ASSIGNMENT 4

IMPORTING LIBRARIES

In [1]:

```
import pandas as pd
import numpy as np
from matplotlib import pyplot as plt
import seaborn as sns
from sklearn.linear_model import LinearRegression
```

2. Load the dataset into the Google Colab

In [2]:

```
df=pd.read_csv("/content/abalone.csv")
```

In [3]:

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

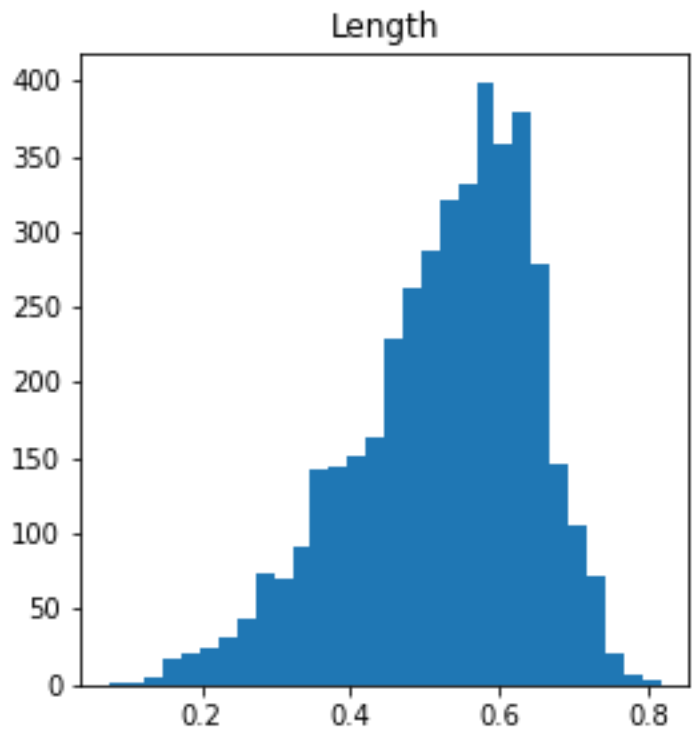
3. UNIVARIATE ANALYSIS

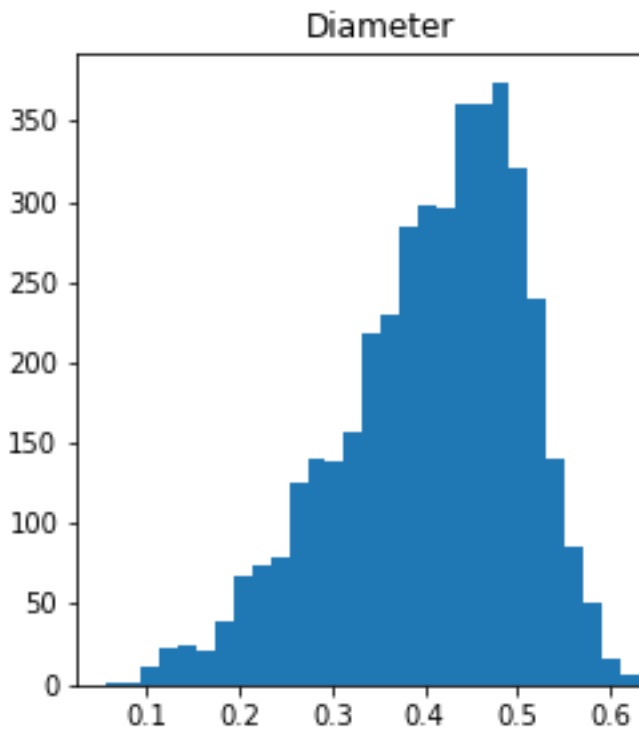
In [4]:

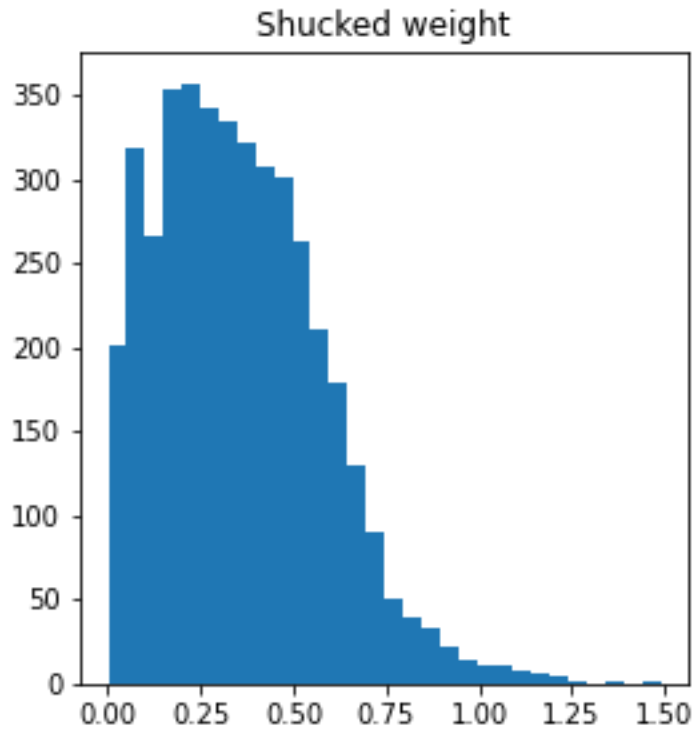
```
df.hist(figsize=(20,10), grid=False, layout=(2, 4), bins = 30)
```

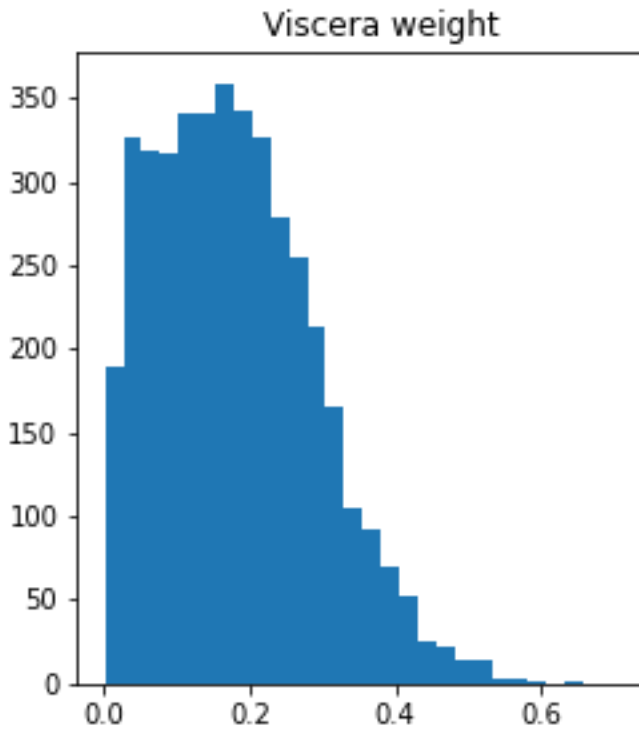
Out[4]:

```
array([[,
        ,
        ,
        ],
       [,
        ,
        ,
        ]],
      dtype=object)
```









In [5]:

```
df.groupby('Sex')[['Length', 'Diameter', 'Height', 'Whole weight', 'Shucked
weight',
       'Viscera weight', 'Shell weight', 'age']].mean().sort_values('age')
```

Out[5]:

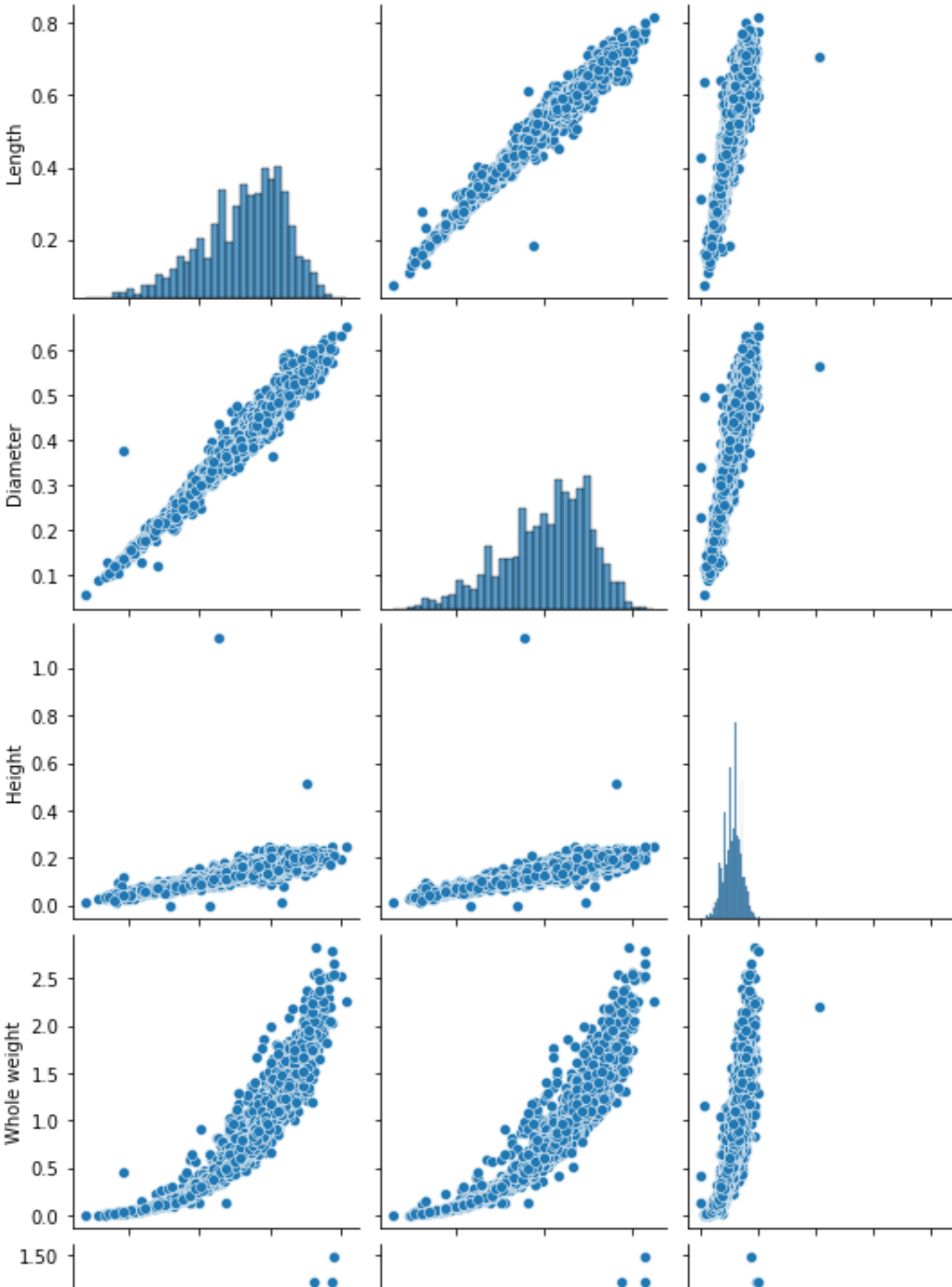
Sex	Length	Diameter	Height	Whole weight	Shucked weight	Viscera weight	Shell weight	age
I	0.427746	0.326494	0.107996	0.431363	0.191035	0.092010	0.128182	9.390462
M	0.561391	0.439287	0.151381	0.991459	0.432946	0.215545	0.281969	12.205497
F	0.579093	0.454732	0.158011	1.046532	0.446188	0.230689	0.302010	12.629304

3. BIVARIATE ANALYSIS & MULTIVARIATE ANALYSIS

In [6]:

```
numerical_features = df.select_dtypes(include = [np.number]).columns
sns.pairplot(df[numerical_features])
```

Out[6]:


Length
Diameter
Height
Whole weight
0.8
0.6
0.4
0.2
0.6
0.5
0.4
0.3
0.2
0.1
1.0
0.8
0.6
0.4
0.2
0.0
2.5
2.0
1.5
1.0
0.5
0.0
1.50

4. Descriptive statistics

In [7]:

```
df.describe()
```

Out[7]:

	Length	Diameter	Height	Whole weight	Shucked weight	Viscera weight	Shell weight	age
count	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000
mean	0.523992	0.407881	0.139516	0.828742	0.359367	0.180594	0.238831	11.433684
std	0.120093	0.099240	0.041827	0.490389	0.221963	0.109614	0.139203	3.224169
min	0.075000	0.055000	0.000000	0.002000	0.001000	0.000500	0.001500	2.500000
25%	0.450000	0.350000	0.115000	0.441500	0.186000	0.093500	0.130000	9.500000
50%	0.545000	0.425000	0.140000	0.799500	0.336000	0.171000	0.234000	10.500000
75%	0.615000	0.480000	0.165000	1.153000	0.502000	0.253000	0.329000	12.500000
max	0.815000	0.650000	1.130000	2.825500	1.488000	0.760000	1.005000	30.500000

5. Check for Missing Values

In [8]:

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

Out[8]:

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

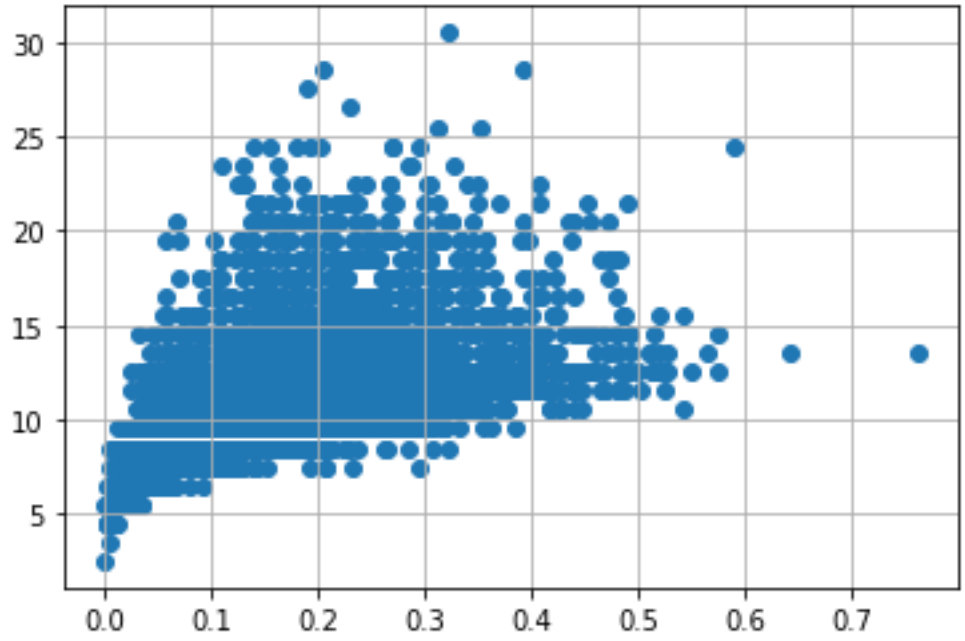
6. OUTLIER HANDLING

In [9]:

```
df = pd.get_dummies(df)
dummy_data = df.copy()
```

In [10]:

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

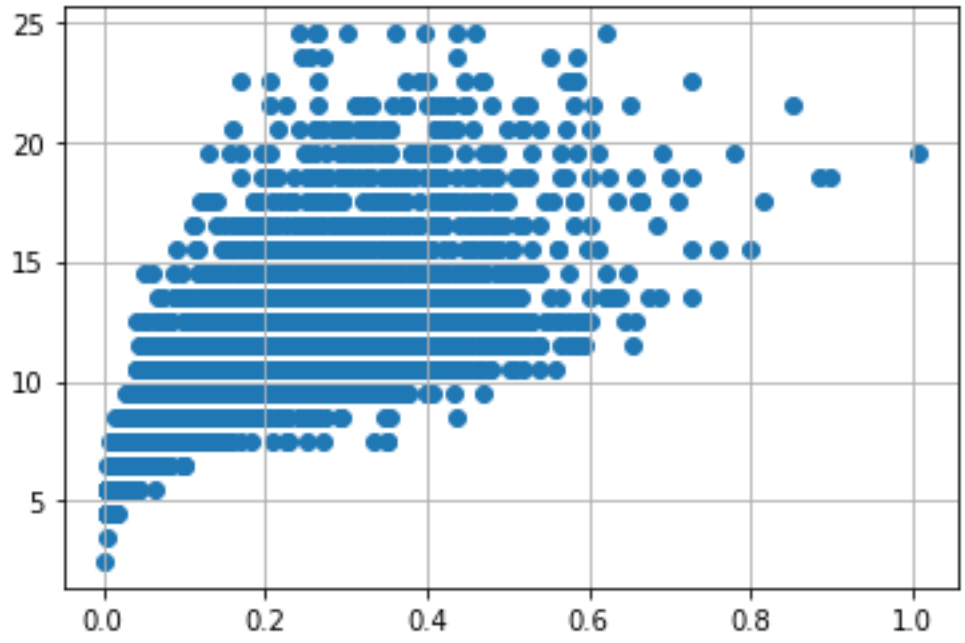


In [11]:

```
# outliers removal
df.drop(df[(df['Viscera weight']> 0.5) & (df['age'] < 20)].index,
inplace=True)
df.drop(df[(df['Viscera weight']<0.5) & (df['age'] > 25)].index,
inplace=True)
```

In [12]:

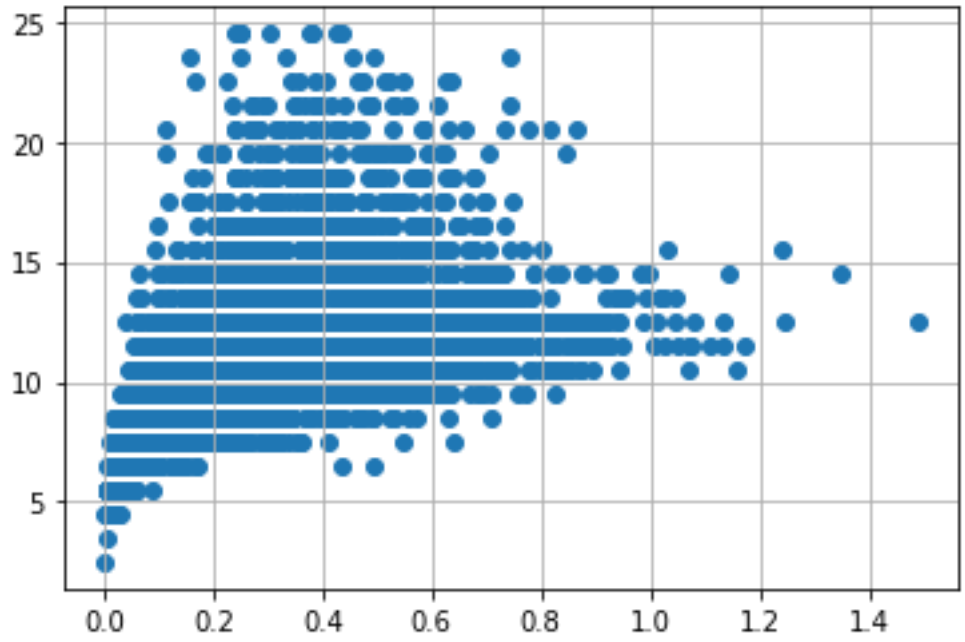
```
var = 'Shell weight'
plt.scatter(x = df[var], y = df['age'],)
plt.grid(True)
#Outliers removal
df.drop(df[(df['Shell weight']> 0.6) & (df['age'] < 25)].index, inplace=True)
df.drop(df[(df['Shell weight']<0.8) & (df['age'] > 25)].index, inplace=True)
```



In [13]:

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

#Outlier removal
df.drop(df[(df['Shucked weight']>= 1) & (df['age'] < 20)].index,
inplace=True)
df.drop(df[(df['Shucked weight']<1) & (df['age'] > 20)].index, inplace=True)
```

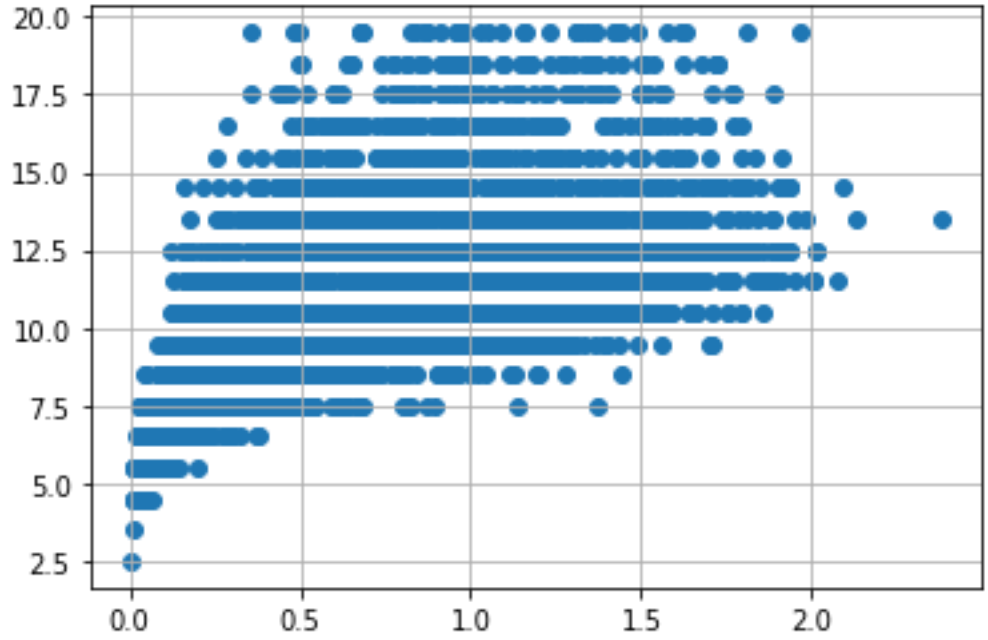


In [14]:

```
var = 'Whole weight'
```

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

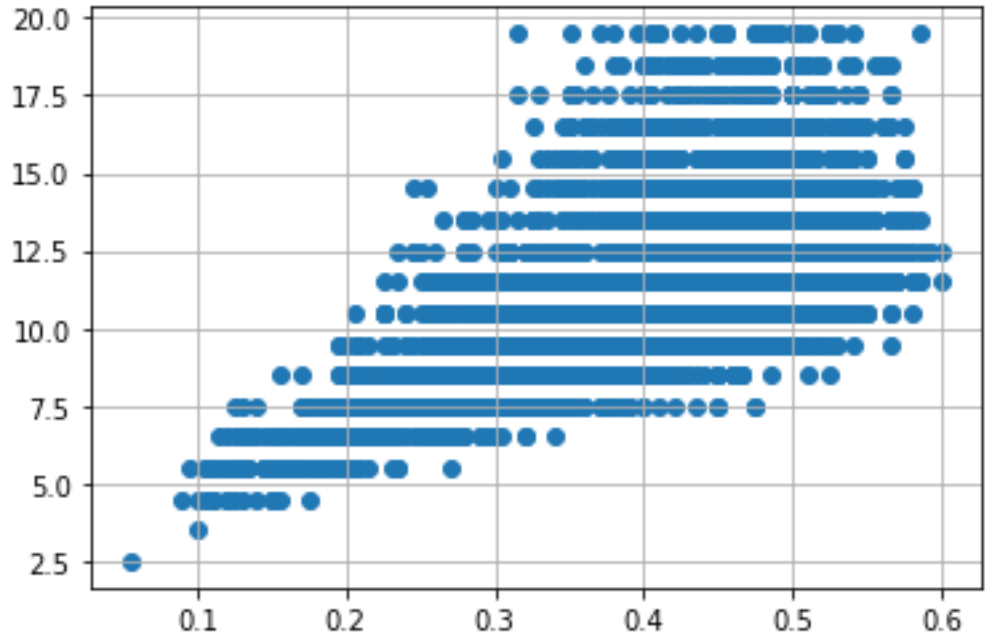
df.drop(df[(df['Whole weight'] >= 2.5) &
          (df['age'] < 25)].index, inplace = True)
df.drop(df[(df['Whole weight']<2.5) & (
df['age'] > 25)].index, inplace = True)
```



In [15]:

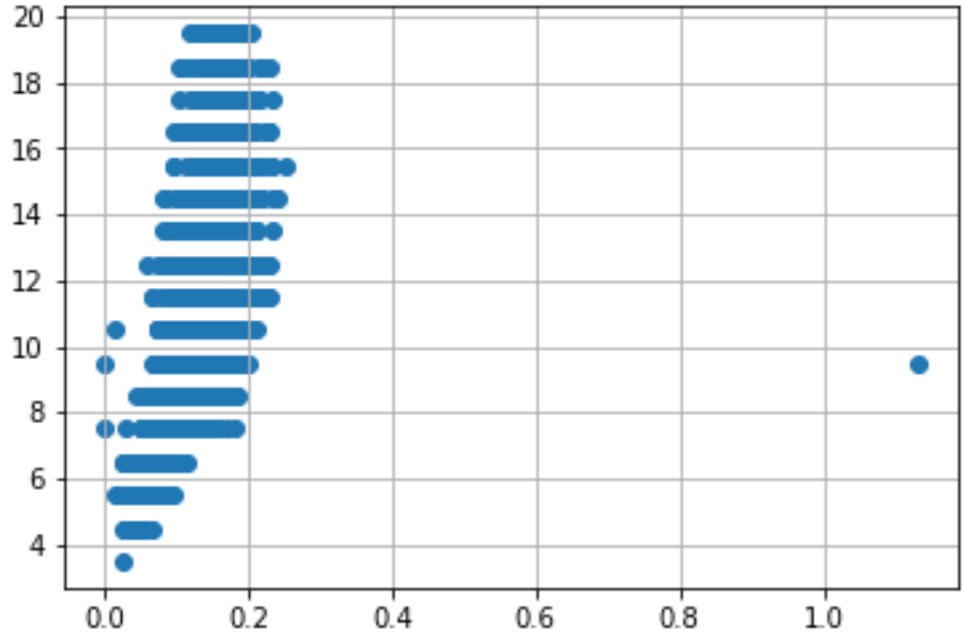
```
var = 'Diameter'
plt.scatter(x = df[var], y = df['age'])
plt.grid(True)

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



In [16]:

```
var = 'Height'
plt.scatter(x = df[var], y = df['age'])
plt.grid(True)
df.drop(df[(df['Height'] > 0.4) &
           (df['age'] < 15)].index, inplace = True)
df.drop(df[(df['Height']<0.4) & (
df['age'] > 25)].index, inplace = True)
```

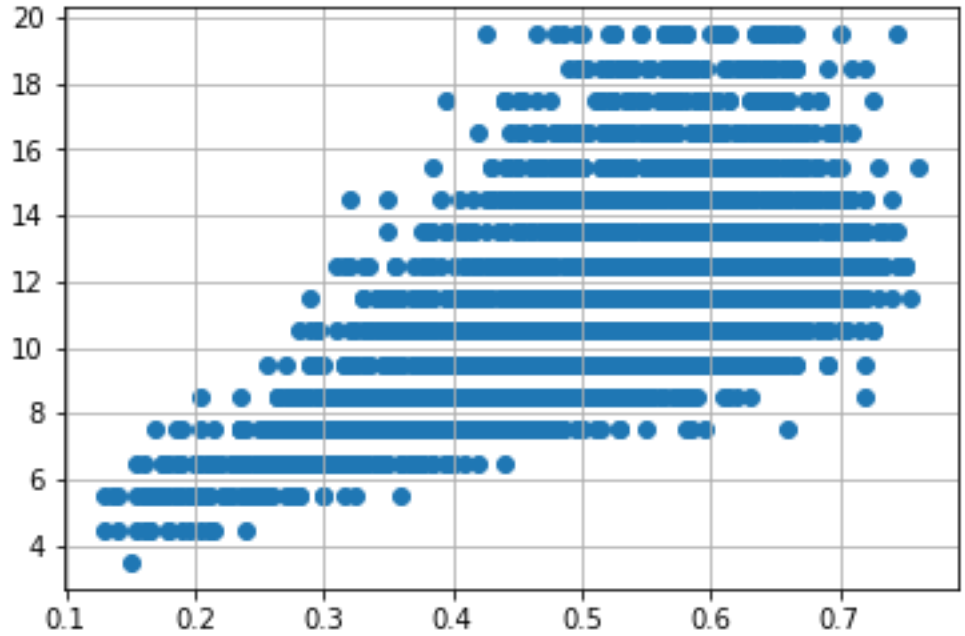


In [17]:

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

```
plt.grid(True)

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



7. Categorical columns

In [18]:

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

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:2: DeprecationWa
rning: `np.object` is a deprecated alias for the builtin `object`. To silence
this warning, use `object` by itself. Doing this will not modify any behavior
and is safe.
Deprecated in NumPy 1.20; for more details and guidance: https://numpy.org/de
vdocs/release/1.20.0-notes.html#deprecations
```

In [19]:

```
numerical_features
```

Out[19]:

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

In [20]:

```
categorical_features
```

Out[20]:

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

ENCODING

In [21]:

```
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
print(df.Length.value_counts())
```

```
0.575    93
0.625    91
0.580    89
0.550    89
0.620    83
         ..
0.220     2
0.150     1
0.755     1
0.135     1
0.760     1
Name: Length, Length: 126, dtype: int64
```

8. Split the dependent and independent variables

In [22]:

```
x=df.iloc[:,:5]
x
```

Out[22]:

	Length	Diameter	Height	Whole weight	Shucked weight
0	0.455	0.365	0.095	0.5140	0.2245
1	0.350	0.265	0.090	0.2255	0.0995
2	0.530	0.420	0.135	0.6770	0.2565
3	0.440	0.365	0.125	0.5160	0.2155
4	0.330	0.255	0.080	0.2050	0.0895
...	...	...	...	...	...
4172	0.565	0.450	0.165	0.8870	0.3700

	Length	Diameter	Height	Whole weight	Shucked weight
4173	0.590	0.440	0.135	0.9660	0.4390
4174	0.600	0.475	0.205	1.1760	0.5255
4175	0.625	0.485	0.150	1.0945	0.5310
4176	0.710	0.555	0.195	1.9485	0.9455

3995 rows × 5 columns

In [23]:

```
y=df.iloc[:,5:]
y
```

Out[23]:

	Viscera weight	Shell weight	age	Sex_F	Sex_I	Sex_M
0	0.1010	0.1500	16.5	0	0	1
1	0.0485	0.0700	8.5	0	0	1
2	0.1415	0.2100	10.5	1	0	0
3	0.1140	0.1550	11.5	0	0	1
4	0.0395	0.0550	8.5	0	1	0
...	...	...	...	...	...	...
4172	0.2390	0.2490	12.5	1	0	0
4173	0.2145	0.2605	11.5	0	0	1
4174	0.2875	0.3080	10.5	0	0	1
4175	0.2610	0.2960	11.5	1	0	0

	Viscera weight	Shell weight	age	Sex_F	Sex_I	Sex_M
4176	0.3765	0.4950	13.5	0	0	1

3995 rows × 6 columns

9. Feature Scaling

In [24]:

```
from sklearn.preprocessing import StandardScaler
ss=StandardScaler()
x_train=ss.fit_transform(x_train)
```

In [25]:

```
mlrpred=mlr.predict(x_test[0:9])
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/base.py:444: UserWarning: X ha
s feature names, but LinearRegression was fitted without feature names
  f"X has feature names, but {self.__class__.__name__} was fitted without"
```

In [26]:

```
mlrpred
```

Out[26]:

```
array([[ 0.23339315,  0.30675115, 12.64851662,  0.41303667,  0.21495648,
         0.37200685],
       [ 0.29781617,  0.38717341, 13.7465214 ,  0.49950512,  0.07794454,
         0.42255034],
       [ 0.31212505,  0.40571258, 14.08610548,  0.51832591,  0.0551311 ,
         0.42654299],
       [ 0.28929529,  0.37330035, 13.37905462,  0.47977802,  0.10981522,
         0.41040676],
       [ 0.27398024,  0.35592095, 13.33560842,  0.45982985,  0.14616275,
         0.39400739],
       [ 0.26092694,  0.34070882, 13.08733159,  0.44915929,  0.1554206 ,
         0.3954201 ],
       [ 0.28798179,  0.37424621, 13.57347267,  0.48251798,  0.10441507,
         0.41306695],
       [ 0.35187797,  0.45729677, 14.8824873 ,  0.57548893, -0.03481323,
         0.45932431],
       [ 0.19358839,  0.2544071 , 11.75629202,  0.35124826,  0.30061553,
         0.34813621]])
```

10. Train , Test , Split

In [27]:

```
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)
```

11. Model building

In [28]:

```
from sklearn.linear_model import LinearRegression
mlr=LinearRegression()
mlr.fit(x_train,y_train)
```

Out[28]:

```
LinearRegression()
```

12 & 13. Train and Test the model

In [29]:

```
x_test[0:5]
```

Out[29]:

	Length	Diameter	Height	Whole weight	Shucked weight
144	0.475	0.375	0.130	0.5175	0.2075
2783	0.600	0.495	0.185	1.1145	0.5055
4139	0.635	0.495	0.175	1.2355	0.5205
2801	0.640	0.515	0.080	1.0420	0.5150
3185	0.590	0.415	0.150	0.8805	0.3645

In [30]:

```
y_test[0:5]
```

Out[30]:

	Viscera weight	Shell weight	age	Sex_F	Sex_I	Sex_M
144	0.1165	0.170	11.5	0	0	1
2783	0.2635	0.367	12.5	0	0	1
4139	0.3085	0.347	11.5	1	0	0
2801	0.1755	0.175	11.5	0	0	1
3185	0.2340	0.235	12.5	1	0	0

14. Measure the performance using metrics

In [31]:

```
from sklearn.metrics import r2_score
r2_score(mlr.predict(x_test),y_test)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/base.py:444: UserWarning: X ha
s feature names, but LinearRegression was fitted without feature names
  f"X has feature names, but {self.__class__.__name__} was fitted without"
```

Out[31]:

```
-48.09199504251874
```

IMPORTING LIBRARIES

In [1]:

```
import pandas as pd
import numpy as np
from matplotlib import pyplot as plt
import seaborn as sns
from sklearn.linear_model import LinearRegression
```

2. Load the dataset into the Google Colab

In [2]:

```
df=pd.read_csv("/content/abalone.csv")
```

In [3]:

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

3. UNIVARIATE ANALYSIS

In [4]:

```
df.hist(figsize=(20,10), grid=False, layout=(2, 4), bins = 30)
```

Out[4]:

```
array([[,
        ,
        ,
        ],
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        ,
        ,
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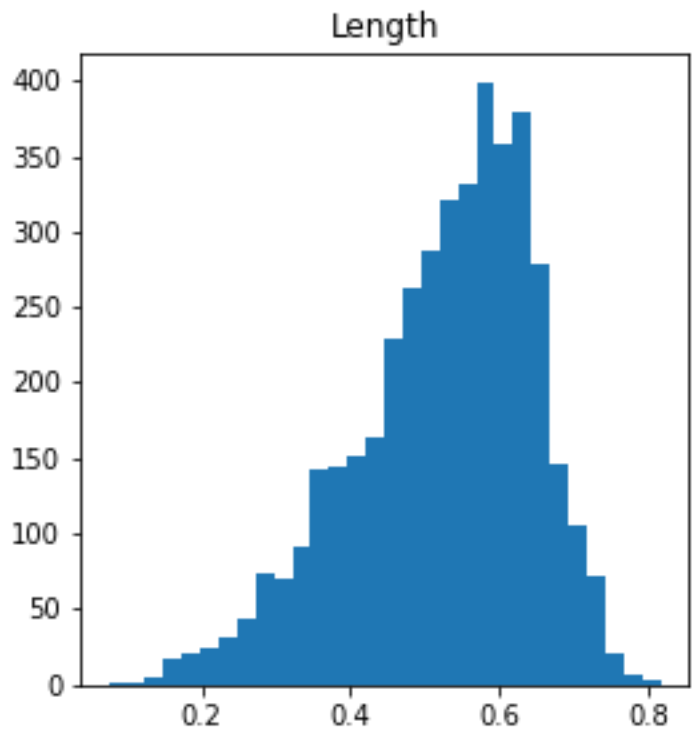

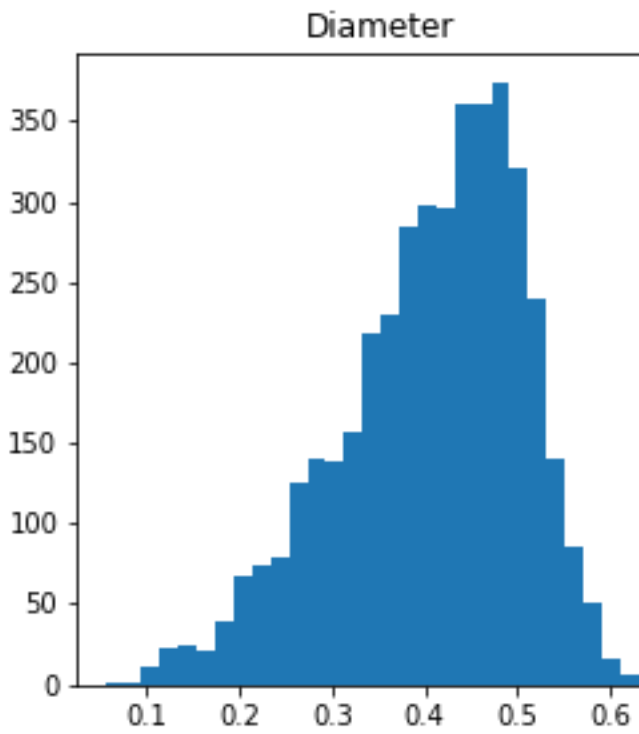

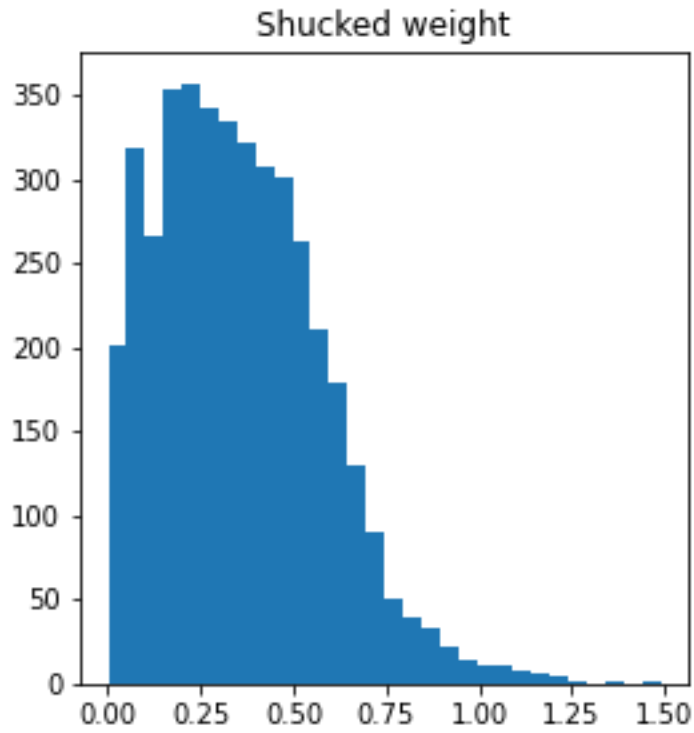

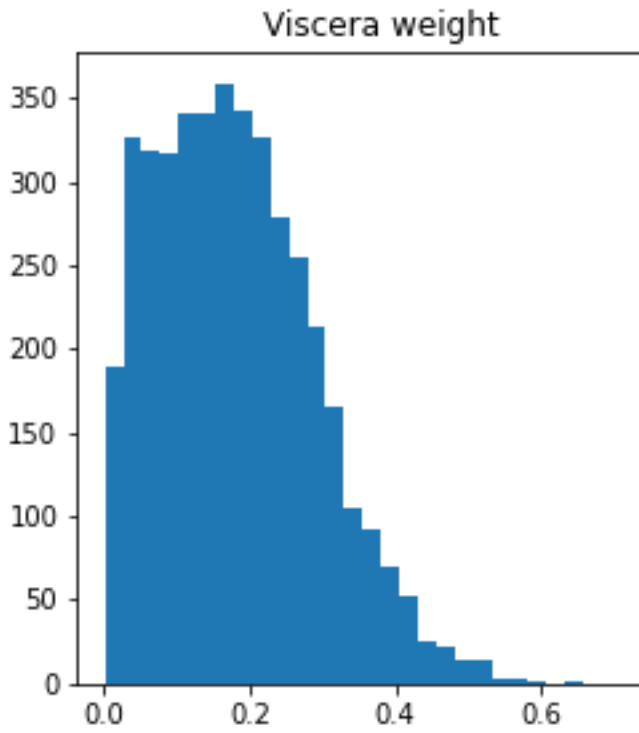

In [5]:

```
df.groupby('Sex')[['Length', 'Diameter', 'Height', 'Whole weight', 'Shucked
weight',
       'Viscera weight', 'Shell weight', 'age']].mean().sort_values('age')
```

Out[5]:

Sex	Length	Diameter	Height	Whole weight	Shucked weight	Viscera weight	Shell weight	age
I	0.427746	0.326494	0.107996	0.431363	0.191035	0.092010	0.128182	9.390462
M	0.561391	0.439287	0.151381	0.991459	0.432946	0.215545	0.281969	12.205497
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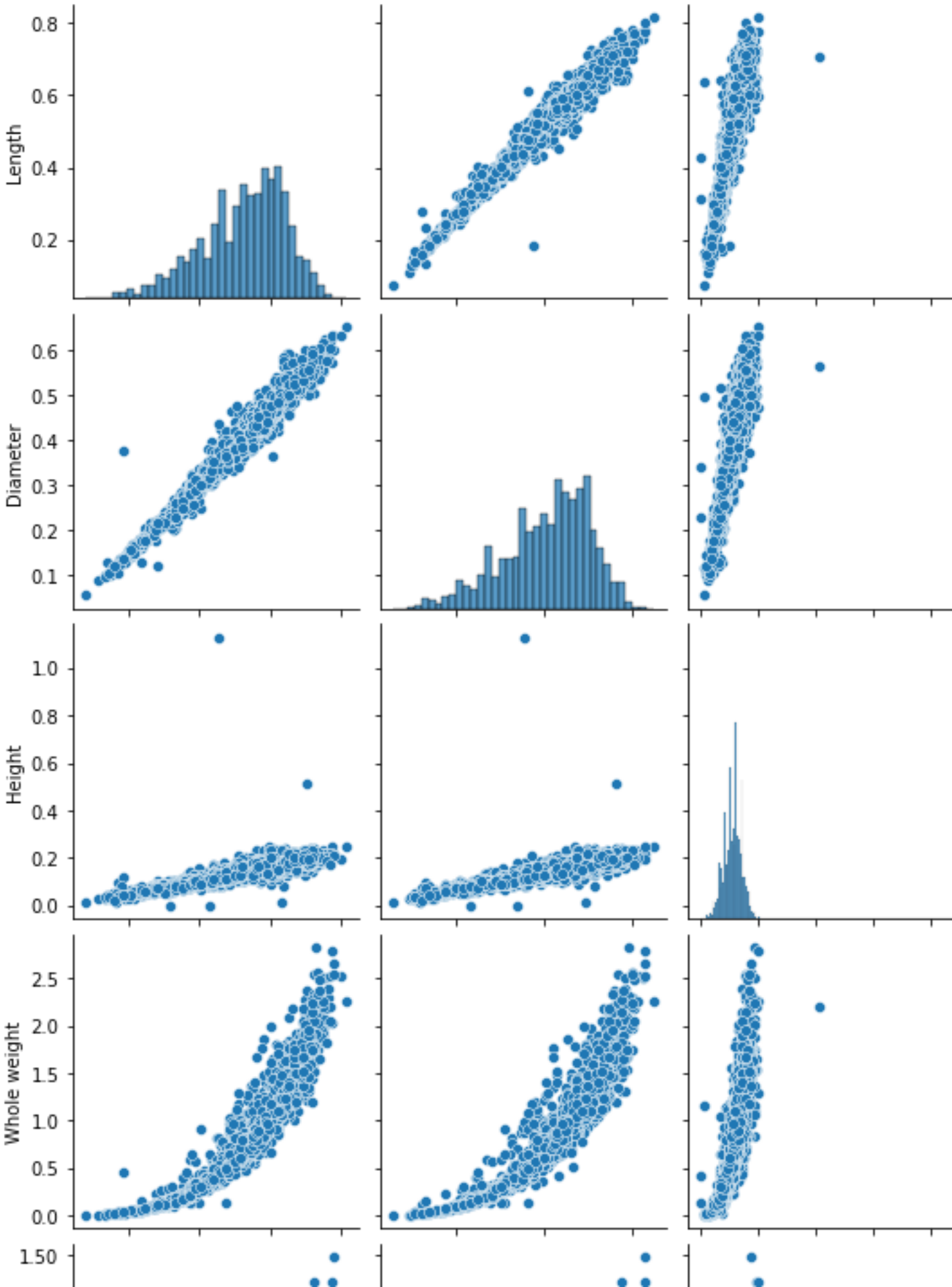
In [6]:

```
numerical_features = df.select_dtypes(include = [np.number]).columns
sns.pairplot(df[numerical_features])
```

Out[6]:


Length
Diameter
Height
Whole weight
0.8
0.6
0.4
0.2
0.6
0.5
0.4
0.3
0.2
0.1
1.0
0.8
0.6
0.4
0.2
0.0
2.5
2.0
1.5
1.0
0.5
0.0
1.50

4. Descriptive statistics

In [7]:

```
df.describe()
```

Out[7]:

	Length	Diameter	Height	Whole weight	Shucked weight	Viscera weight	Shell weight	age
count	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000
mean	0.523992	0.407881	0.139516	0.828742	0.359367	0.180594	0.238831	11.433684
std	0.120093	0.099240	0.041827	0.490389	0.221963	0.109614	0.139203	3.224169
min	0.075000	0.055000	0.000000	0.002000	0.001000	0.000500	0.001500	2.500000
25%	0.450000	0.350000	0.115000	0.441500	0.186000	0.093500	0.130000	9.500000
50%	0.545000	0.425000	0.140000	0.799500	0.336000	0.171000	0.234000	10.500000
75%	0.615000	0.480000	0.165000	1.153000	0.502000	0.253000	0.329000	12.500000
max	0.815000	0.650000	1.130000	2.825500	1.488000	0.760000	1.005000	30.500000

5. Check for Missing Values

In [8]:

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

Out[8]:

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

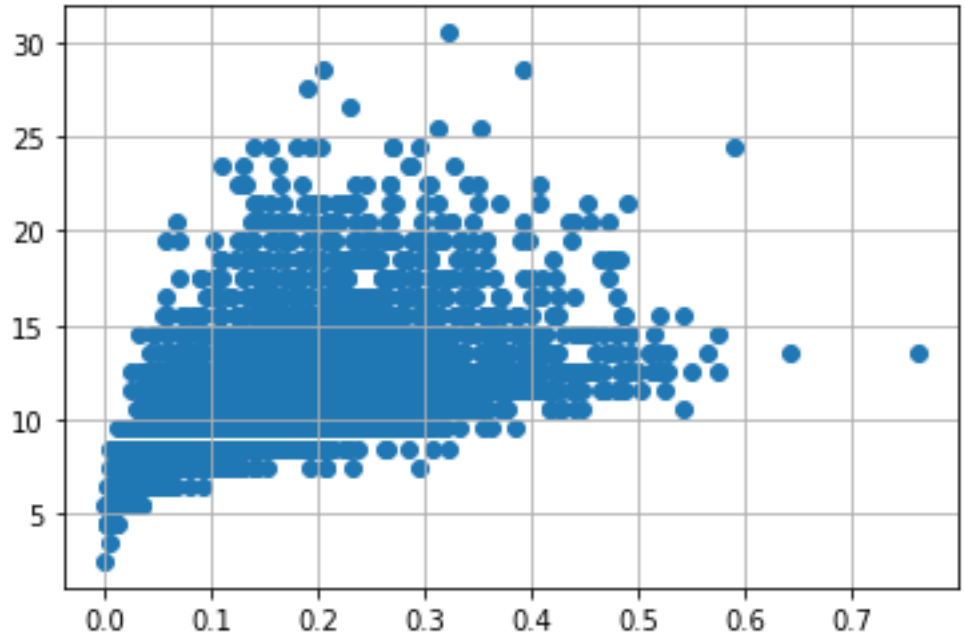
6. OUTLIER HANDLING

In [9]:

```
df = pd.get_dummies(df)
dummy_data = df.copy()
```

In [10]:

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

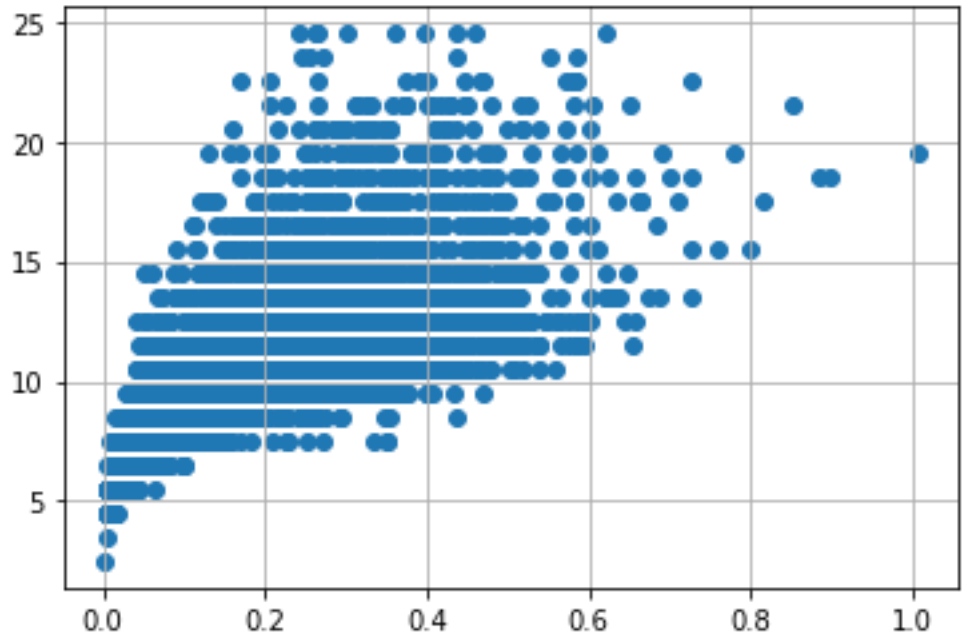


In [11]:

```
# outliers removal
df.drop(df[(df['Viscera weight']> 0.5) & (df['age'] < 20)].index,
inplace=True)
df.drop(df[(df['Viscera weight']<0.5) & (df['age'] > 25)].index,
inplace=True)
```

In [12]:

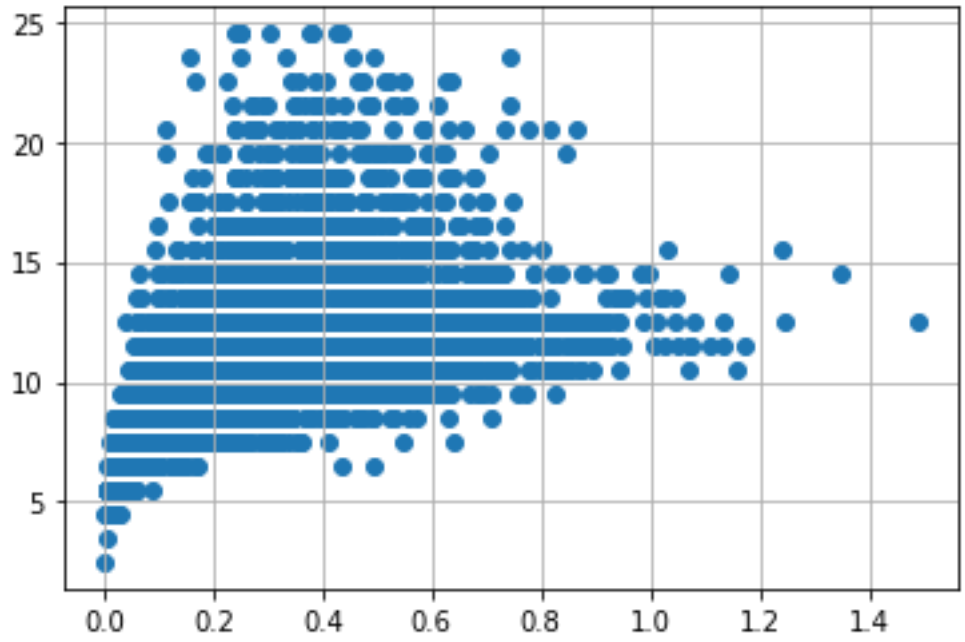
```
var = 'Shell weight'
plt.scatter(x = df[var], y = df['age'],)
plt.grid(True)
#Outliers removal
df.drop(df[(df['Shell weight']> 0.6) & (df['age'] < 25)].index, inplace=True)
df.drop(df[(df['Shell weight']<0.8) & (df['age'] > 25)].index, inplace=True)
```



In [13]:

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

#Outlier removal
df.drop(df[(df['Shucked weight']>= 1) & (df['age'] < 20)].index,
inplace=True)
df.drop(df[(df['Shucked weight']<1) & (df['age'] > 20)].index, inplace=True)
```

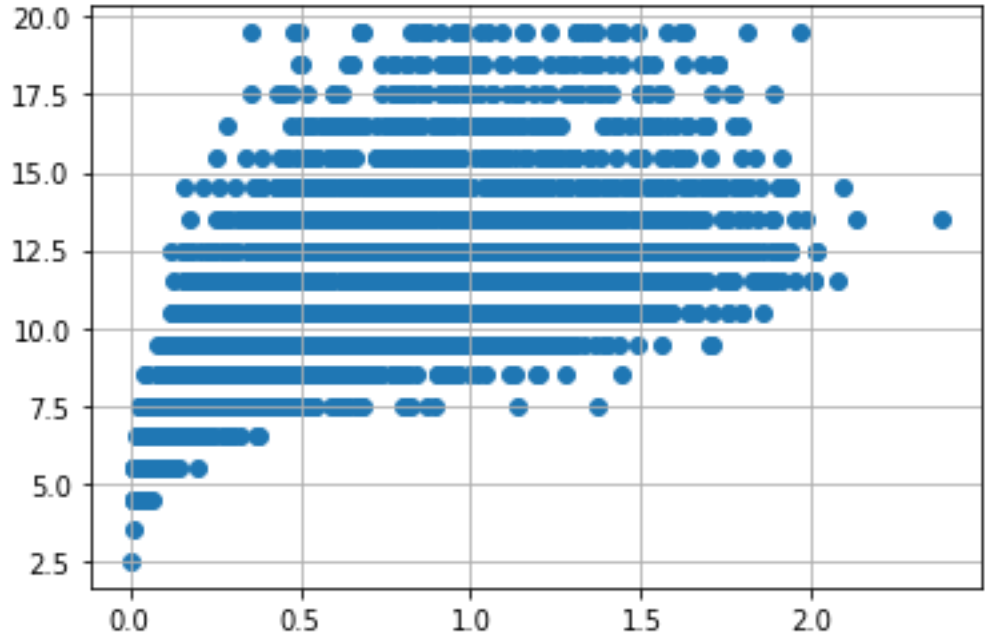


In [14]:

```
var = 'Whole weight'
```

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

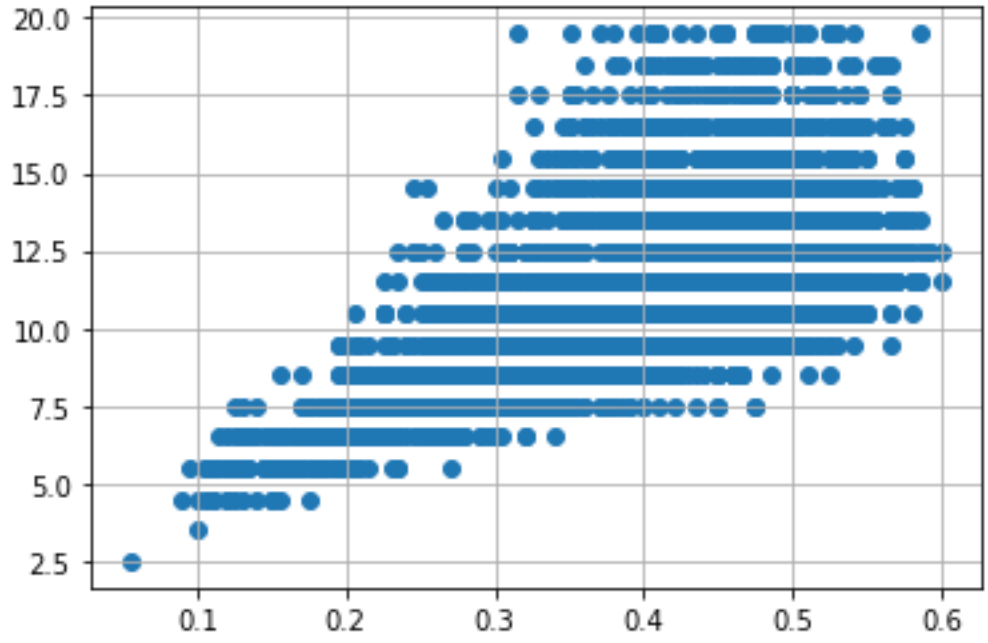
df.drop(df[(df['Whole weight'] >= 2.5) &
          (df['age'] < 25)].index, inplace = True)
df.drop(df[(df['Whole weight']<2.5) & (
df['age'] > 25)].index, inplace = True)
```



In [15]:

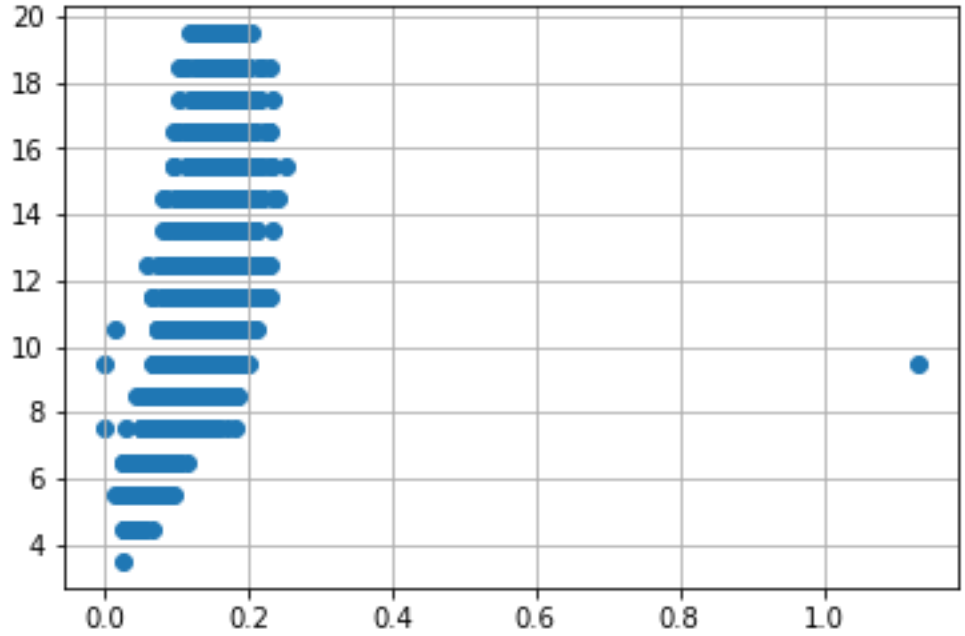
```
var = 'Diameter'
plt.scatter(x = df[var], y = df['age'])
plt.grid(True)

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



In [16]:

```
var = 'Height'
plt.scatter(x = df[var], y = df['age'])
plt.grid(True)
df.drop(df[(df['Height'] > 0.4) &
           (df['age'] < 15)].index, inplace = True)
df.drop(df[(df['Height']<0.4) & (
df['age'] > 25)].index, inplace = True)
```

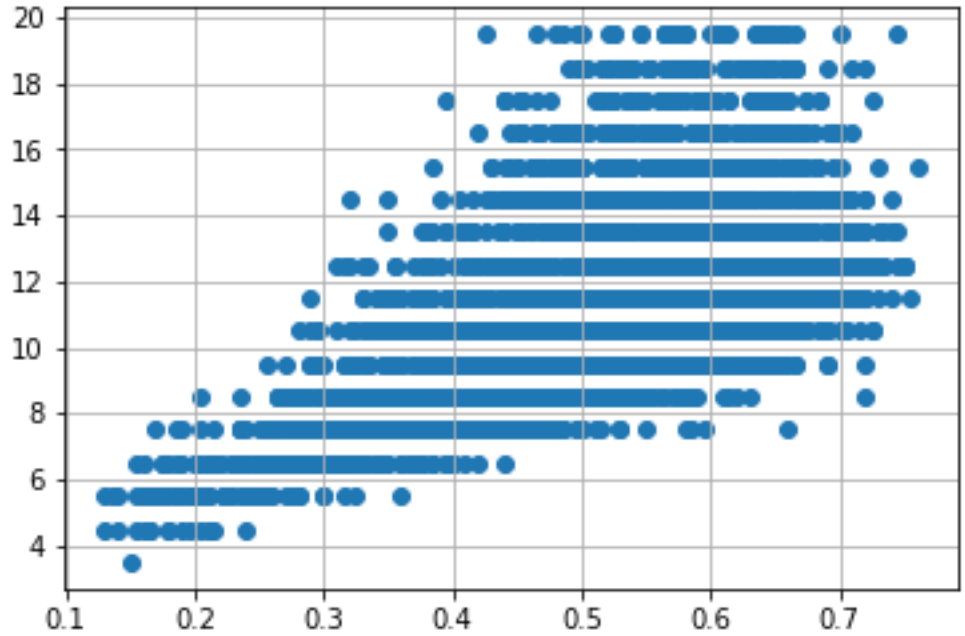


In [17]:

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

```
plt.grid(True)

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



7. Categorical columns

In [18]:

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

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:2: DeprecationWa
rning: `np.object` is a deprecated alias for the builtin `object`. To silence
this warning, use `object` by itself. Doing this will not modify any behavior
and is safe.
Deprecated in NumPy 1.20; for more details and guidance: https://numpy.org/de
vdocs/release/1.20.0-notes.html#deprecations
```

In [19]:

```
numerical_features
```

Out[19]:

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

In [20]:

```
categorical_features
```

Out[20]:

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

ENCODING

In [21]:

```
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
print(df.Length.value_counts())
```

```
0.575    93
0.625    91
0.580    89
0.550    89
0.620    83
         ..
0.220     2
0.150     1
0.755     1
0.135     1
0.760     1
Name: Length, Length: 126, dtype: int64
```

8. Split the dependent and independent variables

In [22]:

```
x=df.iloc[:,:5]
x
```

Out[22]:

	Length	Diameter	Height	Whole weight	Shucked weight
0	0.455	0.365	0.095	0.5140	0.2245
1	0.350	0.265	0.090	0.2255	0.0995
2	0.530	0.420	0.135	0.6770	0.2565
3	0.440	0.365	0.125	0.5160	0.2155
4	0.330	0.255	0.080	0.2050	0.0895
...	...	...	...	...	...
4172	0.565	0.450	0.165	0.8870	0.3700

	Length	Diameter	Height	Whole weight	Shucked weight
4173	0.590	0.440	0.135	0.9660	0.4390
4174	0.600	0.475	0.205	1.1760	0.5255
4175	0.625	0.485	0.150	1.0945	0.5310
4176	0.710	0.555	0.195	1.9485	0.9455

3995 rows × 5 columns

In [23]:

```
y=df.iloc[:,5:]
y
```

Out[23]:

	Viscera weight	Shell weight	age	Sex_F	Sex_I	Sex_M
0	0.1010	0.1500	16.5	0	0	1
1	0.0485	0.0700	8.5	0	0	1
2	0.1415	0.2100	10.5	1	0	0
3	0.1140	0.1550	11.5	0	0	1
4	0.0395	0.0550	8.5	0	1	0
...	...	...	...	...	...	...
4172	0.2390	0.2490	12.5	1	0	0
4173	0.2145	0.2605	11.5	0	0	1
4174	0.2875	0.3080	10.5	0	0	1
4175	0.2610	0.2960	11.5	1	0	0

	Viscera weight	Shell weight	age	Sex_F	Sex_I	Sex_M
4176	0.3765	0.4950	13.5	0	0	1

3995 rows × 6 columns

9. Feature Scaling

In [24]:

```
from sklearn.preprocessing import StandardScaler
ss=StandardScaler()
x_train=ss.fit_transform(x_train)
```

In [25]:

```
mlrpred=mlr.predict(x_test[0:9])
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/base.py:444: UserWarning: X ha
s feature names, but LinearRegression was fitted without feature names
  f"X has feature names, but {self.__class__.__name__} was fitted without"
```

In [26]:

```
mlrpred
```

Out[26]:

```
array([[ 0.23339315,  0.30675115, 12.64851662,  0.41303667,  0.21495648,
         0.37200685],
       [ 0.29781617,  0.38717341, 13.7465214 ,  0.49950512,  0.07794454,
         0.42255034],
       [ 0.31212505,  0.40571258, 14.08610548,  0.51832591,  0.0551311 ,
         0.42654299],
       [ 0.28929529,  0.37330035, 13.37905462,  0.47977802,  0.10981522,
         0.41040676],
       [ 0.27398024,  0.35592095, 13.33560842,  0.45982985,  0.14616275,
         0.39400739],
       [ 0.26092694,  0.34070882, 13.08733159,  0.44915929,  0.1554206 ,
         0.3954201 ],
       [ 0.28798179,  0.37424621, 13.57347267,  0.48251798,  0.10441507,
         0.41306695],
       [ 0.35187797,  0.45729677, 14.8824873 ,  0.57548893, -0.03481323,
         0.45932431],
       [ 0.19358839,  0.2544071 , 11.75629202,  0.35124826,  0.30061553,
         0.34813621]])
```

10. Train , Test , Split

In [27]:

```
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)
```

11. Model building

In [28]:

```
from sklearn.linear_model import LinearRegression
mlr=LinearRegression()
mlr.fit(x_train,y_train)
```

Out[28]:

```
LinearRegression()
```

12 & 13. Train and Test the model

In [29]:

```
x_test[0:5]
```

Out[29]:

	Length	Diameter	Height	Whole weight	Shucked weight
144	0.475	0.375	0.130	0.5175	0.2075
2783	0.600	0.495	0.185	1.1145	0.5055
4139	0.635	0.495	0.175	1.2355	0.5205
2801	0.640	0.515	0.080	1.0420	0.5150
3185	0.590	0.415	0.150	0.8805	0.3645

In [30]:

```
y_test[0:5]
```

Out[30]:

	Viscera weight	Shell weight	age	Sex_F	Sex_I	Sex_M
144	0.1165	0.170	11.5	0	0	1
2783	0.2635	0.367	12.5	0	0	1
4139	0.3085	0.347	11.5	1	0	0
2801	0.1755	0.175	11.5	0	0	1
3185	0.2340	0.235	12.5	1	0	0

14. Measure the performance using metrics

In [31]:

```
from sklearn.metrics import r2_score
r2_score(mlr.predict(x_test),y_test)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/base.py:444: UserWarning: X ha
s feature names, but LinearRegression was fitted without feature names
  f"X has feature names, but {self.__class__.__name__} was fitted without"
```

Out[31]:

```
-48.09199504251874
```