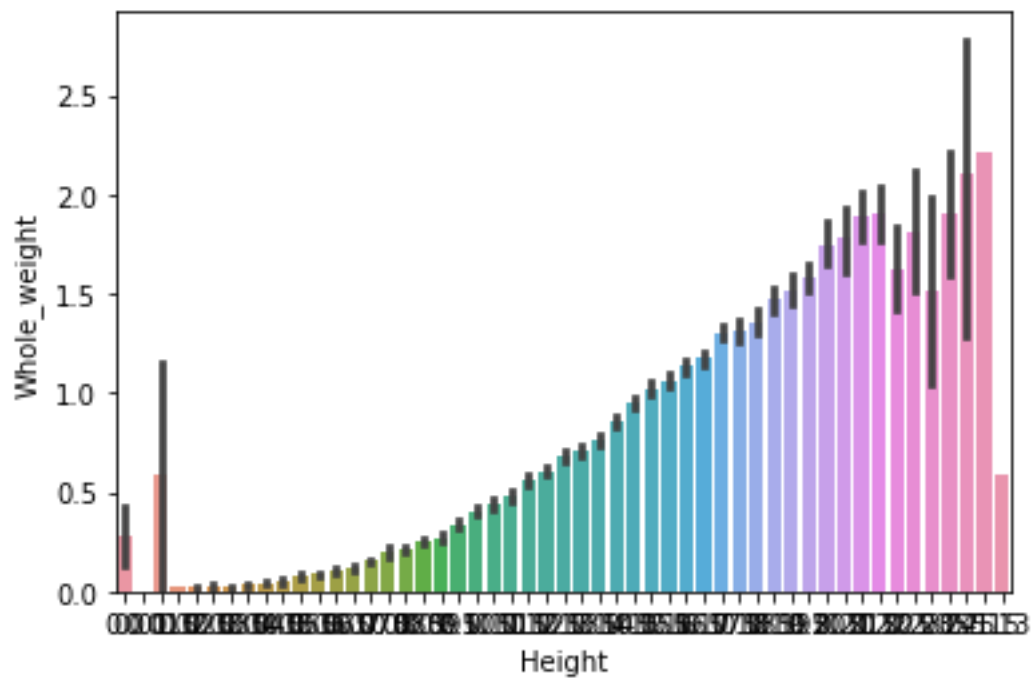
Bivariate Analysis

```
sns.barplot(x=df["Height"],y=df["Whole_weight"])
```

In [17]:

```
<AxesSubplot:xlabel='Height', ylabel='Whole_weight'>
```

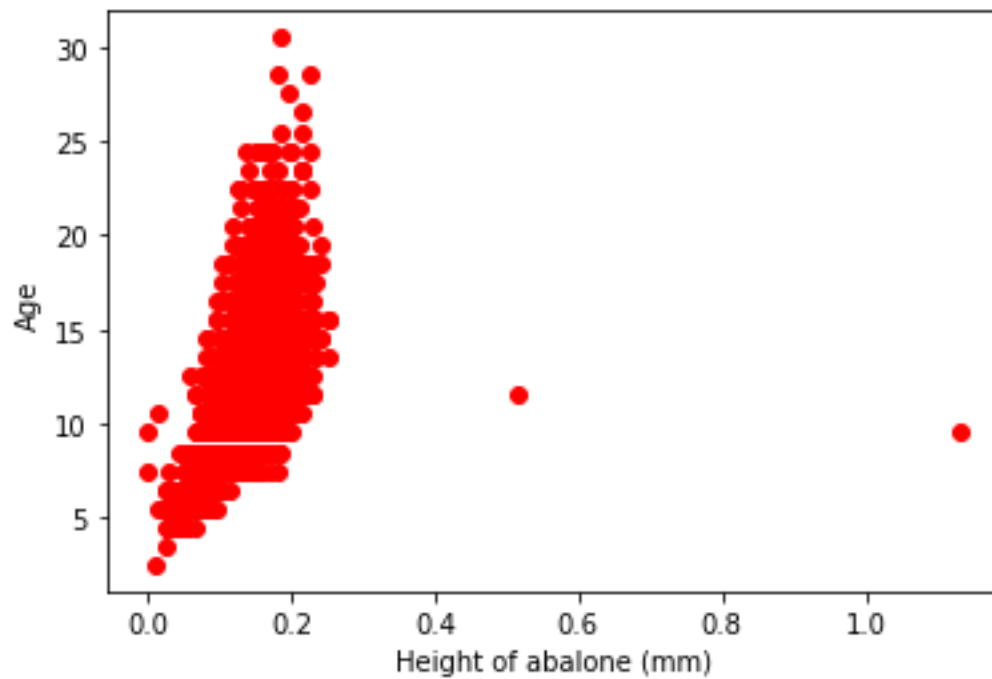
Out[17]:



```
plt.scatter(df['Height'], df['Age'], c='red')
```

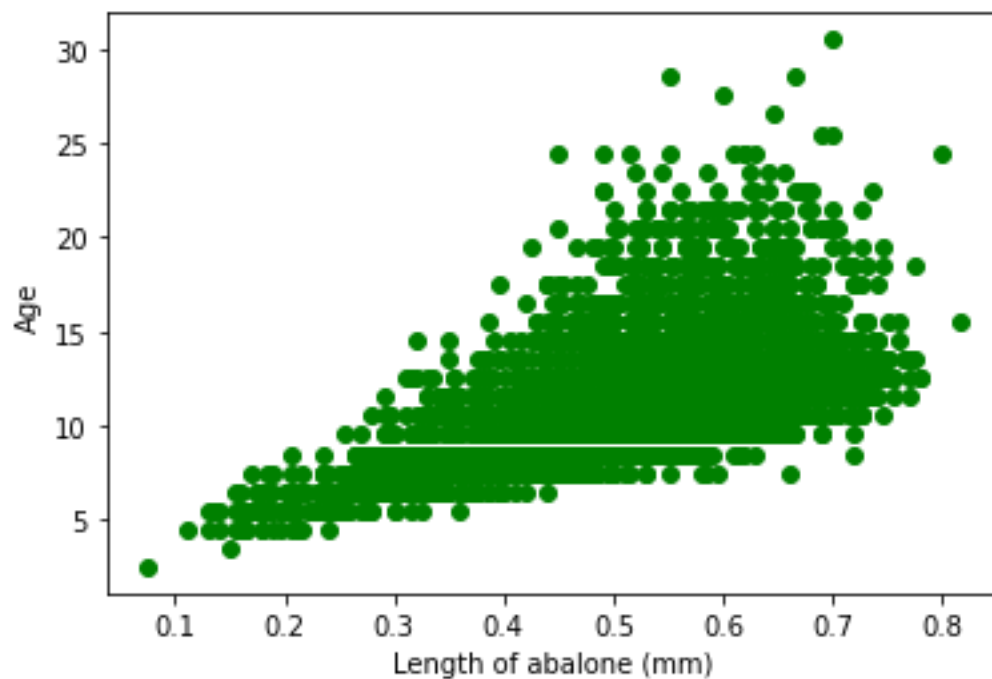
In [21]:

```
plt.xlabel('Height of abalone (mm)')  
plt.ylabel('Age')  
plt.show()
```



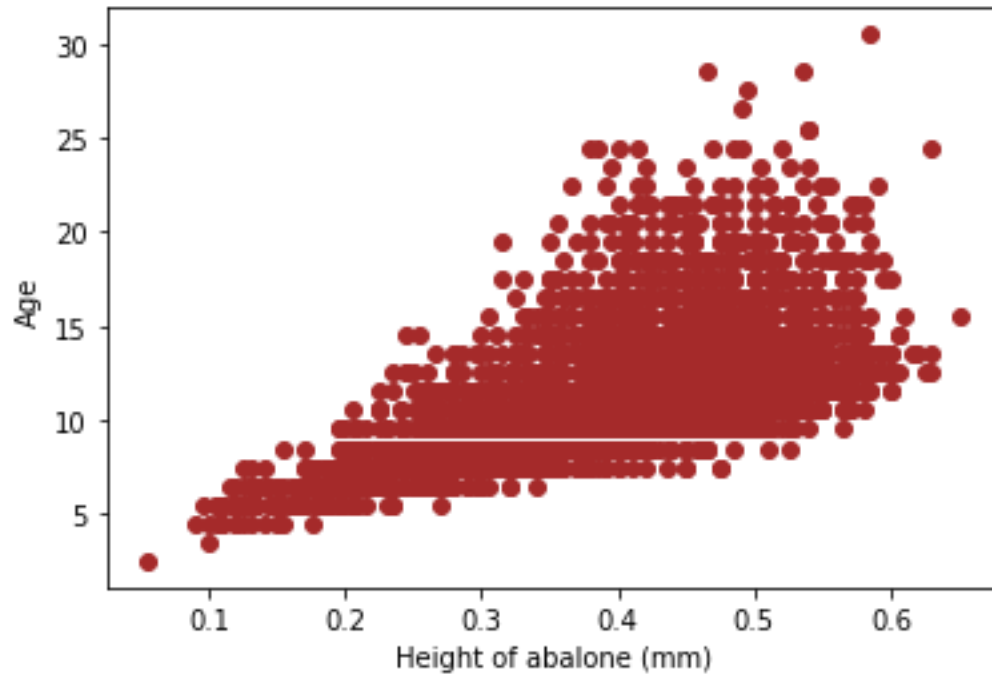
In [20]:

```
plt.scatter(df['Length'], df['Age'], c='green')  
plt.xlabel('Length of abalone (mm)')  
plt.ylabel('Age')  
plt.show()
```



In [23]:

```
plt.scatter(df['Diameter'], df['Age'],c='brown')
plt.xlabel('Height of abalone (mm)')
plt.ylabel('Age')
plt.show()
```



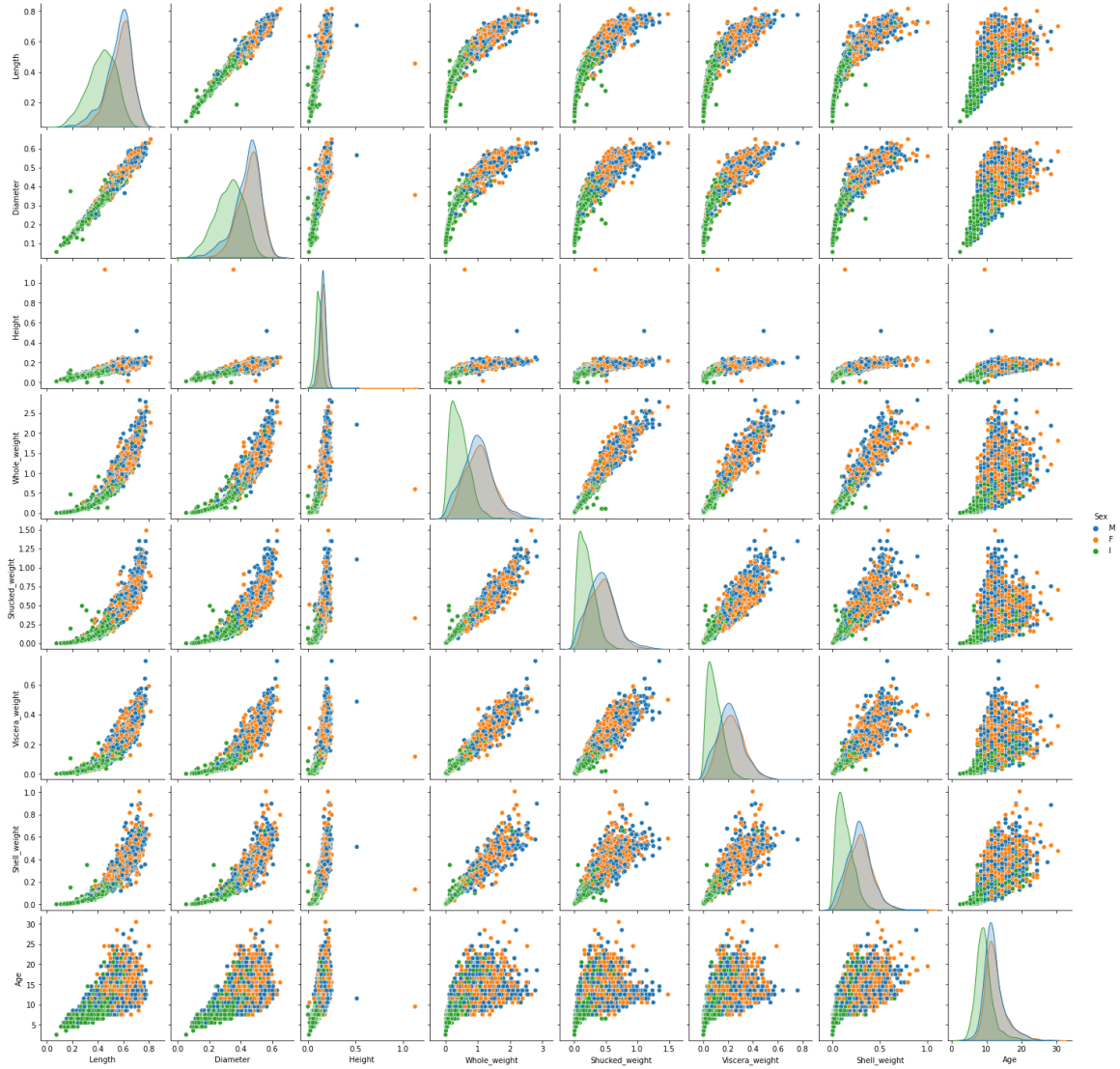
Multi-Variate Analysis

```
sns.pairplot(df,hue='Sex')
```

In [24]:

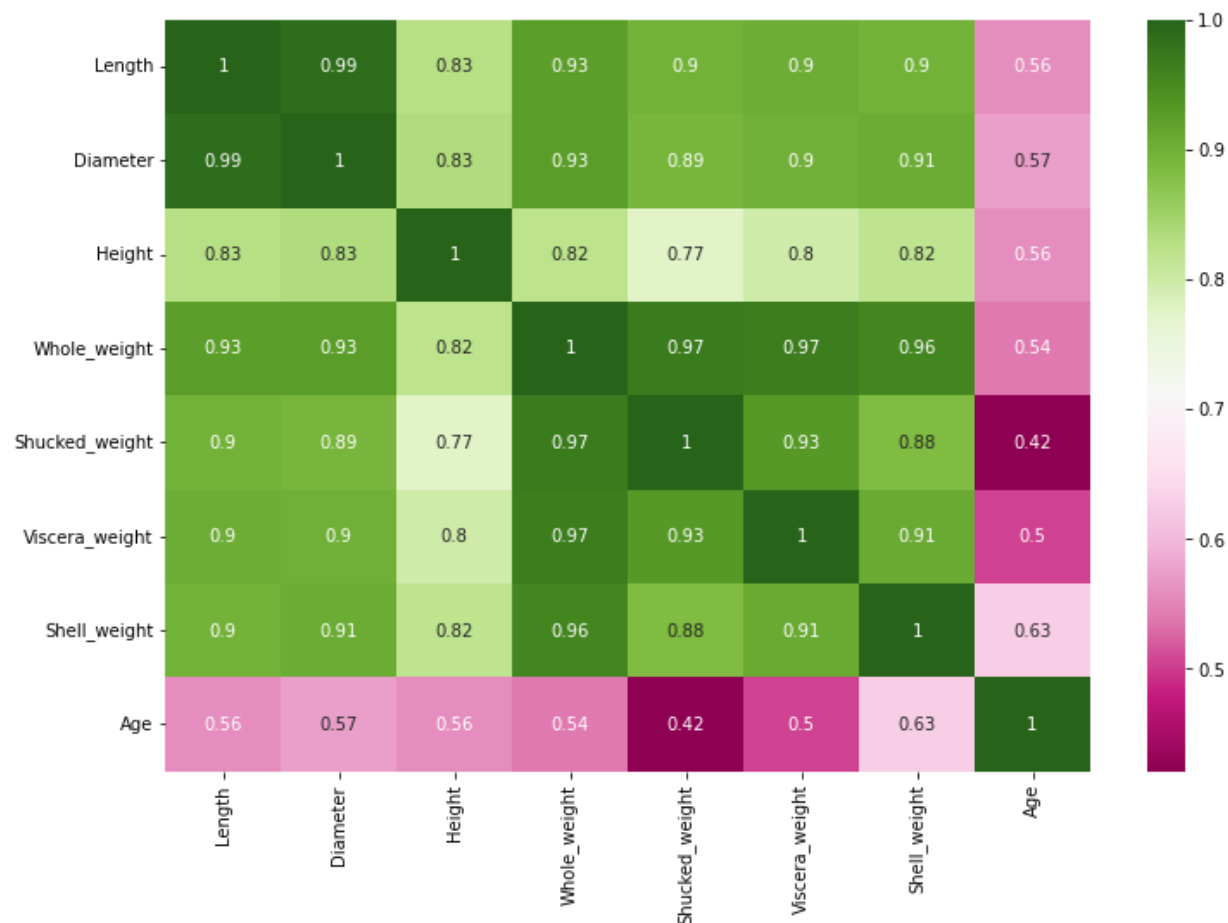
```
<seaborn.axisgrid.PairGrid at 0x2d752e146d0>
```

Out[24]:



In [25]:

```
plt.figure(figsize=(12,8));
sns.heatmap(df.corr(), cmap="PiYG",annot=True);
```

4.Descriptive statistics

```
In [27]:
df.describe(include='all')
```

In [27]:

Out[27]:

	Sex	Length	Diameter	Height	Whole_weight	Shucked_weight	Viscera_weight	Shell_weight
count	4177	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000
unique	3	NaN	NaN	NaN	NaN	NaN	NaN	NaN
top	M	NaN	NaN	NaN	NaN	NaN	NaN	NaN
freq	1528	NaN	NaN	NaN	NaN	NaN	NaN	NaN
mean	NaN	0.523992	0.407881	0.139516	0.828742	0.359367	0.180594	0.238831
std	NaN	0.120093	0.099240	0.041827	0.490389	0.221963	0.109614	0.139203
min	NaN	0.075000	0.055000	0.000000	0.002000	0.001000	0.000500	0.001500
25%	NaN	0.450000	0.350000	0.115000	0.441500	0.186000	0.093500	0.130000
50%	NaN	0.545000	0.425000	0.140000	0.799500	0.336000	0.171000	0.234000
75%	NaN	0.615000	0.480000	0.165000	1.153000	0.502000	0.253000	0.329000
max	NaN	0.815000	0.650000	1.130000	2.825500	1.488000	0.760000	1.005000

5. Check for Missing values and deal with them

```
df.isnull().sum()
```

In [29]:

Out[29]:

```
Sex          0
Length       0
Diameter     0
Height       0
Whole_weight 0
Shucked_weight 0
Viscera_weight 0
Shell_weight 0
Age          0
dtype: int64
```

6. Find the outliers and replacing them outliers

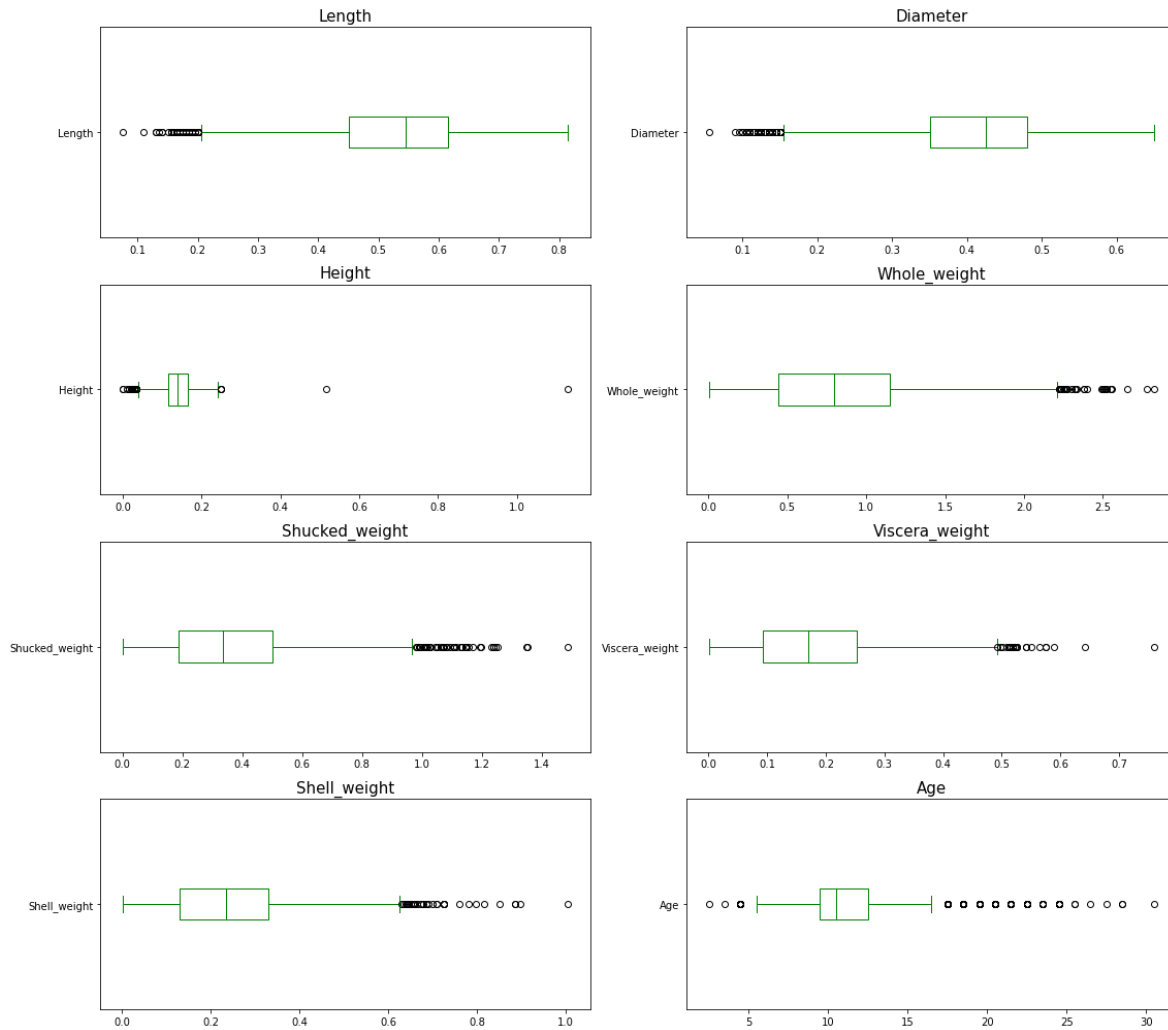
```
col = ['Length', 'Diameter', 'Height', 'Whole_weight', 'Shucked_weight',
       'Viscera_weight', 'Shell_weight', 'Age']
```

In [30]:

In [31]:

```
fig, axes = plt.subplots(4,2,figsize=(16, 14))
axes = np.ravel(axes)
for i, c in enumerate(col):
    hist = df[c].plot(kind = 'box', ax=axes[i],color='green', vert=False)
    axes[i].set_title(c, fontsize=15)

plt.tight_layout()
plt.show()
```



In [32]:

```
qnt = df.quantile([0.75,0.25])
qnt
```

Out[32]:

	Length	Diameter	Height	Whole_weight	Shucked_weight	Viscera_weight	Shell_weight	Age
0.75	0.615	0.48	0.165	1.1530	0.502	0.2530	0.329	12.5
0.25	0.450	0.35	0.115	0.4415	0.186	0.0935	0.130	9.5

In [34]:

```
IQR = qnt.loc[0.75] - qnt.loc[0.25]
IQR
```

Out[34]:

```
Length          0.1650
Diameter        0.1300
Height          0.0500
Whole_weight    0.7115
Shucked_weight  0.3160
Viscera_weight  0.1595
Shell_weight    0.1990
```

```
Age          3.0000
dtype: float64
```

In [35]:

```
lower = qnt.loc[0.25] - 1.5 * IQR
lower
```

Out[35]:

```
Length          0.20250
Diameter         0.15500
Height          0.04000
Whole_weight    -0.62575
Shucked_weight  -0.28800
Viscera_weight  -0.14575
Shell_weight    -0.16850
Age             5.00000
dtype: float64
```

In [36]:

```
upper = qnt.loc[0.75] + 1.5 * IQR
upper
```

Out[36]:

```
Length          0.86250
Diameter         0.67500
Height          0.24000
Whole_weight     2.22025
Shucked_weight   0.97600
Viscera_weight   0.49225
Shell_weight     0.62750
Age             17.00000
dtype: float64
```

In [37]:

```
df.mean()
```

Out[37]:

```
Length          0.523992
Diameter         0.407881
Height          0.139516
Whole_weight     0.828742
Shucked_weight   0.359367
Viscera_weight   0.180594
Shell_weight     0.238831
Age             11.433684
dtype: float64
```

In [38]:

```
df['Length']=np.where(df['Length']<0.22,0.52,df['Length'])
df['Diameter']=np.where(df['Diameter']<0.155,0.407,df['Diameter'])
df['Height']=np.where(df['Height']<0.04,0.13,df['Height'])
```

In [39]:

```
df['Height']=np.where(df['Height']>0.24,0.13,df['Height'])
df['Whole_weight']=np.where(df['Whole_weight']>2.18,0.83,df['Whole_weight'])
```

```
df['Shucked_weight']=np.where(df['Shucked_weight']>0.958,0.359367,df['Shucked_weight'])
df['Viscera_weight']=np.where(df['Viscera_weight']>0.478,0.18,df['Viscera_weight'])
```

In [40]:

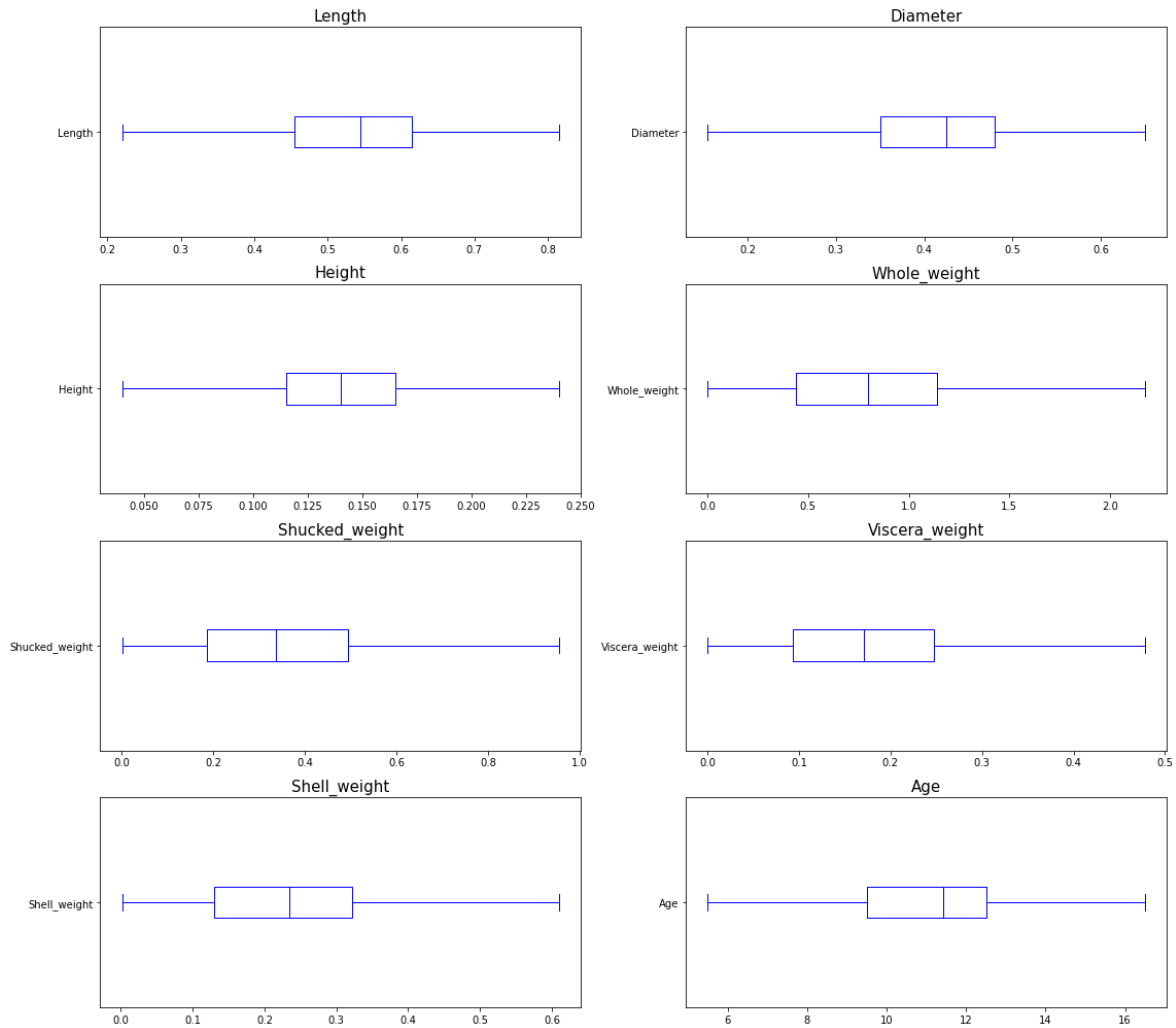
```
df['Shell_weight']=np.where(df['Shell_weight']>0.61,0.238831,df['Shell_weight'])
df['Age']=np.where(df['Age']<5.0,11.43,df['Age'])
df['Age']=np.where(df['Age']>17.0,11.43,df['Age'])
```

In [41]:

```
fig, axes = plt.subplots(4,2,figsize=(16, 14))
axes = np.ravel(axes)

for i, c in enumerate(col):
    hist = df[c].plot(kind = 'box', ax=axes[i],color='blue', vert=False)
    axes[i].set_title(c, fontsize=15)

plt.tight_layout()
plt.show()
```



In [42]:

```
df.shape
```

Out[42]:

```
(4177, 9)
```

7. Check for Categorical columns and perform encoding

In [43]:

```
df['Sex'].unique()
```

Out[43]:

```
array(['M', 'F', 'I'], dtype=object)
```

In [44]:

```
x = pd.get_dummies(df)
```

In [45]:

```
x.head()
```

Out[45]:

	Length	Diameter	Height	Whole_weight	Shucked_weight	Viscera_weight	Shell_weight	Age	Sex_F	Sex_I	Sex_M
0	0.455	0.365	0.095	0.5140	0.2245	0.1010	0.150	16.5	0	0	1

	Length	Diameter	Height	Whole_weight	Shucked_weight	Viscera_weight	Shell_weight	Age	Sex_F	Sex_I	Sex_M
1	0.350	0.265	0.090	0.2255	0.0995	0.0485	0.070	8.5	0	0	1
2	0.530	0.420	0.135	0.6770	0.2565	0.1415	0.210	10.5	1	0	0
3	0.440	0.365	0.125	0.5160	0.2155	0.1140	0.155	11.5	0	0	1
4	0.330	0.255	0.080	0.2050	0.0895	0.0395	0.055	8.5	0	1	0

8. Split the data into dependent and independent variables

In [46]:

```
x.info()
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4177 entries, 0 to 4176
Data columns (total 11 columns):
#   Column                Non-Null Count  Dtype
---  -
0   Length                 4177 non-null   float64
1   Diameter               4177 non-null   float64
2   Height                 4177 non-null   float64
3   Whole_weight           4177 non-null   float64
4   Shucked_weight         4177 non-null   float64
5   Viscera_weight         4177 non-null   float64
6   Shell_weight           4177 non-null   float64
7   Age                    4177 non-null   float64
8   Sex_F                  4177 non-null   uint8
9   Sex_I                  4177 non-null   uint8
10  Sex_M                  4177 non-null   uint8
dtypes: float64(8), uint8(3)
memory usage: 273.4 KB
```

In [47]:

```
X = x.drop(['Age'], axis = 1)
```

In [48]:

```
X.head()
```

Out[48]:

	Length	Diameter	Height	Whole_weight	Shucked_weight	Viscera_weight	Shell_weight	Sex_F	Sex_I	Sex_M
0	0.455	0.365	0.095	0.5140	0.2245	0.1010	0.150	0	0	1
1	0.350	0.265	0.090	0.2255	0.0995	0.0485	0.070	0	0	1
2	0.530	0.420	0.135	0.6770	0.2565	0.1415	0.210	1	0	0
3	0.440	0.365	0.125	0.5160	0.2155	0.1140	0.155	0	0	1
4	0.330	0.255	0.080	0.2050	0.0895	0.0395	0.055	0	1	0

In [49]:

```
y = x['Age']
```

In [50]:

```
y.head()
```

Out[50]:

```

0    16.5
1     8.5
2    10.5
3    11.5
4     8.5
Name: Age, dtype: float64

```

9. Scale the independent variables

```

In [51]:
from sklearn.preprocessing import StandardScaler

In [52]:
X_columns = X.select_dtypes(include=np.number).columns.tolist()
X_columns

Out[52]:
['Length',
 'Diameter',
 'Height',
 'Whole_weight',
 'Shucked_weight',
 'Viscera_weight',
 'Shell_weight',
 'Sex_F',
 'Sex_I',
 'Sex_M']

In [53]:
scaler = StandardScaler()

In [54]:
X[X_columns] = scaler.fit_transform(X[X_columns])
X.head()

```

Out[54]:

	Length	Diameter	Height	Whole_weight	Shucked_weight	Viscera_weight	Shell_weight	Sex_F	Sex_I	Sex_M
0	-0.663474	-0.501673	-1.196422	-0.643390	-0.611770	-0.732343	-0.643590	-0.674834	-0.688018	-0.688018
1	-1.601273	-1.572915	-1.330241	-1.259765	-1.219694	-1.236126	-1.257424	-0.674834	-0.688018	-0.688018
2	0.006383	0.087510	-0.125873	-0.295144	-0.456142	-0.343709	-0.183214	1.481846	-0.688018	-0.688018
3	-0.797445	-0.501673	-0.393511	-0.639118	-0.655541	-0.607596	-0.605225	-0.674834	-0.688018	-0.688018
4	-1.779901	-1.680039	-1.597878	-1.303563	-1.268328	-1.322489	-1.372518	-0.674834	-0.688018	-0.688018

10. Split the data into training and testing


```
X.shape, y.shape
```

In [55]:

```
((4177, 10), (4177,))
```

Out[55]:

```
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=42)
```

In [56]:

```
print(' x_train.shape : ',x_train.shape)
print(' y_train.shape : ',y_train.shape)
print(' x_test.shape : ',x_test.shape)
print(' y_test.shape : ',y_test.shape)
x_train.shape :  (3341, 10)
y_train.shape :  (3341,)
x_test.shape :   (836, 10)
y_test.shape :   (836,)
```

In [57]:

Build the Model, Train the Model and Test the Model

```
#Linear Regression
from sklearn.linear_model import LinearRegression

lr = LinearRegression()
lr.fit(x_train, y_train)

lr_pred = lr.predict(x_test)
```

In [58]:

```
#Random Forest
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import mean_squared_error,make_scorer
from sklearn.model_selection import RandomizedSearchCV

rf = RandomForestRegressor()

param = {
    'max_depth':[3,6,9,12,15],
    'n_estimators' : [10,50,100,150,200]
}

rf_search =
RandomizedSearchCV(rf,param_distributions=param,n_iter=5,scoring=make_scorer(
mean_squared_error),
                    n_jobs=-1,cv=5,verbose=3)
```

In [59]:

```
rf_search.fit(x_train, y_train)
```

Fitting 5 folds for each of 5 candidates, totalling 25 fits

Out[59]:

```
RandomizedSearchCV(cv=5, estimator=RandomForestRegressor(), n_iter=5,
n_jobs=-1,
                    param_distributions={'max_depth': [3, 6, 9, 12, 15],
                                         'n_estimators': [10, 50, 100, 150,
                                                         200]},
                    scoring=make_scorer(mean_squared_error), verbose=3)
```

In [60]:

```
#In a Jupyter environment, please rerun this cell to show the HTML
representation or trust the notebook.
#On GitHub, the HTML representation is unable to render, please try loading
this page with nbviewer.org.
```

In [61]:

```
means = rf_search.cv_results_['mean_test_score']
params = rf_search.cv_results_['params']
for mean, param in zip(means, params):
    print("%f with: %r" % (mean, param))
    if mean == min(means):
        print('Best parameters with the minimum Mean Square Error
are:', param)
2.753132 with: {'n_estimators': 50, 'max_depth': 12}
2.644186 with: {'n_estimators': 200, 'max_depth': 6}
2.640827 with: {'n_estimators': 50, 'max_depth': 6}
Best parameters with the minimum Mean Square Error are: {'n_estimators': 50,
'max_depth': 6}
2.762468 with: {'n_estimators': 50, 'max_depth': 15}
2.739511 with: {'n_estimators': 200, 'max_depth': 15}
```

In [62]:

```
rf = RandomForestRegressor(n_estimators=50, max_depth=6)
rf.fit(x_train, y_train)

rf_pred = rf.predict(x_test)
```

14. Measure the performance using Metrics

In [64]:

```
from sklearn import metrics
RMSE1 = np.sqrt(metrics.mean_squared_error(y_test, lr_pred))
MAE = metrics.mean_absolute_error(y_test, lr_pred)
MSE = metrics.mean_squared_error(y_test, lr_pred)
R2 = metrics.r2_score(y_test, lr_pred)
print('Linear Regression :')
print('-----')
print('MAE:', MAE)
```

```

print('MSE:', MSE)
print('RMSE:', RMSE1)
print('R2 Score :',R2)
print('\n\n')
Linear Regression :
-----
MAE: 1.326777442258078
MSE: 2.9868483619389266
RMSE: 1.7282500866306725
R2 Score : 0.4466536519118789

```

In [65]:

```

from sklearn import metrics
RMSE2 = np.sqrt(metrics.mean_squared_error(y_test, rf_pred))
MAE = metrics.mean_absolute_error(y_test, rf_pred)
MSE = metrics.mean_squared_error(y_test, rf_pred)
R2 = metrics.r2_score(y_test,rf_pred)
print('Random Forest Contains:')
print('-----')
print('MAE:', MAE)
print('MSE:', MSE)
print('RMSE:', RMSE2)
print('R2 Score :',R2)
Random Forest Contains:
-----
MAE: 1.2369731265164512
MSE: 2.5047280907807443
RMSE: 1.5826332774148104
R2 Score : 0.5359717086248263

```

Compare Linear Regression and Random Forest

Random Forest got low rmse value than Linear Regression

In [66]:

```

RMSE = RMSE1-RMSE2
print(RMSE)
0.14561680921586206

```

In []: