```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns

import os
os.chdir("./Data/")

abalone = pd.read_csv('abalone.csv')

abalone
```

```
     Sex  Length  Diameter  Height  Whole weight  Shucked weight  \
0      M   0.455     0.365   0.095        0.5140          0.2245
1      M   0.350     0.265   0.090        0.2255          0.0995
2      F   0.530     0.420   0.135        0.6770          0.2565
3      M   0.440     0.365   0.125        0.5160          0.2155
4      I   0.330     0.255   0.080        0.2050          0.0895
...   ..     ...       ...     ...           ...             ...
4172   F   0.565     0.450   0.165        0.8870          0.3700
4173   M   0.590     0.440   0.135        0.9660          0.4390
4174   M   0.600     0.475   0.205        1.1760          0.5255
4175   F   0.625     0.485   0.150        1.0945          0.5310
4176   M   0.710     0.555   0.195        1.9485          0.9455

      Viscera weight  Shell weight  Rings
0             0.1010        0.1500     15
1             0.0485        0.0700      7
2             0.1415        0.2100      9
3             0.1140        0.1550     10
4             0.0395        0.0550      7
...              ...           ...    ...
4172          0.2390        0.2490     11
4173          0.2145        0.2605     10
4174          0.2875        0.3080      9
4175          0.2610        0.2960     10
4176          0.3765        0.4950     12

[4177 rows x 9 columns]
```

```
abalone.head()
```

```
  Sex  Length  Diameter  Height  Whole weight  Shucked weight  Viscera
weight  \
0   M   0.455     0.365   0.095        0.5140          0.2245
0.1010
1   M   0.350     0.265   0.090        0.2255          0.0995
0.0485
2   F   0.530     0.420   0.135        0.6770          0.2565
0.1415
```

```
3   M   0.440     0.365   0.125        0.5160          0.2155
0.1140
4   I   0.330     0.255   0.080        0.2050          0.0895
0.0395
```

```
   Shell weight  Rings
0         0.150     15
1         0.070      7
2         0.210      9
3         0.155     10
4         0.055      7
```

```
abalone.tail()
```

```
     Sex  Length  Diameter  Height  Whole weight  Shucked weight  \
4172   F   0.565     0.450   0.165        0.8870          0.3700
4173   M   0.590     0.440   0.135        0.9660          0.4390
4174   M   0.600     0.475   0.205        1.1760          0.5255
4175   F   0.625     0.485   0.150        1.0945          0.5310
4176   M   0.710     0.555   0.195        1.9485          0.9455

      Viscera weight  Shell weight  Rings
4172          0.2390        0.2490     11
4173          0.2145        0.2605     10
4174          0.2875        0.3080      9
4175          0.2610        0.2960     10
4176          0.3765        0.4950     12
```

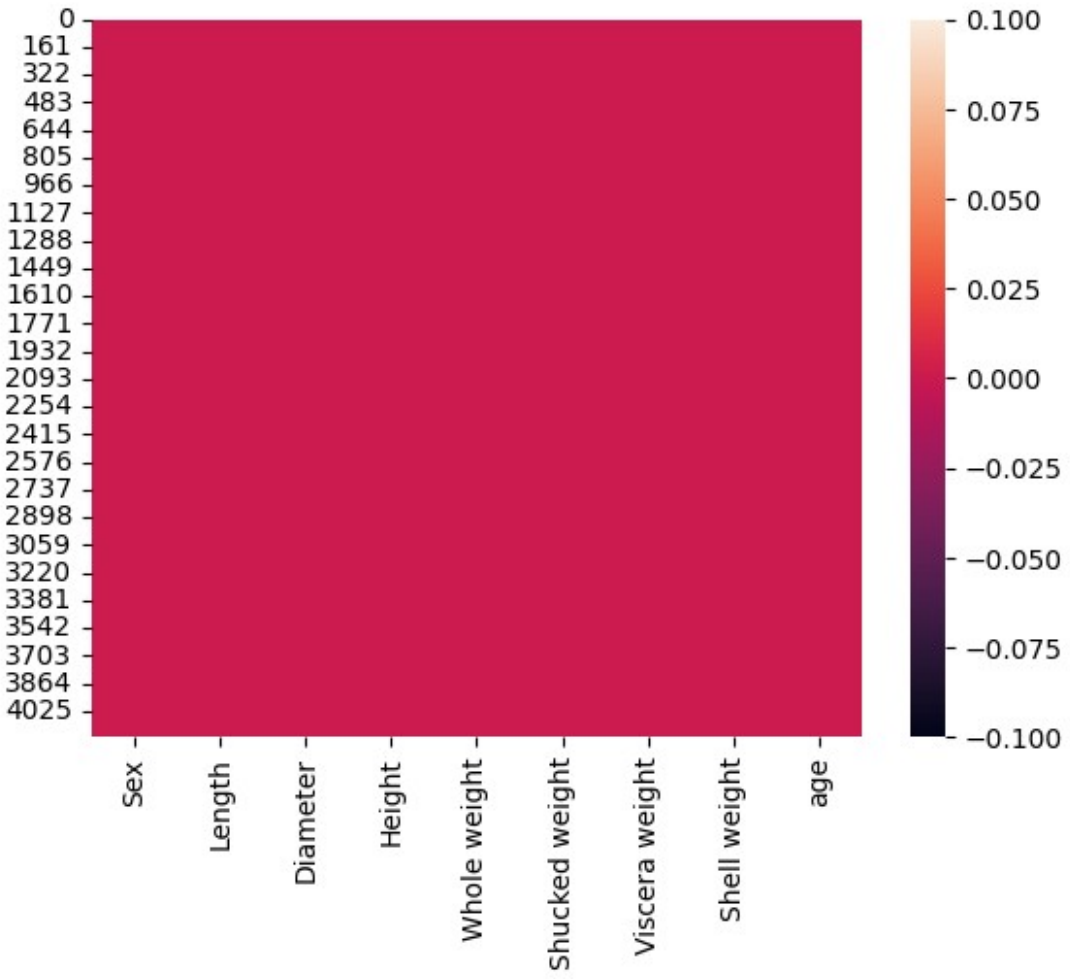
```
#age can be calculated by using adding value 1.5 to Rings
```

```
abalone['age'] = abalone['Rings']+1.5
abalone = abalone.drop('Rings', axis = 1)
```

Univariate Analysis

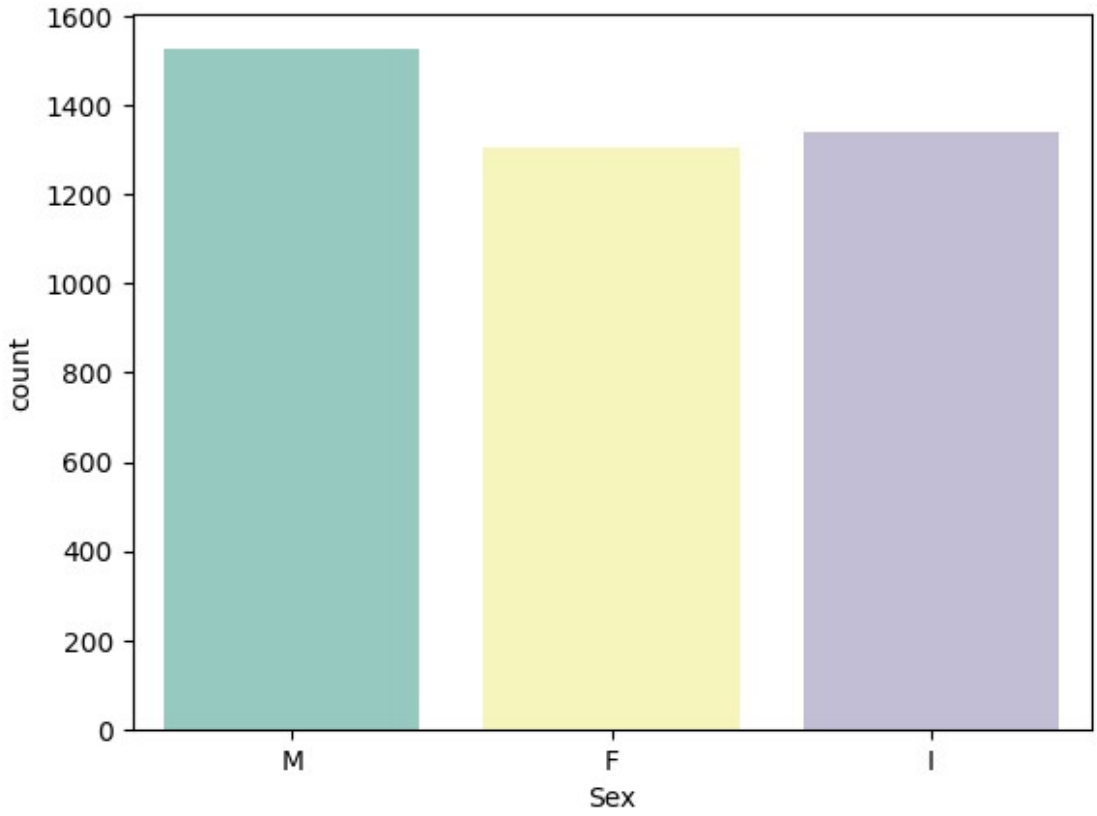
```
sns.heatmap(abalone.isnull())
```

```
<AxesSubplot: >
```



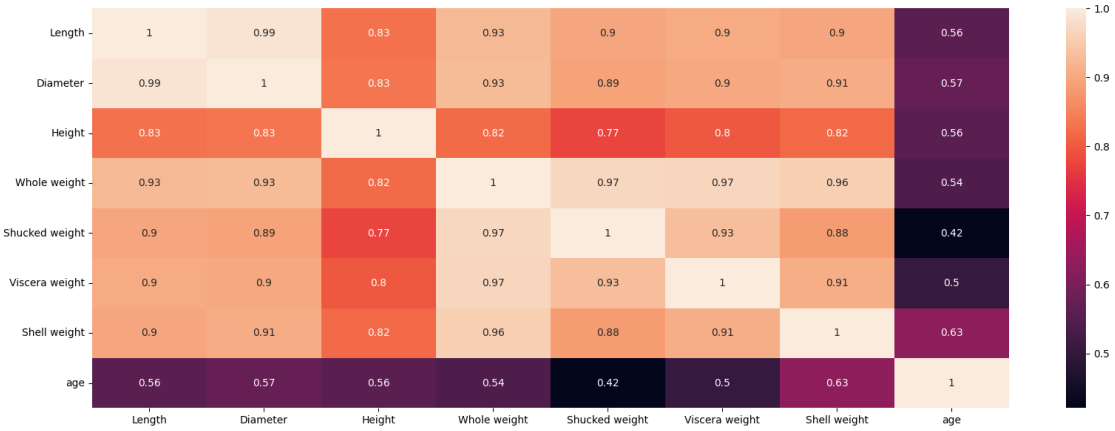

```
plt.figure(figsize = (20,7))
sns.swarmplot(x = 'Sex', y = 'age', data = abalone, hue = 'Sex')
sns.violinplot(x = 'Sex', y = 'age',data = abalone)

sns.countplot(x = 'Sex', data = abalone, palette = 'Set3')
```

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



Bivariate Analysis

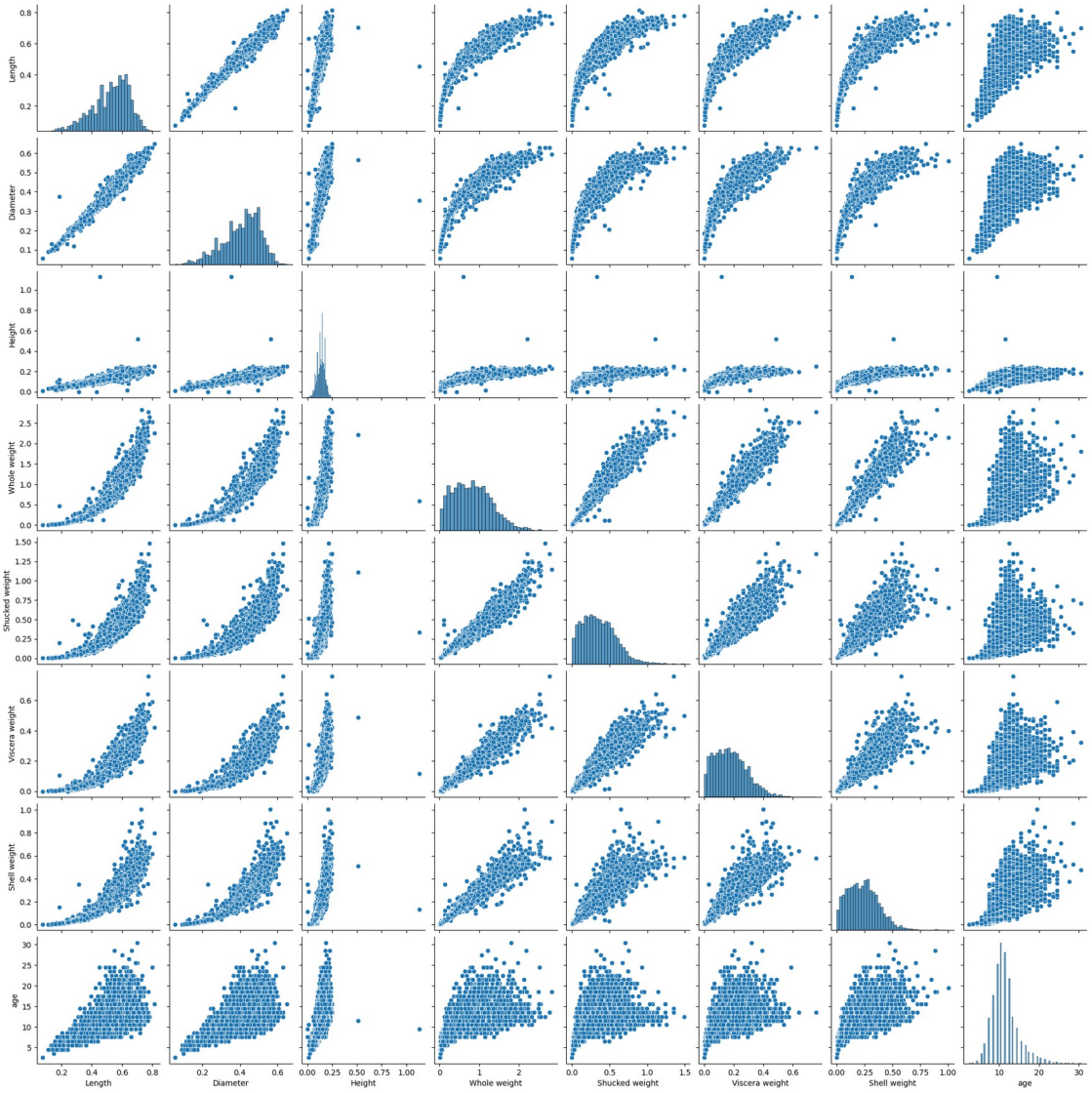
```
numerical_features = abalone.select_dtypes(include =
[np.number]).columns
categorical_features = abalone.select_dtypes(include =
[np.object]).columns

numerical_features

Index(['Length', 'Diameter', 'Height', 'Whole weight', 'Shucked
weight',
       'Viscera weight', 'Shell weight', 'age'],
      dtype='object')

categorical_features

Index(['Sex'], dtype='object')

plt.figure(figsize = (20,7))
sns.heatmap(abalone[numerical_features].corr(),annot = True)

<AxesSubplot: >
```



Multivariate Analysis

```
sns.pairplot(abalone)
```

```
<seaborn.axisgrid.PairGrid at 0x24a6b3f5ae0>
```



Descriptive Statistics

#continuous variables

```
abalone['Length'].describe()
```

```
count    4177.000000
mean        0.523992
std         0.120093
min         0.075000
25%         0.450000
50%         0.545000
75%         0.615000
max         0.815000
Name: Length, dtype: float64
```

```
abalone['Shucked weight'].describe()
```

```
count    4177.000000
mean        0.359367
std         0.221963
min         0.001000
25%         0.186000
50%         0.336000
75%         0.502000
max         1.488000
Name: Shucked weight, dtype: float64
```

```
abalone['Shell weight'].describe()
```

```
count    4177.000000
mean        0.238831
std         0.139203
min         0.001500
25%         0.130000
50%         0.234000
75%         0.329000
max         1.005000
Name: Shell weight, dtype: float64
```

```
abalone['Height'].describe()
```

```
count    4177.000000
mean        0.139516
std         0.041827
min         0.000000
25%         0.115000
50%         0.140000
75%         0.165000
max         1.130000
Name: Height, dtype: float64
```

```
# Categorical variable
```

```
abalone['Sex'].describe()
```

```
count     4177
unique       3
top          M
freq      1528
Name: Sex, dtype: object
```

```
abalone['Sex'].value_counts()
```

```
M    1528
I    1342
F    1307
Name: Sex, dtype: int64
```

```
#Distribution measures
```

```
abalone['Length'].kurtosis()
```

```
0.06462097389494126
```

```
abalone['Length'].skew()
```

```
-0.639873268981801
```

```
abalone['Shucked weight'].kurtosis()
```

```
0.5951236783694207
```

```
abalone['Shucked weight'].skew()
```

```
0.7190979217612694
```

Missing values

```
missing_values = abalone.isnull().sum()
```

```
missing_values
```

```
Sex               0
Length            0
Diameter          0
Height            0
Whole weight      0
Shucked weight    0
Viscera weight    0
Shell weight      0
age               0
dtype: int64
```

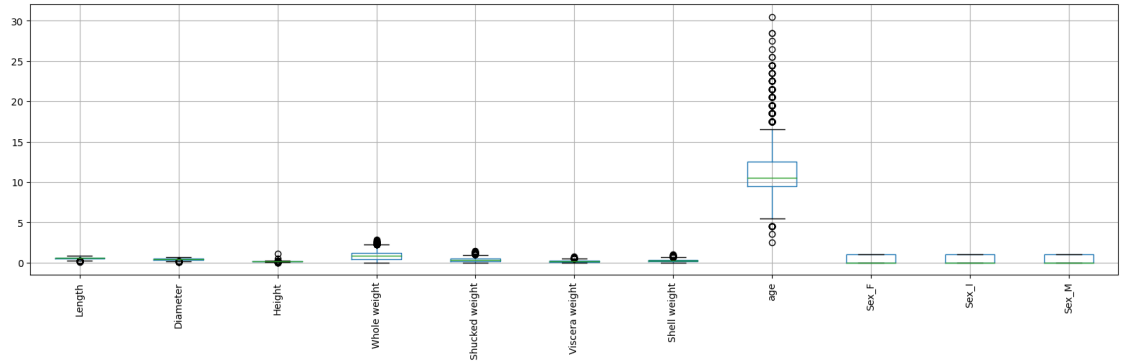
```
missing_values = abalone.isnull().sum().sort_values(ascending = False)
percentage_missing_values = (missing_values/len(abalone))*100
pd.concat([missing_values, percentage_missing_values], axis = 1, keys=
['Missing values', '% Missing'])
```

```
                Missing values  % Missing
Sex                          0        0.0
Length                       0        0.0
Diameter                     0        0.0
Height                       0        0.0
Whole weight                 0        0.0
Shucked weight               0        0.0
Viscera weight               0        0.0
Shell weight                 0        0.0
age                          0        0.0
```

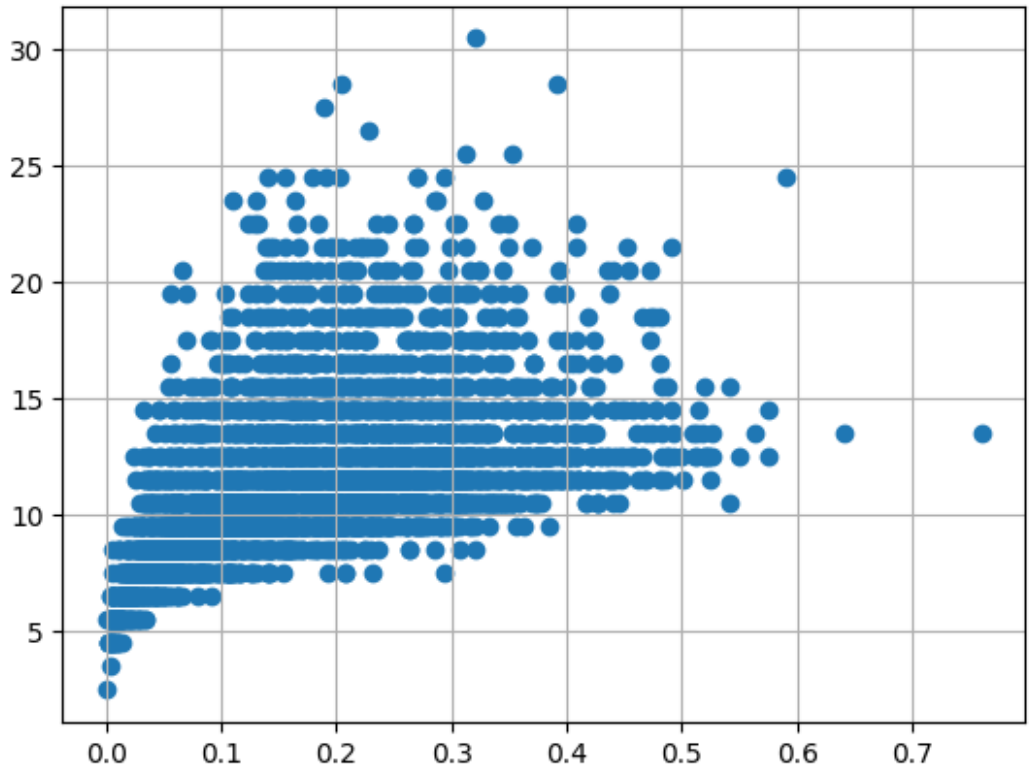
Outliers

```
abalone = pd.get_dummies(abalone)
dummy_df = abalone

abalone.boxplot( rot = 90, figsize=(20,5))
```

```
<AxesSubplot: >
```

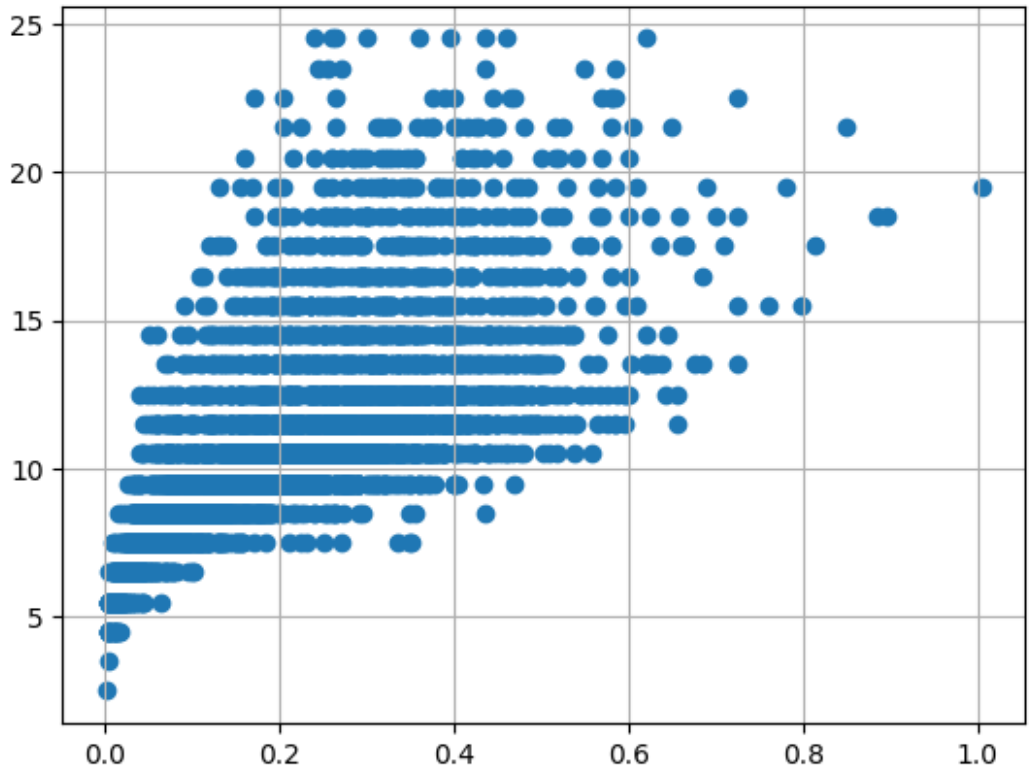



```
var = 'Viscera weight'
plt.scatter(x = abalone[var], y = abalone['age'])
plt.grid(True)
```

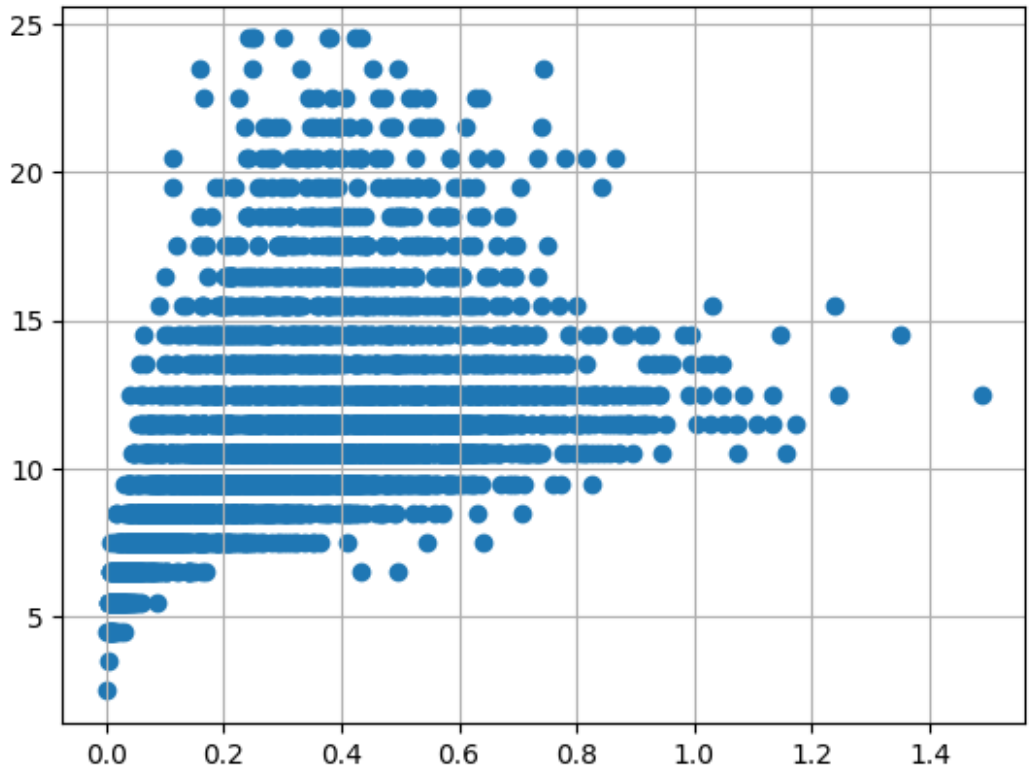



```
abalone.drop(abalone[(abalone['Viscera weight']> 0.5) &
(abalone['age'] < 20)].index, inplace=True)
```

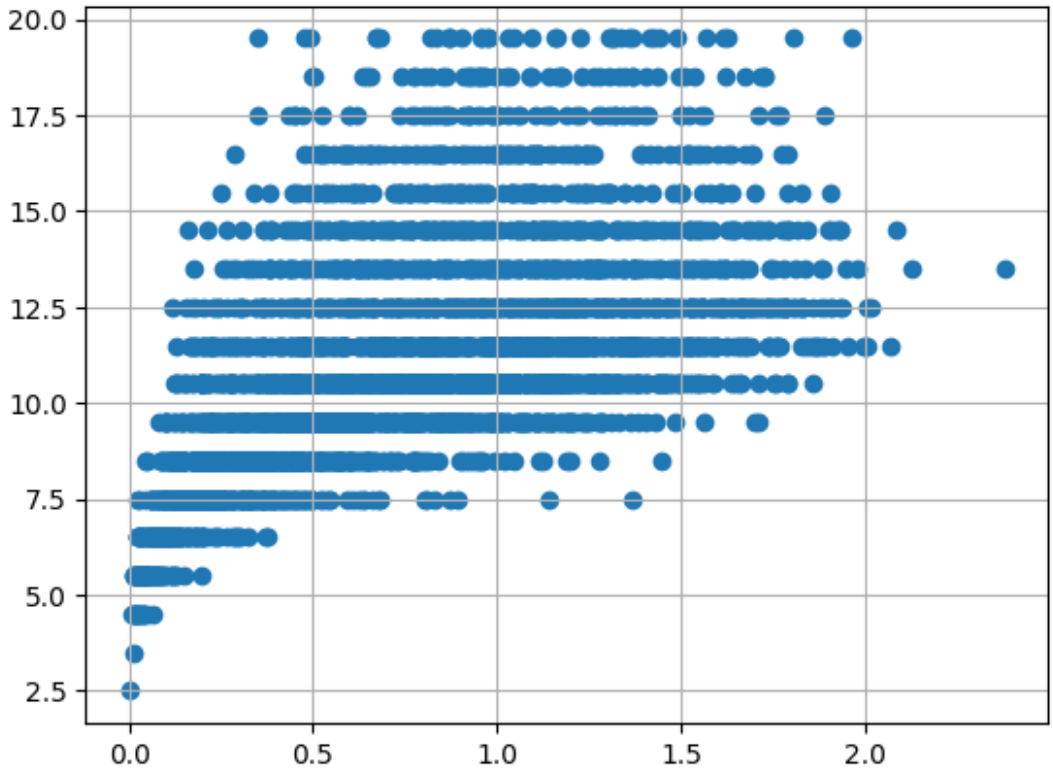
```
abalone.drop(abalone[(abalone['Viscera weight']<0.5) & (abalone['age']
> 25)].index, inplace=True)

var = 'Shell weight'
plt.scatter(x = abalone[var], y = abalone['age'])
plt.grid(True)
```



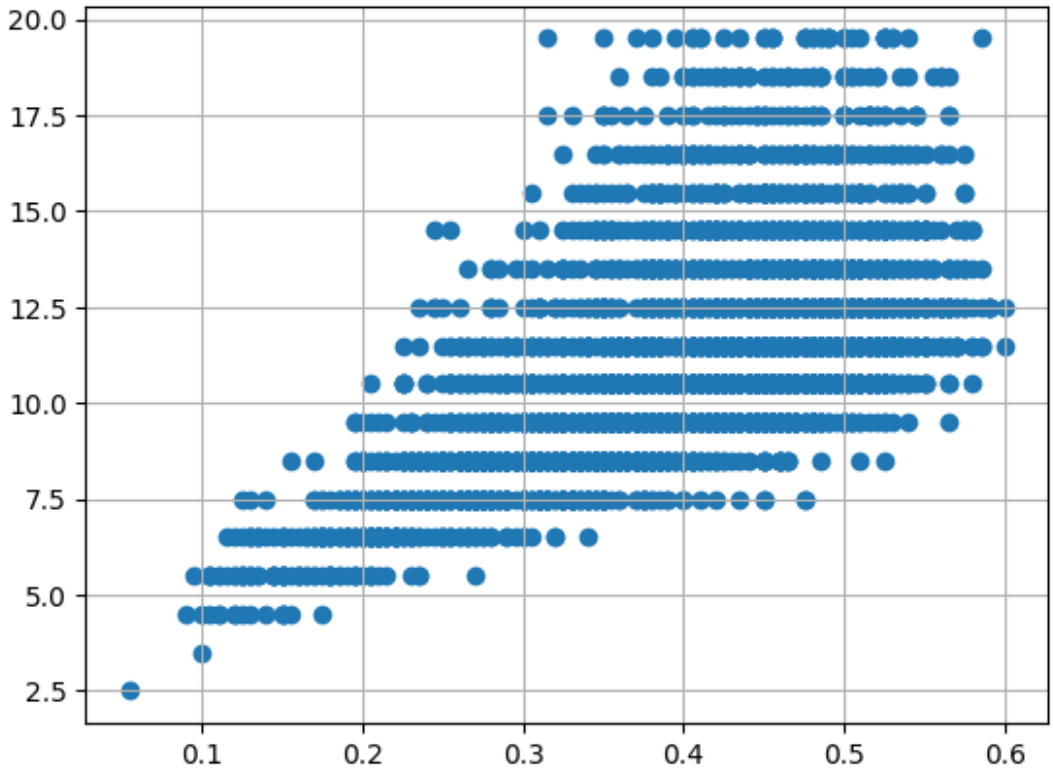

```
abalone.drop(abalone[(abalone['Shell weight']> 0.6) & (abalone['age']
< 25)].index, inplace=True)
abalone.drop(abalone[(abalone['Shell weight']<0.8) & (abalone['age'] >
25)].index, inplace=True)

var = 'Shucked weight'
plt.scatter(x = abalone[var], y = abalone['age'])
plt.grid(True)
```



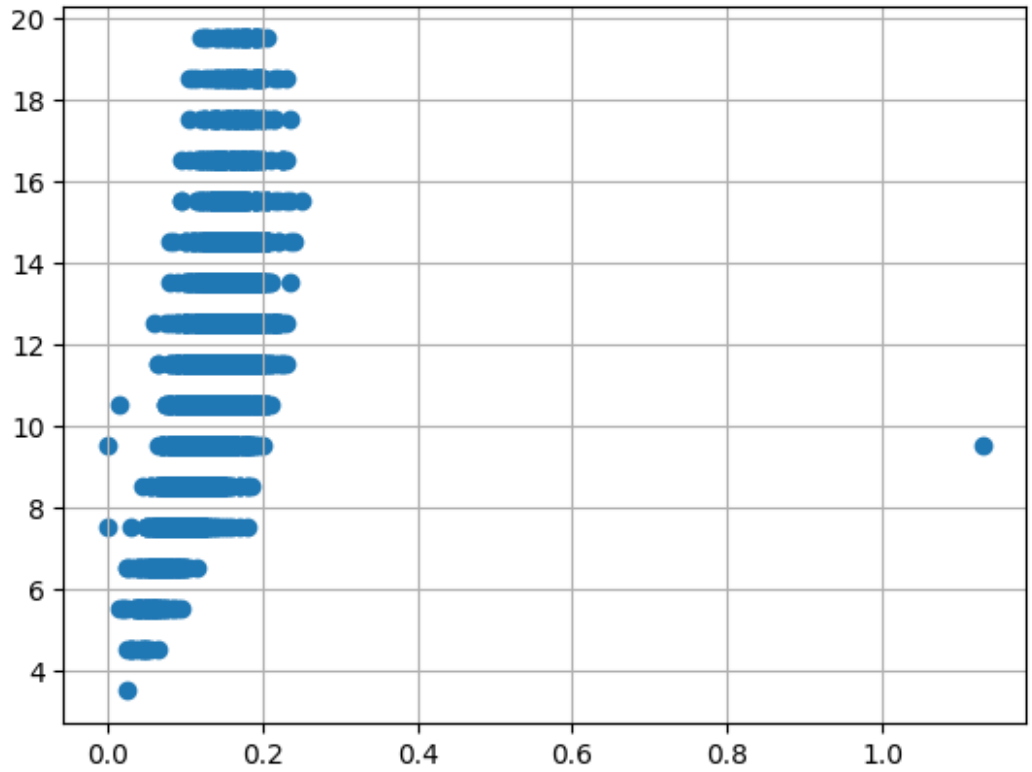

```
abalone.drop(abalone[(abalone['Shucked weight'] >= 1) &
(abalone['age'] < 20)].index, inplace = True)
abalone.drop(abalone[(abalone['Viscera weight']<1) & (abalone['age'] >
20)].index, inplace = True)

var = 'Whole weight'
plt.scatter(x = abalone[var], y = abalone['age'])
plt.grid(True)
```



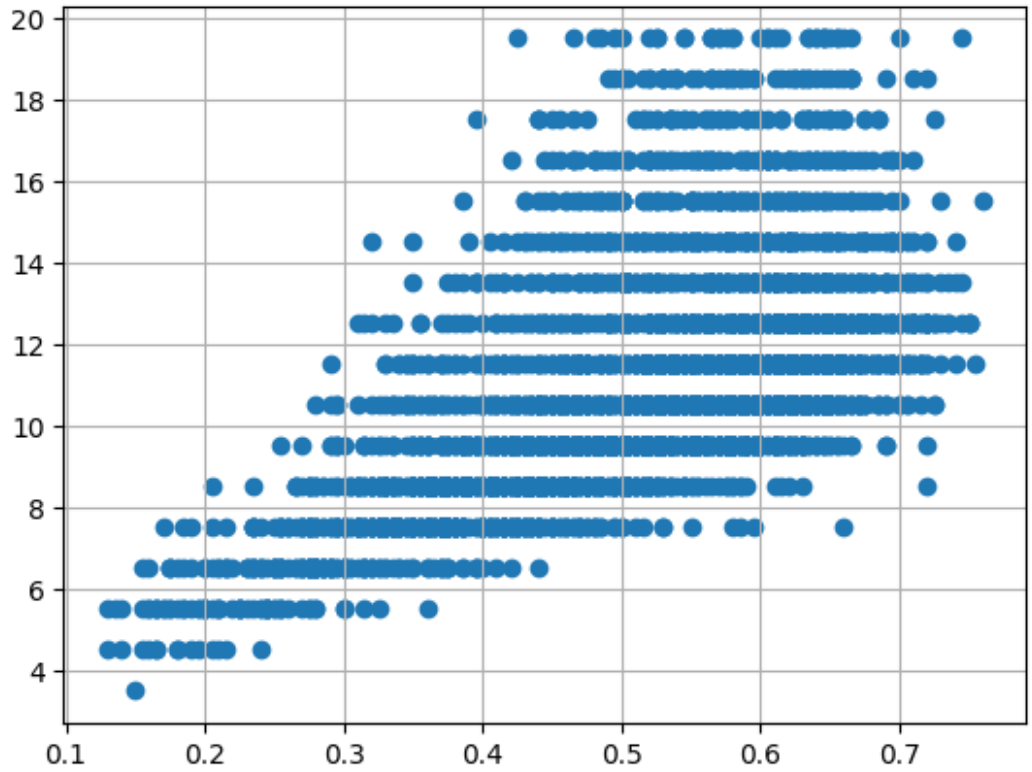

```
abalone.drop(abalone[(abalone['Whole weight'] >= 2.5) &
(abalone['age'] < 25)].index, inplace = True)
abalone.drop(abalone[(abalone['Whole weight']<2.5) & (abalone['age'] >
25)].index, inplace = True)

var = 'Diameter'
plt.scatter(x = abalone[var], y = abalone['age'])
plt.grid(True)
```




```
abalone.drop(abalone[(abalone['Diameter'] <0.1) & (abalone['age'] <
5)].index, inplace = True)
abalone.drop(abalone[(abalone['Diameter']<0.6) & (abalone['age'] >
25)].index, inplace = True)
abalone.drop(abalone[(abalone['Diameter']>=0.6) & (abalone['age'] <
25)].index, inplace = True)

var = 'Height'
plt.scatter(x = abalone[var], y = abalone['age'])
plt.grid(True)
```




```
abalone.drop(abalone[(abalone['Height'] > 0.4) & (abalone['age'] <
15)].index, inplace = True)
abalone.drop(abalone[(abalone['Height']<0.4) & (abalone['age'] >
25)].index, inplace = True)

var = 'Length'
plt.scatter(x = abalone[var], y = abalone['age'])
plt.grid(True)
```




```
abalone.drop(abalone[(abalone['Length'] <0.1) & (abalone['age'] <
5)].index, inplace = True)
abalone.drop(abalone[(abalone['Length']<0.8) & (abalone['age'] >
25)].index, inplace = True)
abalone.drop(abalone[(abalone['Length']>=0.8) & (abalone['age'] <
25)].index, inplace = True)

abalone
```

```
      Length  Diameter  Height  Whole weight  Shucked weight  Viscera
weight  \
0      0.455     0.365   0.095        0.5140          0.2245
0.1010
1      0.350     0.265   0.090        0.2255          0.0995
0.0485
2      0.530     0.420   0.135        0.6770          0.2565
0.1415
3      0.440     0.365   0.125        0.5160          0.2155
0.1140
4      0.330     0.255   0.080        0.2050          0.0895
0.0395
...      ...       ...     ...           ...             ...
...
4172   0.565     0.450   0.165        0.8870          0.3700
0.2390
4173   0.590     0.440   0.135        0.9660          0.4390
```

```
0.2145
4174   0.600     0.475   0.205        1.1760          0.5255
0.2875
4175   0.625     0.485   0.150        1.0945          0.5310
0.2610
4176   0.710     0.555   0.195        1.9485          0.9455
0.3765

      Shell weight   age  Sex_F  Sex_I  Sex_M
0           0.1500  16.5      0      0      1
1           0.0700   8.5      0      0      1
2           0.2100  10.5      1      0      0
3           0.1550  11.5      0      0      1
4           0.0550   8.5      0      1      0
...            ...   ...    ...    ...    ...
4172        0.2490  12.5      1      0      0
4173        0.2605  11.5      0      0      1
4174        0.3080  10.5      0      0      1
4175        0.2960  11.5      1      0      0
4176        0.4950  13.5      0      0      1

[3995 rows x 11 columns]
```

Categorical columns

```
numerical_features = abalone.select_dtypes(include =
[np.number]).columns
categorical_features = abalone.select_dtypes(include =
[np.object]).columns

numerical_features

Index(['Length', 'Diameter', 'Height', 'Whole weight', 'Shucked
weight',
       'Viscera weight', 'Shell weight', 'age', 'Sex_F', 'Sex_I',
'Sex_M'],
      dtype='object')

categorical_features

Index([], dtype='object')

abalone_numeric = abalone[['Length', 'Diameter', 'Height', 'Whole
weight', 'Shucked weight','Viscera weight', 'Shell weight', 'age',
'Sex_F', 'Sex_I', 'Sex_M']]

abalone_numeric.head()

   Length  Diameter  Height  Whole weight  Shucked weight  Viscera
weight  \
0   0.455     0.365   0.095        0.5140          0.2245
```

```
0.1010
1   0.350     0.265   0.090        0.2255          0.0995
0.0485
2   0.530     0.420   0.135        0.6770          0.2565
0.1415
3   0.440     0.365   0.125        0.5160          0.2155
0.1140
4   0.330     0.255   0.080        0.2050          0.0895
0.0395
```

	Shell weight	age	Sex_F	Sex_I	Sex_M
0	0.150	16.5	0	0	1
1	0.070	8.5	0	0	1
2	0.210	10.5	1	0	0
3	0.155	11.5	0	0	1
4	0.055	8.5	0	1	0

Dependent and Independent Variables

```
x = abalone.iloc[:, 0:1].values

y = abalone.iloc[:, 1]

x
```

```
array([[0.455],
       [0.35 ],
       [0.53 ],
       ...,
       [0.6  ],
       [0.625],
       [0.71 ]])

y
```

```
0       0.365
1       0.265
2       0.420
3       0.365
4       0.255
        ...
4172    0.450
4173    0.440
4174    0.475
4175    0.485
4176    0.555
Name: Diameter, Length: 3995, dtype: float64
```

Scaling the Independent Variables

```
print ("\n ORIGINAL VALUES: \n\n", x,y)
```

```
 ORIGINAL VALUES:

 [[0.455]
 [0.35 ]
 [0.53 ]
 ...
 [0.6  ]
 [0.625]
 [0.71 ]] 0       0.365
1       0.265
2       0.420
3       0.365
4       0.255
        ...
4172    0.450
4173    0.440
4174    0.475
4175    0.485
4176    0.555
Name: Diameter, Length: 3995, dtype: float64
```

```
from sklearn import preprocessing
min_max_scaler = preprocessing.MinMaxScaler(feature_range =(0, 1))
new_y= min_max_scaler.fit_transform(x,y)
print ("\n VALUES AFTER MIN MAX SCALING: \n\n", new_y)
```

```
 VALUES AFTER MIN MAX SCALING:

 [[0.51587302]
 [0.34920635]
 [0.63492063]
 ...
 [0.74603175]
 [0.78571429]
 [0.92063492]]
```

Split the data into Training and Testing

```
X = abalone.drop('age', axis = 1)
y = abalone['age']
```

```
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn.feature_selection import SelectKBest
```

```
standardScale = StandardScaler()
standardScale.fit_transform(X)

selectkBest = SelectKBest()
X_new = selectkBest.fit_transform(X, y)

X_train, X_test, y_train, y_test = train_test_split(X_new, y,
test_size = 0.25)
```

Build the model

Linear Regression

```
from sklearn import linear_model as lm
from sklearn.linear_model import LinearRegression
model=lm.LinearRegression()
results=model.fit(X_train,y_train)

accuracy = model.score(X_train, y_train)
print('Accuracy of the model:', accuracy)
```

```
Accuracy of the model: 0.523907384638246
```

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

```
LinearRegression()
```

```
y_train_pred = lm.predict(X_train)
y_test_pred = lm.predict(X_test)
```

Training the model

```
X_train
```

```
array([[0.61 , 0.46 , 0.145, ..., 1.   , 0.   , 0.   ],
       [0.525, 0.415, 0.15 , ..., 1.   , 0.   , 0.   ],
       [0.45 , 0.33 , 0.105, ..., 0.   , 1.   , 0.   ],
       ...,
       [0.4  , 0.32 , 0.095, ..., 0.   , 0.   , 1.   ],
       [0.37 , 0.275, 0.1  , ..., 0.   , 1.   , 0.   ],
       [0.72 , 0.55 , 0.2  , ..., 1.   , 0.   , 0.   ]])
```

```
y_train
```

```
1923    11.5
2755    11.5
1089     8.5
1710    11.5
```

```
1544     7.5
        ...
3873     6.5
3201     7.5
51       8.5
680      8.5
1200    11.5
Name: age, Length: 2996, dtype: float64
```

```
from sklearn.metrics import mean_absolute_error, mean_squared_error
s = mean_squared_error(y_train, y_train_pred)
print('Mean Squared error of training set :%2f'%s)
```

```
Mean Squared error of training set :3.682301
```

Testing the model

```
X_test
```

```
array([[0.445, 0.34 , 0.12 , ..., 0.   , 0.   , 1.   ],
       [0.33 , 0.265, 0.085, ..., 0.   , 1.   , 0.   ],
       [0.62 , 0.525, 0.155, ..., 0.   , 0.   , 1.   ],
       ...,
       [0.61 , 0.495, 0.19 , ..., 1.   , 0.   , 0.   ],
       [0.615, 0.465, 0.15 , ..., 1.   , 0.   , 0.   ],
       [0.6  , 0.465, 0.165, ..., 0.   , 0.   , 1.   ]])
```

```
y_test
```

```
2185    10.5
907      7.5
3683    11.5
380     16.5
3838     9.5
        ...
823      7.5
2552     7.5
3247    16.5
1165    10.5
2922    12.5
Name: age, Length: 999, dtype: float64
```

```
p = mean_squared_error(y_test, y_test_pred)
print('Mean Squared error of testing set :%2f'%p)
```

```
Mean Squared error of testing set :3.215477
```

```
from sklearn.metrics import r2_score
s = r2_score(y_train, y_train_pred)
print('R2 Score of training set:%.2f'%s)
```

```
R2 Score of training set:0.52
```

```
from sklearn.metrics import r2_score
p = r2_score(y_test, y_test_pred)
print('R2 Score of testing set:%.2f'%p)
```

```
R2 Score of testing set:0.56
```