IBM ASSIGNMENT 4

Mithesh A

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from pandas.api.types import is_numeric_dtype
sns.set()
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import StandardScaler
sns.set_style("darkgrid")
from sklearn.linear_model import LinearRegression
from sklearn.svm import SVR
from sklearn.tree import DecisionTreeRegressor

from sklearn import  metrics
%matplotlib inline
```

LOADING DATASET

```
abalone = pd.read_csv('abalone.csv', sep=',')
abalone.head()
```

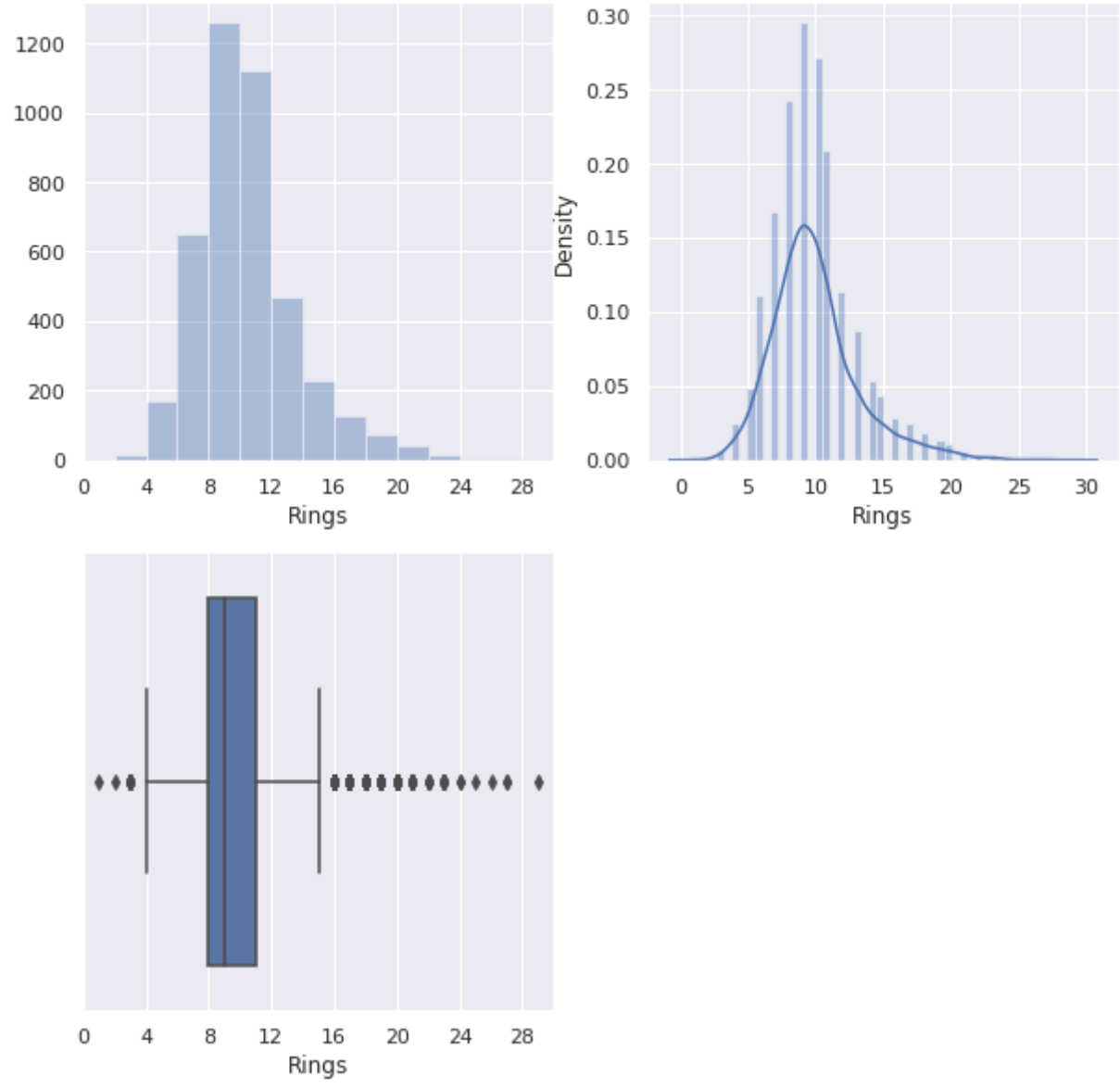
	Sex	Length	Diameter	Height	Whole weight	Shucked weight	Viscera weight	Shell weight	Rings
0	M	0.455	0.365	0.095	0.5140	0.2245	0.1010	0.150	15
1	M	0.350	0.265	0.090	0.2255	0.0995	0.0485	0.070	7
2	F	0.530	0.420	0.135	0.6770	0.2565	0.1415	0.210	9
3	M	0.440	0.365	0.125	0.5160	0.2155	0.1140	0.155	10

UNIVARIATE ANALYSIS

```
rows = 2
cols = 2
i = 0

plt.figure(figsize=(cols * 5, rows * 5))

i += 1
plt.subplot(rows, cols, i)
plt.xticks(range(0, 31, 4))
plt.xlim(0, 30)
_ = sns.distplot(abalone['Rings'], kde=False, bins=range(0, 31, 2))
```

```
i += 1
plt.subplot(rows, cols, i)
_ = sns.distplot(abalone['Rings'])

i += 1
plt.subplot(rows, cols, i)
plt.xticks(range(0, 31, 4))
plt.xlim(0, 30)
_ = sns.boxplot(abalone['Rings'])
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: FutureWarning:
  warnings.warn(msg, FutureWarning)
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
```



2.Size attributes

```
# removing outliers
abalone = abalone[abalone['Height'] < 0.4]
```

```
plt.figure(figsize=(15, 15))

colors = sns.color_palette()

lines = 3
rows = 3
i = 0

i += 1
plt.subplot(lines, rows, i)
_ = sns.distplot(abalone['Length'], color=colors[i % 3])

i += 1
plt.subplot(lines, rows, i)
_ = sns.distplot(abalone['Diameter'], color=colors[i % 3])

i += 1
plt.subplot(lines, rows, i)
_ = sns.distplot(abalone['Height'], color=colors[i % 3])

i += 1
plt.subplot(lines, rows, i)
_ = sns.distplot(abalone['Length'], kde=False, bins=np.arange(0.0, 0.9, 0.05), color=color

i += 1
plt.subplot(lines, rows, i)
_ = sns.distplot(abalone['Diameter'], kde=False, bins=np.arange(0.0, 0.7, 0.05), color=col

i += 1
plt.subplot(lines, rows, i)
_ = sns.distplot(abalone['Height'], kde=False, bins=10, color=colors[i % 3])

i += 1
plt.subplot(lines, rows, i)
_ = sns.boxplot(abalone['Length'], color=sns.color_palette()[i % 3])

i += 1
plt.subplot(lines, rows, i)
_ = sns.boxplot(abalone['Diameter'], color=colors[i % 3])

i += 1
plt.subplot(lines, rows, i)
_ = sns.boxplot(abalone['Height'], color=colors[i % 3])
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: FutureWarning:
  warnings.warn(msg, FutureWarning)
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: FutureWarning:
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  FutureWarning
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
```

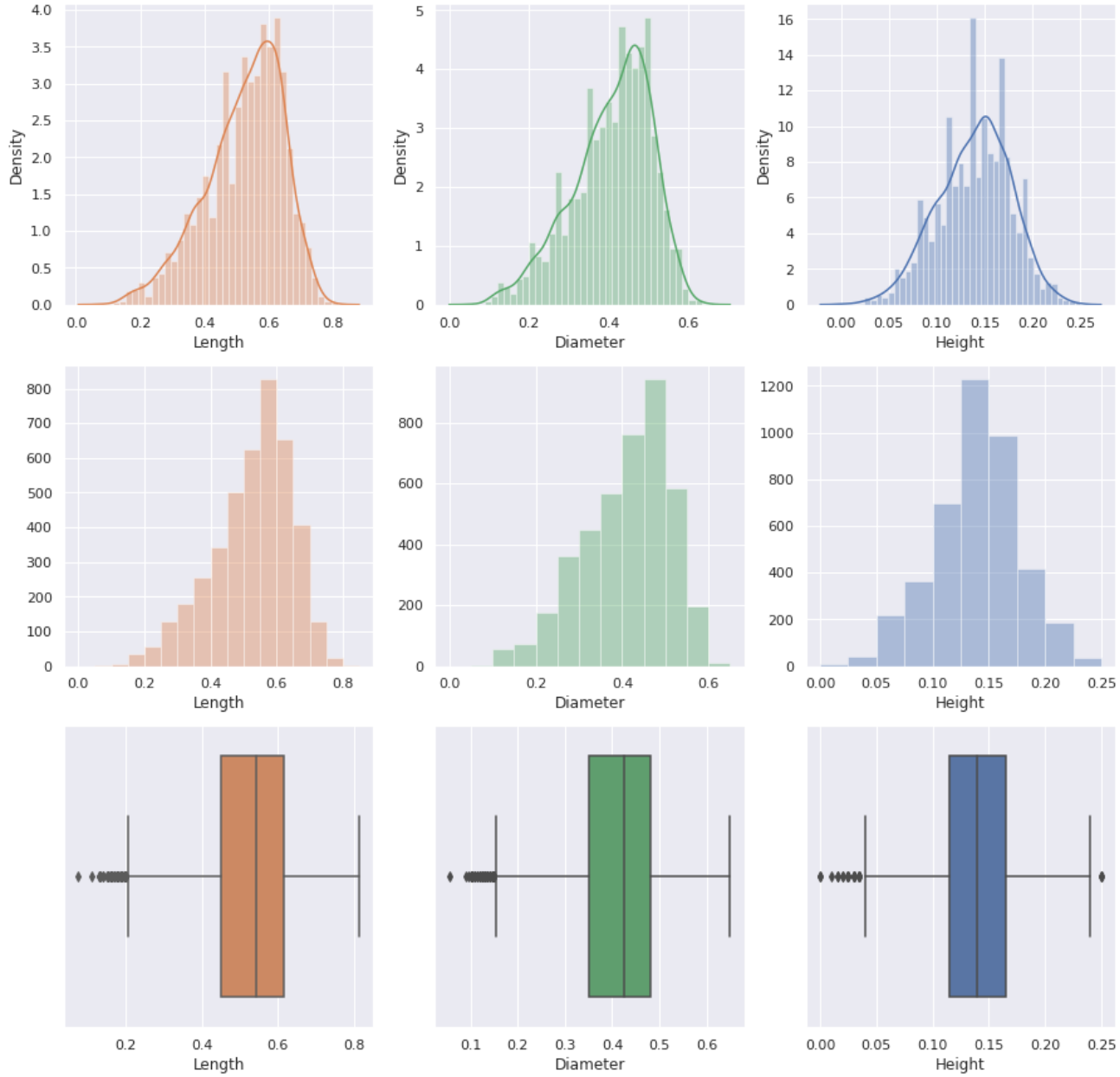

3.Weight Attributes

```
plt.figure(figsize=(20, 15))
```

```
colors = sns.color_palette()

rows = 3
cols = 4
i = 0

i += 1
plt.subplot(rows, cols, i)
_ = sns.distplot(abalone['Whole weight'], color=colors[i % cols])

i += 1
plt.subplot(rows, cols, i)
_ = sns.distplot(abalone['Shucked weight'], color=colors[i % cols])

i += 1
plt.subplot(rows, cols, i)
_ = sns.distplot(abalone['Viscera weight'], color=colors[i % cols])

i += 1
plt.subplot(rows, cols, i)
_ = sns.distplot(abalone['Shell weight'], color=colors[i % cols])

i += 1
plt.subplot(rows, cols, i)
_ = sns.distplot(abalone['Whole weight'], kde=False, bins=14, color=colors[i % cols])

i += 1
plt.subplot(rows, cols, i)
_ = sns.distplot(abalone['Shucked weight'], kde=False, bins=14, color=colors[i % cols])

i += 1
plt.subplot(rows, cols, i)
_ = sns.distplot(abalone['Viscera weight'], kde=False, bins=16, color=colors[i % cols])

i += 1
plt.subplot(rows, cols, i)
_ = sns.distplot(abalone['Shell weight'], kde=False, bins=20, color=colors[i % cols])

i += 1
plt.subplot(rows, cols, i)
_ = sns.boxplot(abalone['Whole weight'], color=colors[i % cols])

i += 1
plt.subplot(rows, cols, i)
_ = sns.boxplot(abalone['Shucked weight'], color=colors[i % cols])

i += 1
plt.subplot(rows, cols, i)
_ = sns.boxplot(abalone['Viscera weight'], color=colors[i % cols])

i += 1
plt.subplot(rows, cols, i)
_ = sns.boxplot(abalone['Shell weight'], color=colors[i % cols])
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: FutureWarning:
  warnings.warn(msg, FutureWarning)
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: FutureWarning:
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  warnings.warn(msg, FutureWarning)
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
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  FutureWarning
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  FutureWarning
```
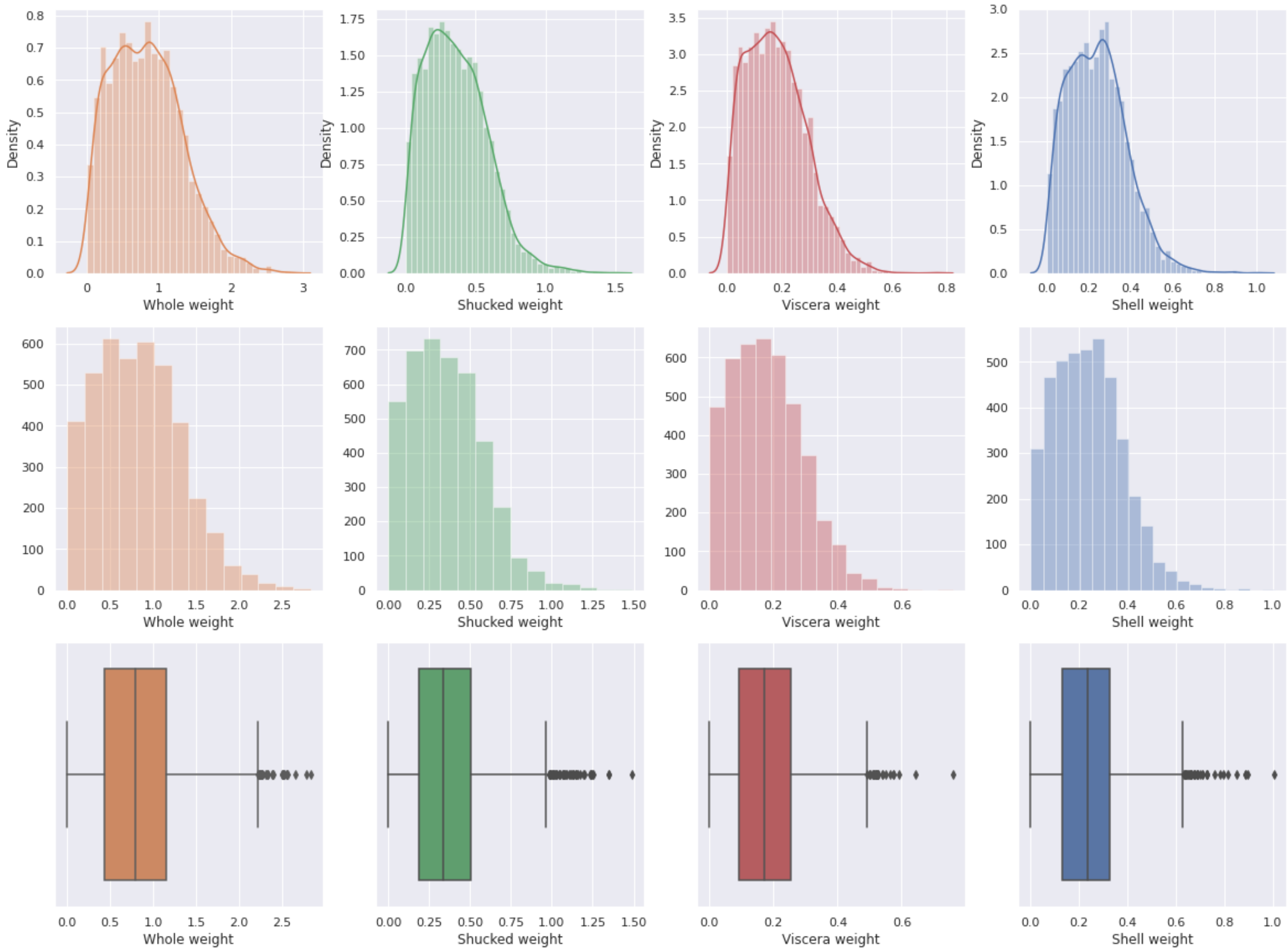
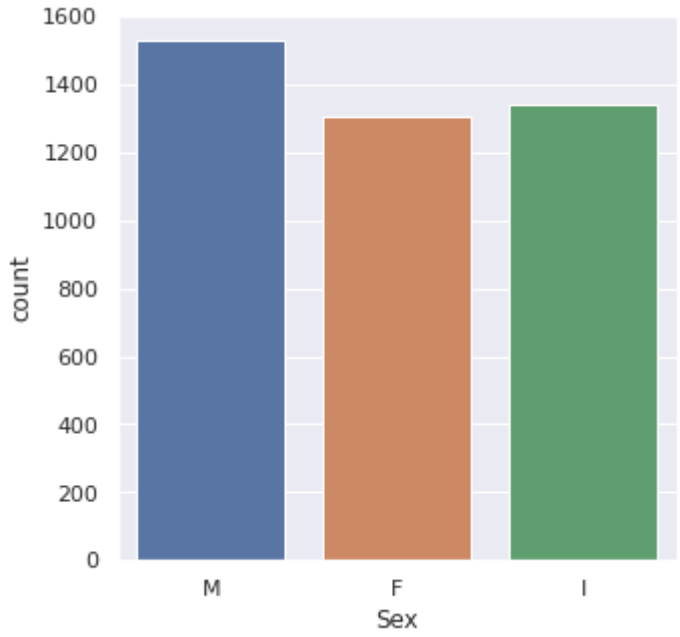



4. Sex attribute

```
plt.figure(figsize=(5,5))
_ = sns.countplot(abalone.Sex)
```

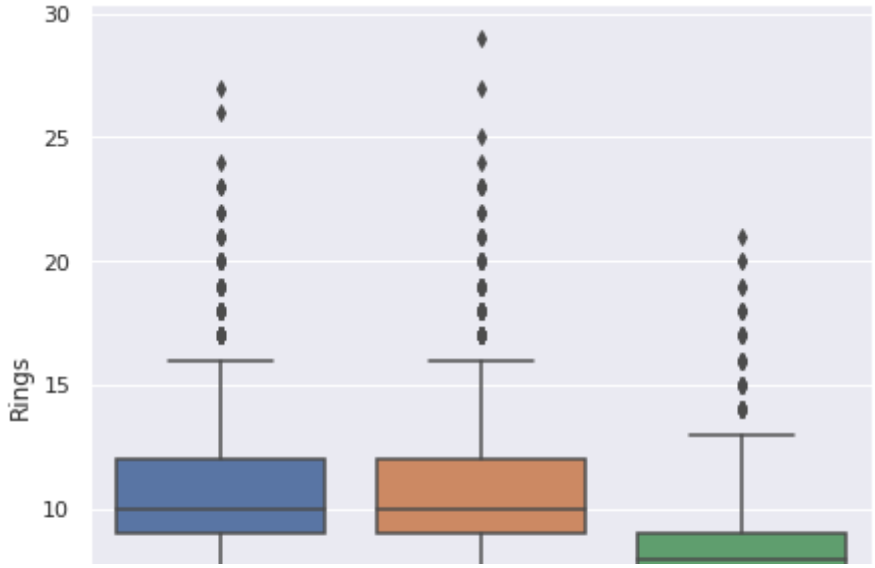
```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
```



BIVARATE ANALYSIS

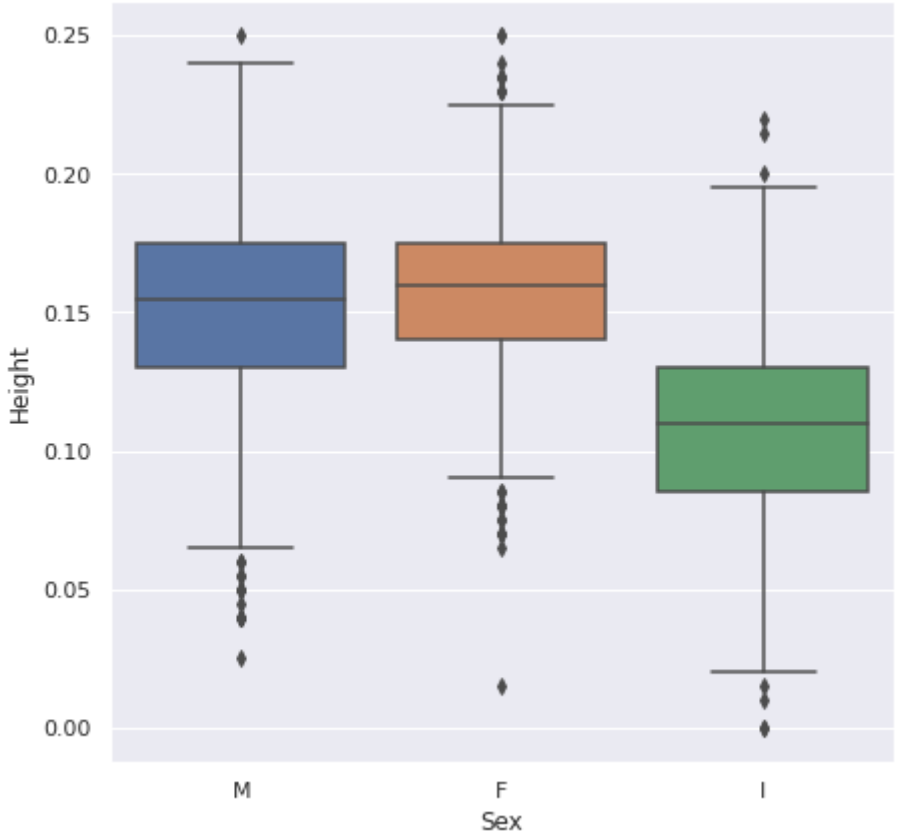
1. (sex,ring) attribute

```
plt.figure(figsize=(7, 7))
_ = sns.boxplot(data=abalone, x='Sex', y='Rings')
```



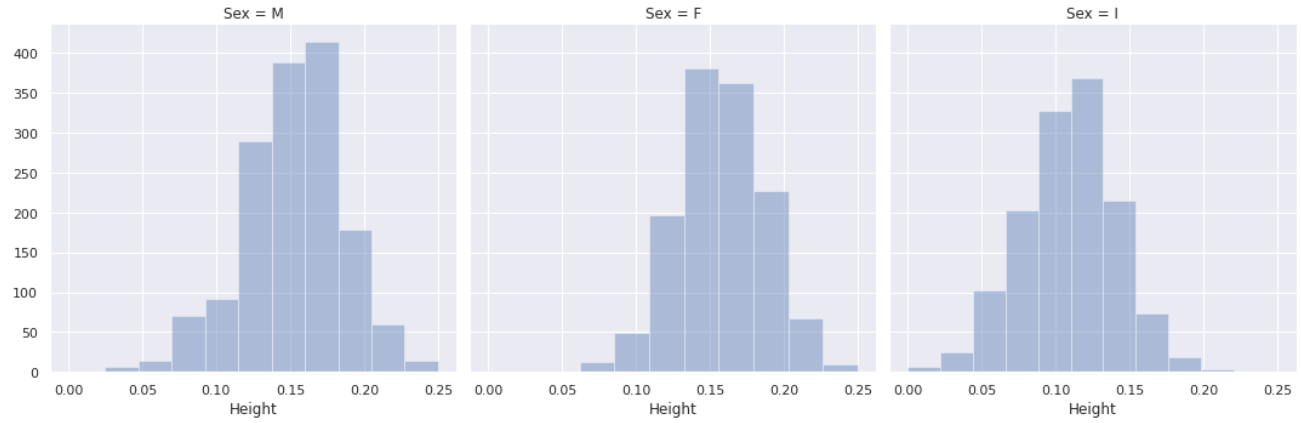
2. (Sex,height) attribute

```
plt.figure(figsize=(7, 7))
_ = sns.boxplot(data=abalone, x='Sex', y='Height')
```



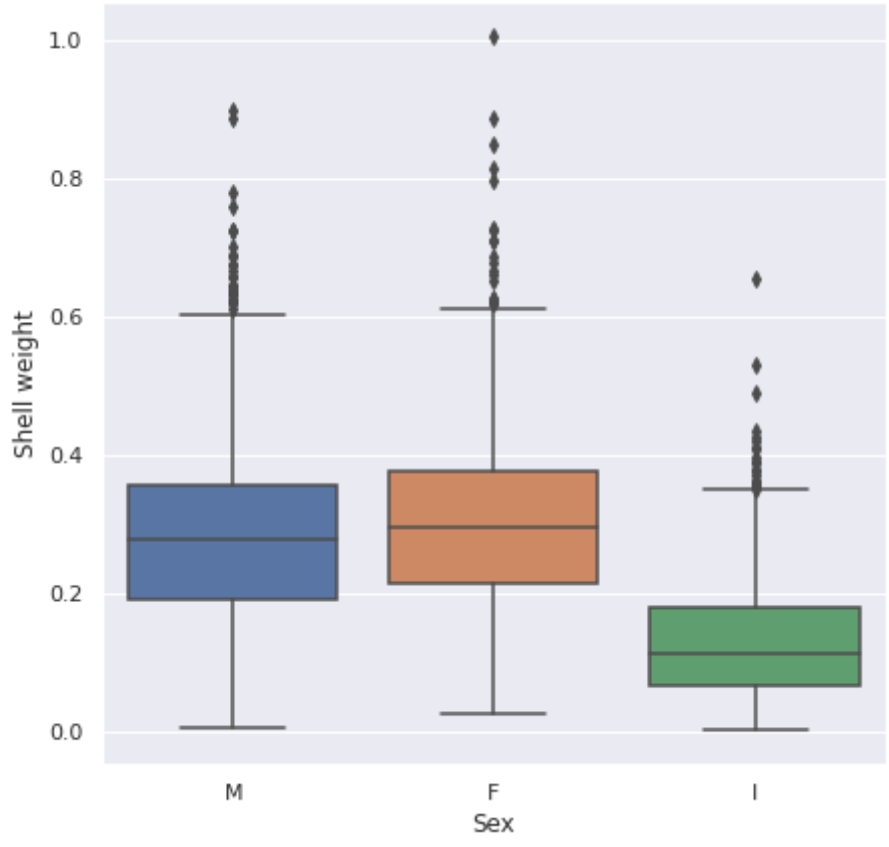

```
g = sns.FacetGrid(abalone, col='Sex', margin_titles=True, size=5)
_ = g.map(sns.distplot, 'Height', kde=False, bins=10)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/axisgrid.py:337: UserWarning: The `siz
  warnings.warn(msg, UserWarning)
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: FutureWarning:
  warnings.warn(msg, FutureWarning)
```



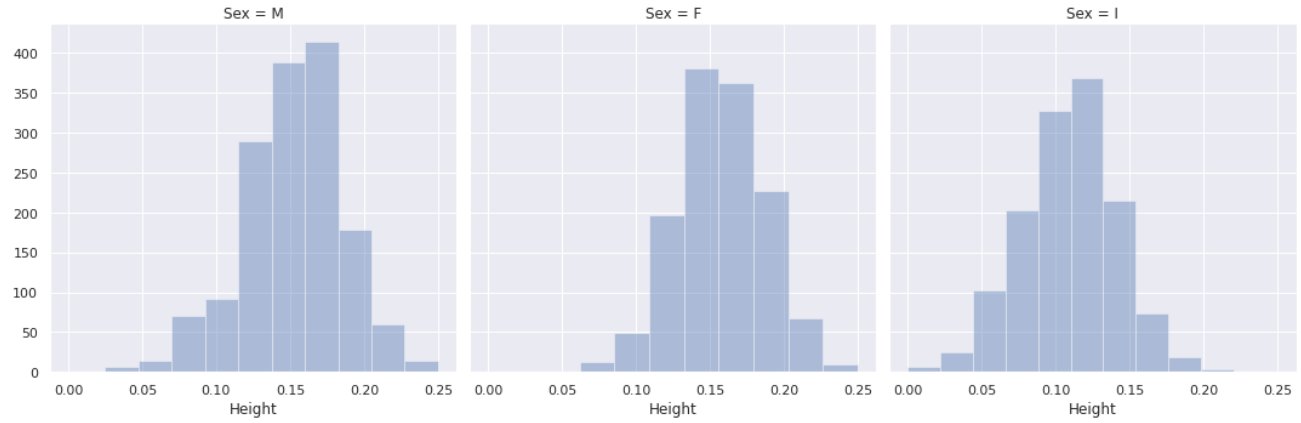
3. (Sex,shell weight) attribute

```
plt.figure(figsize=(7, 7))
_ = sns.boxplot(data=abalone, x='Sex', y='Shell weight')
```




```
g = sns.FacetGrid(abalone, col='Sex', margin_titles=True, size=5)
_ = g.map(sns.distplot, 'Height', kde=False, bins=10)
```

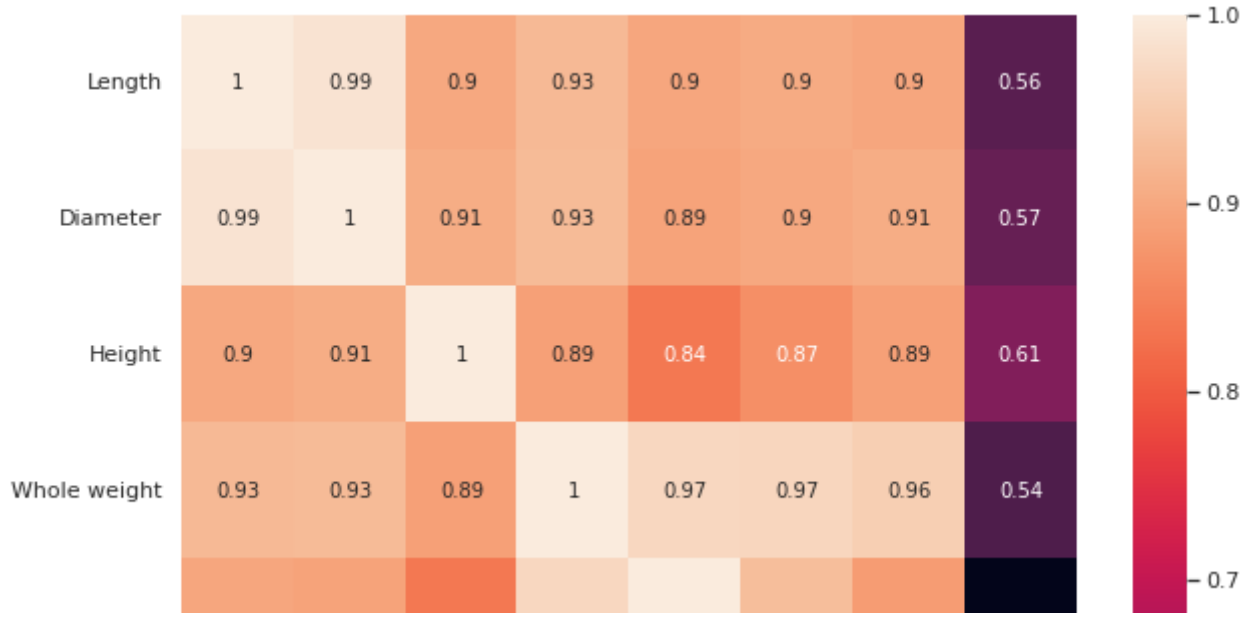
```
/usr/local/lib/python3.7/dist-packages/seaborn/axisgrid.py:337: UserWarning: The `siz
  warnings.warn(msg, UserWarning)
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: FutureWarning:
  warnings.warn(msg, FutureWarning)
```



MULTIVARIATE ANALYSIS

Correlation matrix in Heatmap:

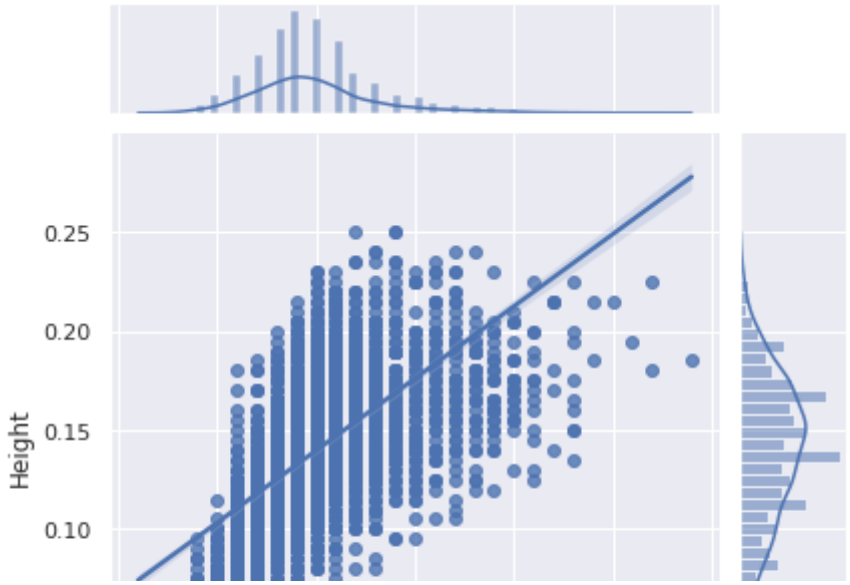
```
plt.figure(figsize=(10, 10))
corr = abalone.corr()
_ = sns.heatmap(corr, annot=True)
```



Multivariate analysis on the correlation of these two attributes with Rings:

```
plt.figure(figsize=(20, 5))

_·=·sns.jointplot(data=abalone,·x='Rings',·y='Height',·kind='reg')
_·=·sns.jointplot(data=abalone,·x='Rings',·y='Shell·weight',·kind='reg')
```

```
<Figure size 1440x360 with 0 Axes>
```



DESCRIPTIVE STATISTICS

```
abalone.describe().T
```

	count	mean	std	min	25%	50%	75%	max
Length	4175.0	0.523965	0.120084	0.0750	0.45000	0.5450	0.61500	0.8150
Diameter	4175.0	0.407856	0.099230	0.0550	0.35000	0.4250	0.48000	0.6500
Height	4175.0	0.139189	0.038489	0.0000	0.11500	0.1400	0.16500	0.2500
Whole weight	4175.0	0.828468	0.490027	0.0020	0.44150	0.7995	1.15300	2.8255
Shucked weight	4175.0	0.359195	0.221713	0.0010	0.18600	0.3360	0.50175	1.4880
Viscera weight	4175.0	0.180536	0.109534	0.0005	0.09325	0.1710	0.25275	0.7600
Shell weight	4175.0	0.238791	0.139162	0.0015	0.13000	0.2340	0.32875	1.0050
Rings	4175.0	9.934132	3.224802	1.0000	8.00000	9.0000	11.00000	29.0000

HANDLING WITH MISSING DATA

```
df = pd.DataFrame(abalone)
df.isnull()
```

	Sex	Length	Diameter	Height	Whole weight	Shucked weight	Viscera weight	Shell weight	Rings
0	False	False	False	False	False	False	False	False	False
1	False	False	False	False	False	False	False	False	False
2	False	False	False	False	False	False	False	False	False
3	False	False	False	False	False	False	False	False	False
4	False	False	False	False	False	False	False	False	False

```
df.fillna(0)
```

	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	0.1500	15
1	M	0.350	0.265	0.090	0.2255	0.0995	0.0485	0.0700	7
2	F	0.530	0.420	0.135	0.6770	0.2565	0.1415	0.2100	9
3	M	0.440	0.365	0.125	0.5160	0.2155	0.1140	0.1550	10
4	I	0.330	0.255	0.080	0.2050	0.0895	0.0395	0.0550	7
...	...	...	...	...	...	...	...	...	...
4172	F	0.565	0.450	0.165	0.8870	0.3700	0.2390	0.2490	11
4173	M	0.590	0.440	0.135	0.9660	0.4390	0.2145	0.2605	10
4174	M	0.600	0.475	0.205	1.1760	0.5255	0.2875	0.3080	9
4175	F	0.625	0.485	0.150	1.0945	0.5310	0.2610	0.2960	10
4176	M	0.710	0.555	0.195	1.9485	0.9455	0.3765	0.4950	12

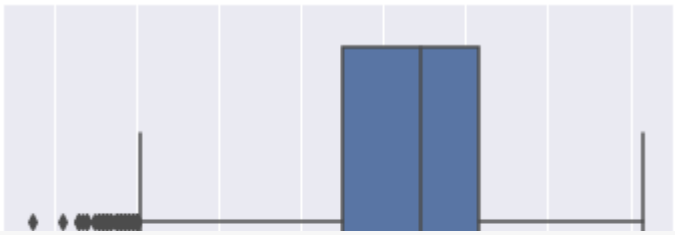
4175 rows × 9 columns

Replacing the missing values with 0 using fillna

OUTLIERS IN EACH ATTRIBUTES

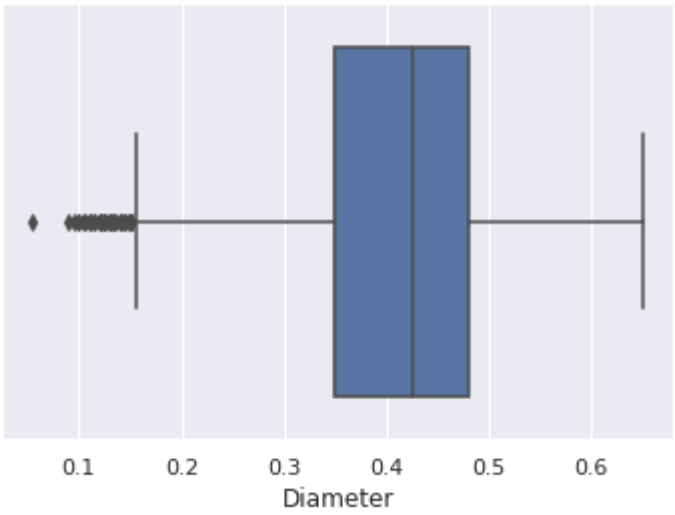
```
sns.boxplot(df['Length'],data=df)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60ab1801d0>
```



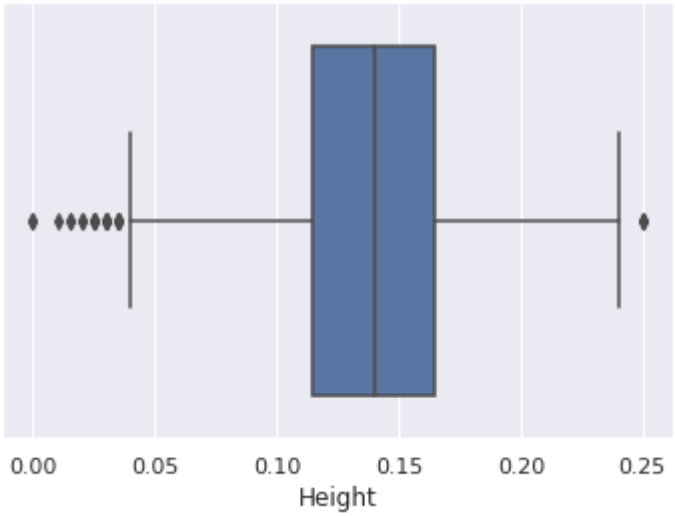
```
sns.boxplot(df['Diameter'],data=df)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60a9167d50>
```



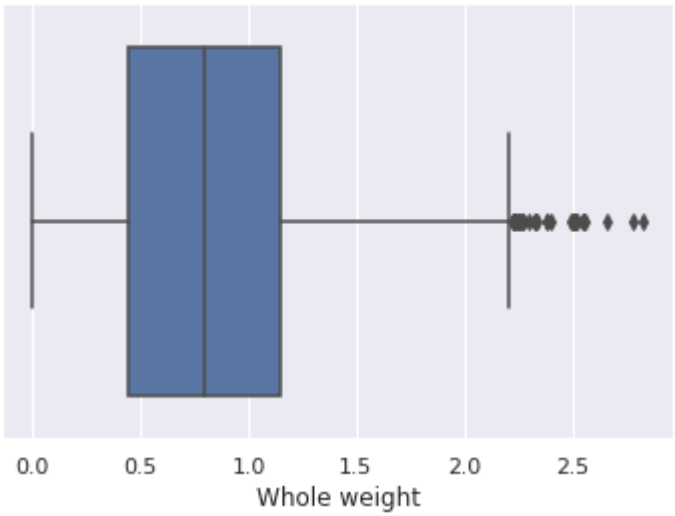

```
sns.boxplot(df['Height'],data=df)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60ab0c41d0>
```



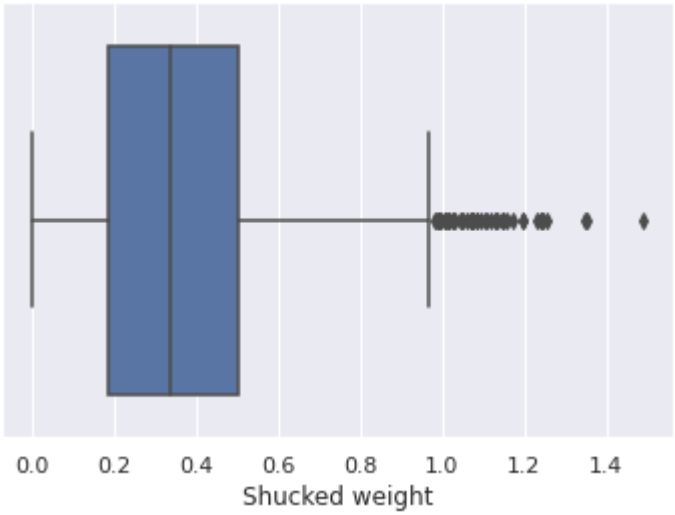

```
sns.boxplot(df['Whole weight'],data=df)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60aaf51050>
```



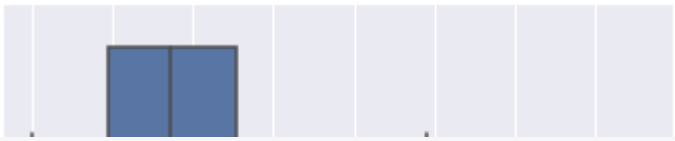

```
sns.boxplot(df['Shucked weight'],data=df)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60a917f850>
```



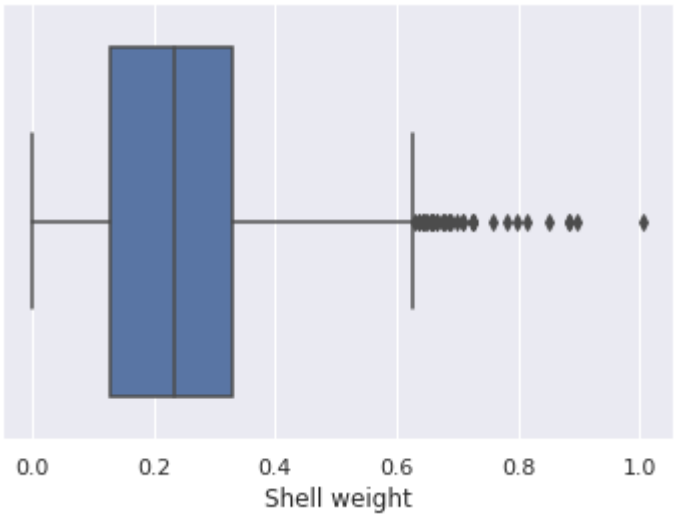

```
sns.boxplot(df['Viscera weight'],data=df)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60ac431450>
```



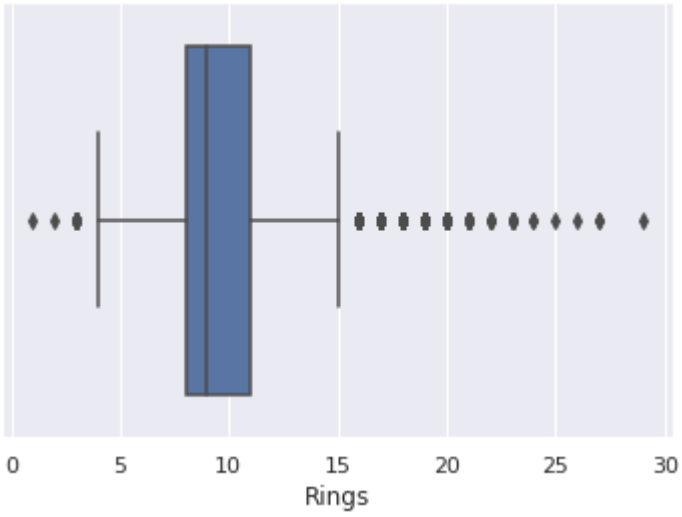
```
sns.boxplot(df['Shell weight'],data=df)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60ab0c27d0>
```




```
sns.boxplot(df['Rings'],data=df)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60aada63d0>
```




```
Q1 = abalone.quantile(0.25)
Q3 = abalone.quantile(0.75)
IQR = Q3-Q1
print(IQR)
```

```
Length            0.16500
Diameter          0.13000
Height            0.05000
Whole weight      0.71150
Shucked weight    0.31575
Viscera weight    0.15950
Shell weight      0.19875
Rings             3.00000
dtype: float64
```

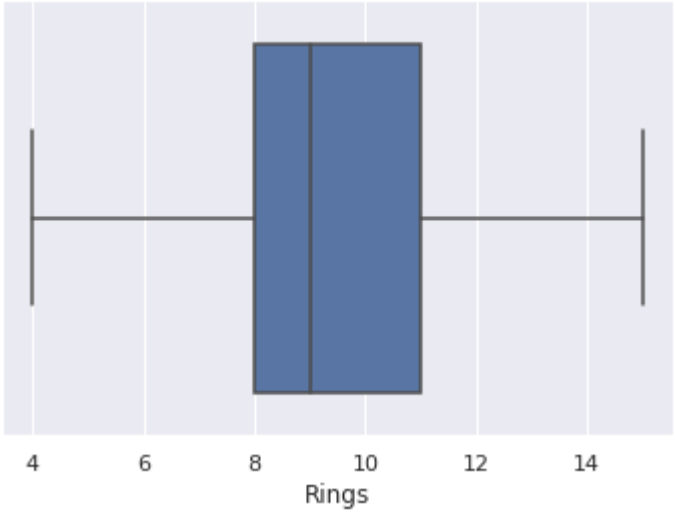
Removing outliers using IQR

```
abalone = abalone[~((abalone < (Q1 - 1.5 * IQR)) |(abalone > (Q3 + 1.5 * IQR))).any(axis=1
abalone.shape
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:1: FutureWarning: Automa
  """Entry point for launching an IPython kernel.
(3781, 9)
```

```
sns.boxplot(abalone['Rings'],data=abalone)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60aad70190>
```

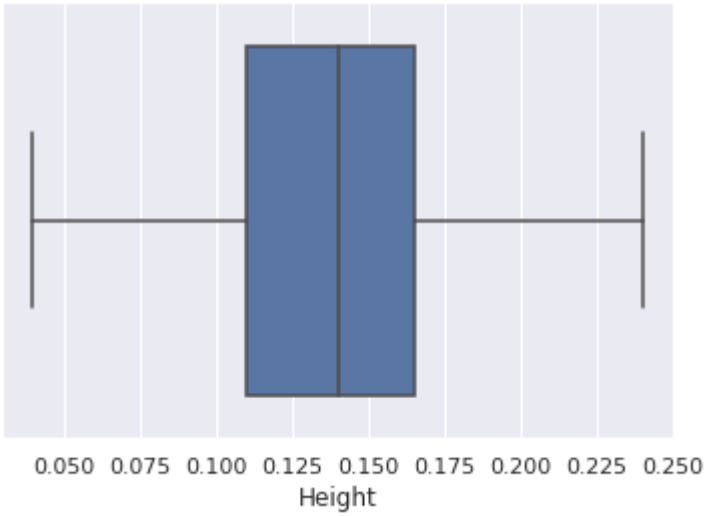



```
sns.boxplot(abalone['Length'],data=abalone)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60a9136b50>
```

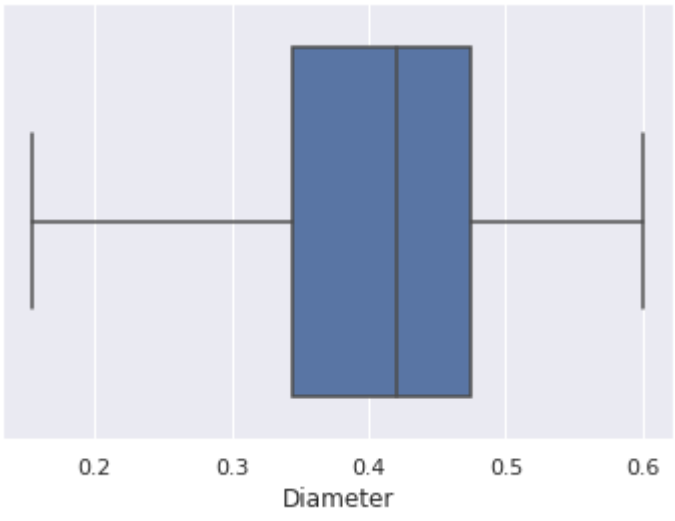
```
sns.boxplot(abalone['Height'],data=abalone)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60a90c9410>
```



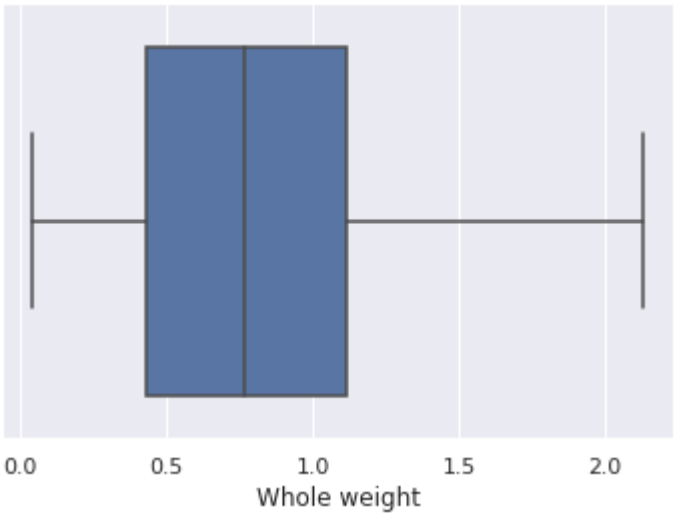

```
sns.boxplot(abalone['Diameter'],data=abalone)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60a9284610>
```



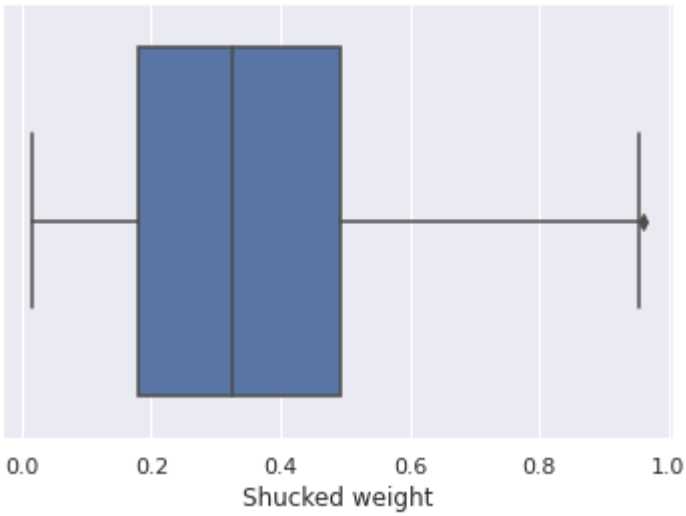

```
sns.boxplot(abalone['Whole weight'],data=abalone)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60aaece190>
```



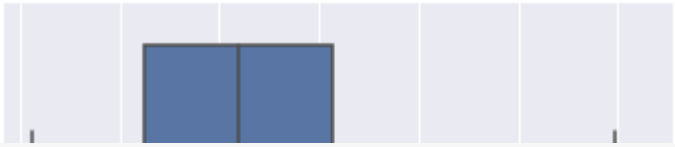

```
sns.boxplot(abalone['Shucked weight'],data=abalone)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60ab08ce90>
```



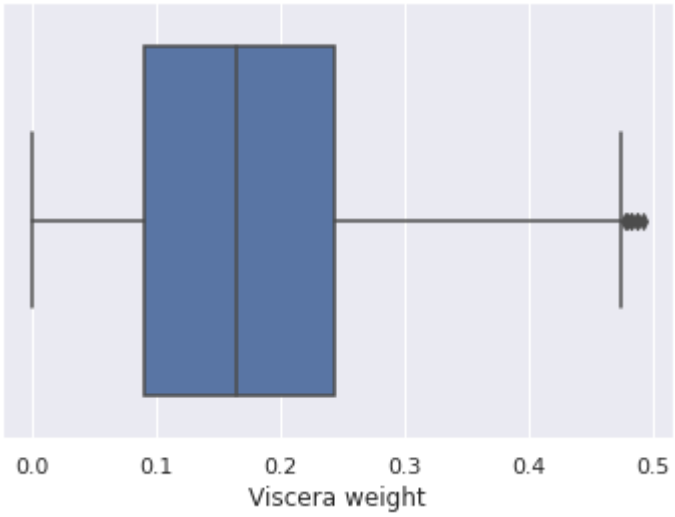

```
sns.boxplot(abalone['Shell weight'],data=abalone)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60a936f610>
```



```
sns.boxplot(abalone['Viscera weight'],data=abalone)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7f60a94d0e50>
```



LABEL ENCODING OF CATEGORICAL DATA

```
le=LabelEncoder()
abalone['Sex']=le.fit_transform(abalone['Sex'])
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:2: SettingWithCopyWarnir
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
```

```
abalone
```

	Sex	Length	Diameter	Height	Whole weight	Shucked weight	Viscera weight	Shell weight	Rings
0	2	0.455	0.365	0.095	0.5140	0.2245	0.1010	0.1500	15
1	2	0.350	0.265	0.090	0.2255	0.0995	0.0485	0.0700	7
2	0	0.530	0.420	0.135	0.6770	0.2565	0.1415	0.2100	9
3	2	0.440	0.365	0.125	0.5160	0.2155	0.1140	0.1550	10
4	1	0.330	0.255	0.080	0.2050	0.0895	0.0395	0.0550	7
...	...	...	...	...	...	...	...	...	...

8. Spliting the Data into dependent and Independent Variables

```
X = abalone.iloc[:, :-1].values
y = abalone.iloc[:, -1].values
```

9. Scaling independent variables

```
scaler = StandardScaler()
scaler.fit(abalone)
```

```
StandardScaler()
```

10.Spliting training and test data

```
train_X,val_X,train_y,val_y = train_test_split(X, y, test_size = 0.2, random_state = 0)
```

```
print("Shape of Training X :",train_X.shape)
print("Shape of Validation X :",val_X.shape)
```

```
Shape of Training X : (3024, 8)
Shape of Validation X : (757, 8)
```

```
print("Shape of Training y :",train_y.shape)
print("Shape of Validation y :",val_y.shape)
```

```
Shape of Training y : (3024,)
Shape of Validation y : (757,)
```

LINEAR REGRESSION

```
lr = LinearRegression()
lr.fit(train_X,train_y)
```

```
LinearRegression()
```

```
%%time
y_pred_val_lr = lr.predict(val_X)
print('MAE on Validation set :',metrics.mean_absolute_error(val_y, y_pred_val_lr))
print("\n")
print('MSE on Validation set :',metrics.mean_squared_error(val_y, y_pred_val_lr))
print("\n")
print('RMSE on Validation set :',np.sqrt(metrics.mean_absolute_error(val_y, y_pred_val_lr)
print("\n")
print('R2 Score on Validation set :',metrics.r2_score(val_y, y_pred_val_lr))
print("\n")
```

```
MAE on Validation set : 1.2719689486359298


MSE on Validation set : 2.7606215450501024


RMSE on Validation set : 1.127816008325795


R2 Score on Validation set : 0.5119499107890585


CPU times: user 5.68 ms, sys: 0 ns, total: 5.68 ms
Wall time: 6.73 ms
```

SUPPORT VECTOR MACHINE

```
svm = SVR()
svm.fit(train_X,train_y)
```

```
SVR()
```

```
%%time
y_pred_val_svm = svm.predict(val_X)
print('MAE on Validation set :',metrics.mean_absolute_error(val_y, y_pred_val_svm))
print("\n")
print('MSE on Validation set :',metrics.mean_squared_error(val_y, y_pred_val_svm))
print("\n")
print('RMSE on Validation set :',np.sqrt(metrics.mean_absolute_error(val_y, y_pred_val_svm
print("\n")
print('R2 Score on Validation set :',metrics.r2_score(val_y, y_pred_val_svm))
print("\n")
```

```
MAE on Validation set : 1.2208952787270895


MSE on Validation set : 2.7012620714060267
```

```
RMSE on Validation set : 1.1049413010323623


R2 Score on Validation set : 0.5224440679687887


CPU times: user 140 ms, sys: 4.84 ms, total: 145 ms
Wall time: 144 ms
```

DECISION TREE REGRESSOR

```
dc = DecisionTreeRegressor(random_state = 0)
dc.fit(train_X,train_y)
```

```
DecisionTreeRegressor(random_state=0)
```

```
%%time
y_pred_val_dc = dc.predict(val_X)
print('MAE on Validation set :',metrics.mean_absolute_error(val_y, y_pred_val_dc))
print("\n")
print('MSE on Validation set :',metrics.mean_squared_error(val_y, y_pred_val_dc))
print("\n")
print('RMSE on Validation set :',np.sqrt(metrics.mean_absolute_error(val_y, y_pred_val_dc)
print("\n")
print('R2 Score on Validation set :',metrics.r2_score(val_y, y_pred_val_dc))
print("\n")
```

```
MAE on Validation set : 1.6393659180977542


MSE on Validation set : 4.88110964332893


RMSE on Validation set : 1.2803772561623212


R2 Score on Validation set : 0.13706896870869845


CPU times: user 7.61 ms, sys: 1.06 ms, total: 8.67 ms
Wall time: 10.2 ms
```

OVERVIEW OF R2 SCORES OF ALL MODELS

```
print('Logistic Regression R2 Score on Validation set :',metrics.r2_score(val_y, y_pred_va
print('SVR R2 Score on Validation set :',metrics.r2_score(val_y, y_pred_val_svm))
print('Decision Tree Regressor R2 Score on Validation set :',metrics.r2_score(val_y, y_pre
```

```
Logistic Regression R2 Score on Validation set : 0.5119499107890585
SVR R2 Score on Validation set : 0.5224440679687887
Decision Tree Regressor R2 Score on Validation set : 0.13706896870869845
```