Data Set Information:

Link of the dataset : https://archive.ics.uci.edu/ml/datasets/Algerian+Forest+Fires+Dataset++

The dataset includes 244 instances that regroup a data of two regions of Algeria,namely the Bejaia region located in the northeast of Algeria and the Sidi Bel-abbes region located in the northwest of Algeria.

122 instances for each region.

The period from June 2012 to September 2012. The dataset includes 11 attribues and 1 output attribue (class) The 244 instances have been classified into fire (138 classes) and not fire (106 classes) classes.

Attribute Information:

1. Date : (DD/MM/YYYY) Day, month ('june' to 'september'), year (2012) #### Weather data observations
2. Temp : temperature noon (temperature max) in Celsius degrees: 22 to 42
3. RH : Relative Humidity in %: 21 to 90
4. Ws :Wind speed in km/h: 6 to 29
5. Rain: total day in mm: 0 to 16.8 #### FWI Components
6. Fine Fuel Moisture Code (FFMC) index from the FWI system: 28.6 to 92.5
7. Duff Moisture Code (DMC) index from the FWI system: 1.1 to 65.9
8. Drought Code (DC) index from the FWI system: 7 to 220.4
9. Initial Spread Index (ISI) index from the FWI system: 0 to 18.5
10. Buildup Index (BUI) index from the FWI system: 1.1 to 68
11. Fire Weather Index (FWI) Index: 0 to 31.1
12. Classes: two classes, namely Fire and not Fire

In [1]:
```python
# importing necessary libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings("ignore")

%matplotlib inline
```

In [2]:
```python
forest_data = pd.read_csv("Algerian_forest_fires_dataset_UPDATE.csv",header=1)
```

In [3]:
```python
forest_data.head()
```

Out[3]:

	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes
0	01	06	2012	29	57	18	0	65.7	3.4	7.6	1.3	3.4	0.5	not fire
1	02	06	2012	29	61	13	1.3	64.4	4.1	7.6	1	3.9	0.4	not fire
2	03	06	2012	26	82	22	13.1	47.1	2.5	7.1	0.3	2.7	0.1	not fire
3	04	06	2012	25	89	13	2.5	28.6	1.3	6.9	0	1.7	0	not fire
4	05	06	2012	27	77	16	0	64.8	3	14.2	1.2	3.9	0.5	not fire

In [4]:
```python
forest_data.tail()
```

Out[4]:

	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes
241	26	09	2012	30	65	14	0	85.4	16	44.5	4.5	16.9	6.5	fire
242	27	09	2012	28	87	15	4.4	41.1	6.5	8	0.1	6.2	0	not fire
243	28	09	2012	27	87	29	0.5	45.9	3.5	7.9	0.4	3.4	0.2	not fire
244	29	09	2012	24	54	18	0.1	79.7	4.3	15.2	1.7	5.1	0.7	not fire
245	30	09	2012	24	64	15	0.2	67.3	3.8	16.5	1.2	4.8	0.5	not fire

In [5]:
```python
# Cloning the original dataset
df = forest_data.copy()
df.head()
```

Out[5]:

	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes
0	01	06	2012	29	57	18	0	65.7	3.4	7.6	1.3	3.4	0.5	not fire
1	02	06	2012	29	61	13	1.3	64.4	4.1	7.6	1	3.9	0.4	not fire
2	03	06	2012	26	82	22	13.1	47.1	2.5	7.1	0.3	2.7	0.1	not fire
3	04	06	2012	25	89	13	2.5	28.6	1.3	6.9	0	1.7	0	not fire
4	05	06	2012	27	77	16	0	64.8	3	14.2	1.2	3.9	0.5	not fire

In [6]:
```python
df.isnull().sum()
```

Out[6]:
```
day            0
month          1
year           1
Temperature    1
 RH            1
 Ws            1
Rain           1
FFMC           1
DMC            1
DC             1
ISI            1
BUI            1
FWI            1
Classes        2
dtype: int64
```

In [7]:
```python
# Categorizing the dataset into two halves for two regions for better visulization
df.loc[:122,'Region']=1
df.loc[122:,'Region']=2
df[['Region']] = df[['Region']].astype(int)
```

In [8]:
```python
df.info()
```
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 246 entries, 0 to 245
Data columns (total 15 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   day          246 non-null    object
 1   month        245 non-null    object
 2   year         245 non-null    object
 3   Temperature  245 non-null    object
 4    RH          245 non-null    object
 5    Ws          245 non-null    object
 6   Rain         245 non-null    object
 7   FFMC         245 non-null    object
 8   DMC          245 non-null    object
 9   DC           245 non-null    object
 10  ISI          245 non-null    object
 11  BUI          245 non-null    object
 12  FWI          245 non-null    object
 13  Classes      244 non-null    object
 14  Region       246 non-null    int32
dtypes: int32(1), object(14)
memory usage: 28.0+ KB
```

In [9]:
```python
df.describe(include='all')
```

Out[9]:

	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes	Region
count	246	245	245	245	245	245	245	245	245	245	245	245	245	244	246.000000
unique	33	5	2	20	63	19	40	174	167	199	107	175	128	9	NaN
top	01	07	2012	35	64	14	0	88.9	7.9	8	1.1	3	0.4	fire	NaN
freq	8	62	244	29	10	43	133	8	5	5	8	5	12	131	NaN
mean	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	1.504065
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
min	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	1.000000
25%	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	1.000000
50%	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2.000000
75%	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2.000000
max	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2.000000

In [10]:
```python
df.describe()
```

Out[10]:

	Region
count	246.000000
mean	1.504065
std	0.501003
min	1.000000
25%	1.000000
50%	2.000000
75%	2.000000
max	2.000000

In [11]:
```python
df.shape
```

Out[11]: (246, 15)

In [12]:
```python
df[df.isnull().any(axis=1)] #Checking the row containing the NaN values
```

Out[12]:

	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes	Region
122	Sidi-Bel Abbes Region Dataset	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2
167	14	07	2012	37	37	18	0.2	88.9	12.9	14.6 9	12.5	10.4	fire	NaN	2

In [13]:
```python
df.loc[:122,'Region']=1
df.loc[122:,'Region']=2
df[['Region']] = df[['Region']].astype(int)
```

In [14]:
```python
df.head()
```

Out[14]:

	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes	Region
0	01	06	2012	29	57	18	0	65.7	3.4	7.6	1.3	3.4	0.5	not fire	1
1	02	06	2012	29	61	13	1.3	64.4	4.1	7.6	1	3.9	0.4	not fire	1
2	03	06	2012	26	82	22	13.1	47.1	2.5	7.1	0.3	2.7	0.1	not fire	1
3	04	06	2012	25	89	13	2.5	28.6	1.3	6.9	0	1.7	0	not fire	1
4	05	06	2012	27	77	16	0	64.8	3	14.2	1.2	3.9	0.5	not fire	1

In [15]:
```python
df.tail()
```

Out[15]:

	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes	Region
241	26	09	2012	30	65	14	0	85.4	16	44.5	4.5	16.9	6.5	fire	2
242	27	09	2012	28	87	15	4.4	41.1	6.5	8	0.1	6.2	0	not fire	2
243	28	09	2012	27	87	29	0.5	45.9	3.5	7.9	0.4	3.4	0.2	not fire	2
244	29	09	2012	24	54	18	0.1	79.7	4.3	15.2	1.7	5.1	0.7	not fire	2
245	30	09	2012	24	64	15	0.2	67.3	3.8	16.5	1.2	4.8	0.5	not fire	2

In [16]:
```python
df =df.dropna().reset_index(drop=True)
df.shape
```

Out[16]: (244, 15)

In [17]:
```python
# Column which has string
df.iloc[[122]]
```

Out[17]:

	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes	Region
122	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes	2

In [18]:
```python
df[df.duplicated()]
```

Out[18]:

day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes	Region

In [19]:
```python
#removing 122th column
df1 = df.drop(122).reset_index(drop=True)
df1.head()
```

Out[19]:

	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes	Region
0	01	06	2012	29	57	18	0	65.7	3.4	7.6	1.3	3.4	0.5	not fire	1
1	02	06	2012	29	61	13	1.3	64.4	4.1	7.6	1	3.9	0.4	not fire	1
2	03	06	2012	26	82	22	13.1	47.1	2.5	7.1	0.3	2.7	0.1	not fire	1
3	04	06	2012	25	89	13	2.5	28.6	1.3	6.9	0	1.7	0	not fire	1
4	05	06	2012	27	77	16	0	64.8	3	14.2	1.2	3.9	0.5	not fire	1

In [20]:
```python
df1.columns
```

Out[20]:
```
Index(['day', 'month', 'year', 'Temperature', ' RH', ' Ws', 'Rain ', 'FFMC',
       'DMC', 'DC', 'ISI', 'BUI', 'FWI', 'Classes  ', 'Region'],
      dtype='object')
```

In [21]:
```python
# Spaces were fixed in the column names
df1.columns = df1.columns.str.strip()
df1.columns
```

Out[21]:
```
Index(['day', 'month', 'year', 'Temperature', 'RH', 'Ws', 'Rain', 'FFMC',
       'DMC', 'DC', 'ISI', 'BUI', 'FWI', 'Classes', 'Region'],
      dtype='object')
```

In [22]:
```python
df1[['month', 'day', 'year', 'Temperature','RH', 'Ws']] = df1[['month', 'day', 'year', 'Temperature','RH', 'Ws'
```

In [23]:
```python
# define numerical & categorical columns
numeric_features = [feature for feature in df1.columns if df1[feature].dtype != 'O']
categorical_features = [feature for feature in df1.columns if df1[feature].dtype == 'O']

# print columns
print('We have {} numerical features : {}'.format(len(numeric_features), numeric_features))
print('\nWe have {} categorical features : {}'.format(len(categorical_features), categorical_features))
```
```
We have 7 numerical features : ['day', 'month', 'year', 'Temperature', 'RH', 'Ws', 'Region']

We have 8 categorical features : ['Rain', 'FFMC', 'DMC', 'DC', 'ISI', 'BUI', 'FWI', 'Classes']
```

In [24]:
```python
# Changing the existing data types into the required data types for the some features for better EDA
objects = [feature for feature in df1.columns if df1[features].dtypes=='O']
for i in objects:
    if i != 'Classes':
        df1[i] = df1[i].astype(float)
```

In [25]:
```python
df1.describe(include='all')
```

Out[25]:

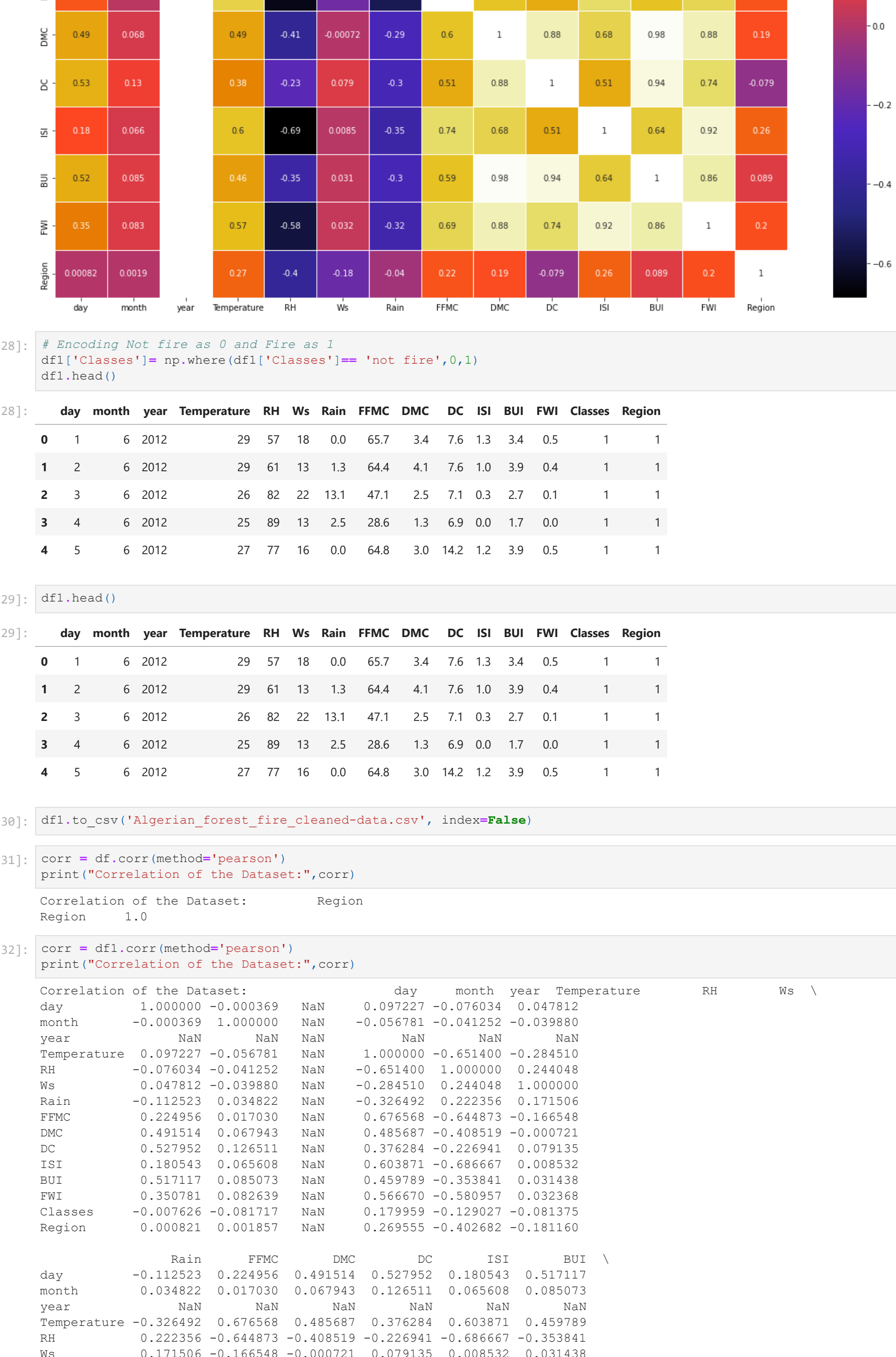
	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI
count	243.000000	243.000000	243.0	243.000000	243.000000	243.000000	243.000000	243.000000	243.000000	243.000000	243.000000	243.0
unique	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
top	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
freq	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
mean	15.761317	7.502058	2012.0	32.152263	62.041152	15.493827	0.762963	77.842387	14.680658	49.430864	4.742387	16.6
...	...	...	...	...	...	...	...	...	...	...	...	
min	1.000000	6.000000	2012.0	22.000000	21.000000	6.000000	0.000000	28.600000	0.700000	6.900000	0.000000	1.1
25%	8.000000	7.000000	2012.0	30.000000	52.500000	14.000000	0.000000	71.850000	5.800000	12.350000	1.400000	6.0
50%	16.000000	8.000000	2012.0	32.000000	63.000000	15.000000	0.000000	83.300000	11.300000	33.100000	3.500000	12.4
75%	23.000000	8.000000	2012.0	35.000000	73.500000	17.000000	0.500000	88.300000	20.800000	69.100000	7.250000	22.6
max	31.000000	9.000000	2012.0	42.000000	90.000000	29.000000	16.800000	96.000000	65.900000	220.400000	19.000000	68.0

In [26]:
```python
df1["Classes"].value_counts()
```

Out[26]:
```
fire             131
not fire         101
fire               4
fire               2
not fire           2
not fire           1
not fire           1
not fire           1
Name: Classes, dtype: int64
```

In [27]:
```python
plt.figure(figsize=(20,15))
sns.heatmap(df1.corr(),annot= True,linewidths=1, linecolor="white", cbar=True,
            cmap = "CMRmap",xticklabels="auto", yticklabels="auto")
```

Out[27]: <AxesSubplot:>



In [28]:
```python
# Encoding Not fire as 0 and Fire as 1
df1['Classes']= np.where(df1['Classes']== 'not fire',0,1)
df1.head()
```

Out[28]:

	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes	Region
0	1	6	2012	29	57	18	0.0	65.7	3.4	7.6	1.3	3.4	0.5	1	1
1	2	6	2012	29	61	13	1.3	64.4	4.1	7.6	1.0	3.9	0.4	1	1
2	3	6	2012	26	82	22	13.1	47.1	2.5	7.1	0.3	2.7	0.1	1	1
3	4	6	2012	25	89	13	2.5	28.6	1.3	6.9	0.0	1.7	0.0	1	1
4	5	6	2012	27	77	16	0.0	64.8	3.0	14.2	1.2	3.9	0.5	1	1

In [29]:
```python
df1.head()
```

Out[29]:

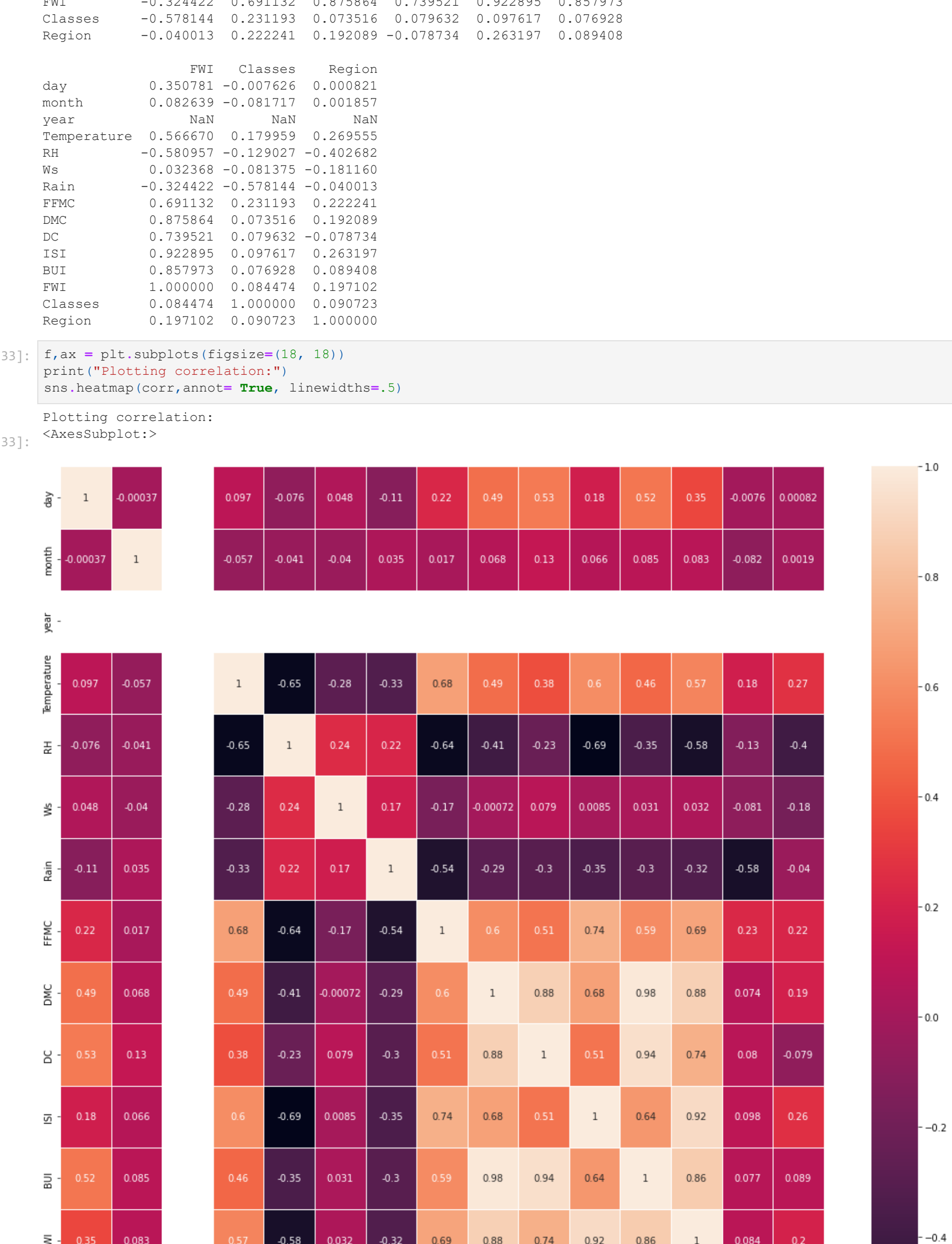
	day	month	year	Temperature	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes	Region
0	1	6	2012	29	57	18	0.0	65.7	3.4	7.6	1.3	3.4	0.5	1	1
1	2	6	2012	29	61	13	1.3	64.4	4.1	7.6	1.0	3.9	0.4	1	1
2	3	6	2012	26	82	22	13.1	47.1	2.5	7.1	0.3	2.7	0.1	1	1
3	4	6	2012	25	89	13	2.5	28.6	1.3	6.9	0.0	1.7	0.0	1	1
4	5	6	2012	27	77	16	0.0	64.8	3.0	14.2	1.2	3.9	0.5	1	1

In [30]:
```python
df1.to_csv('Algerian_forest_fire_cleaned-data.csv', index=False)
```

In [31]:
```python
corr = df.corr(method='pearson')
print("Correlation of the Dataset:",corr)
```
```
Correlation of the Dataset:          Region
Region     1.0
```

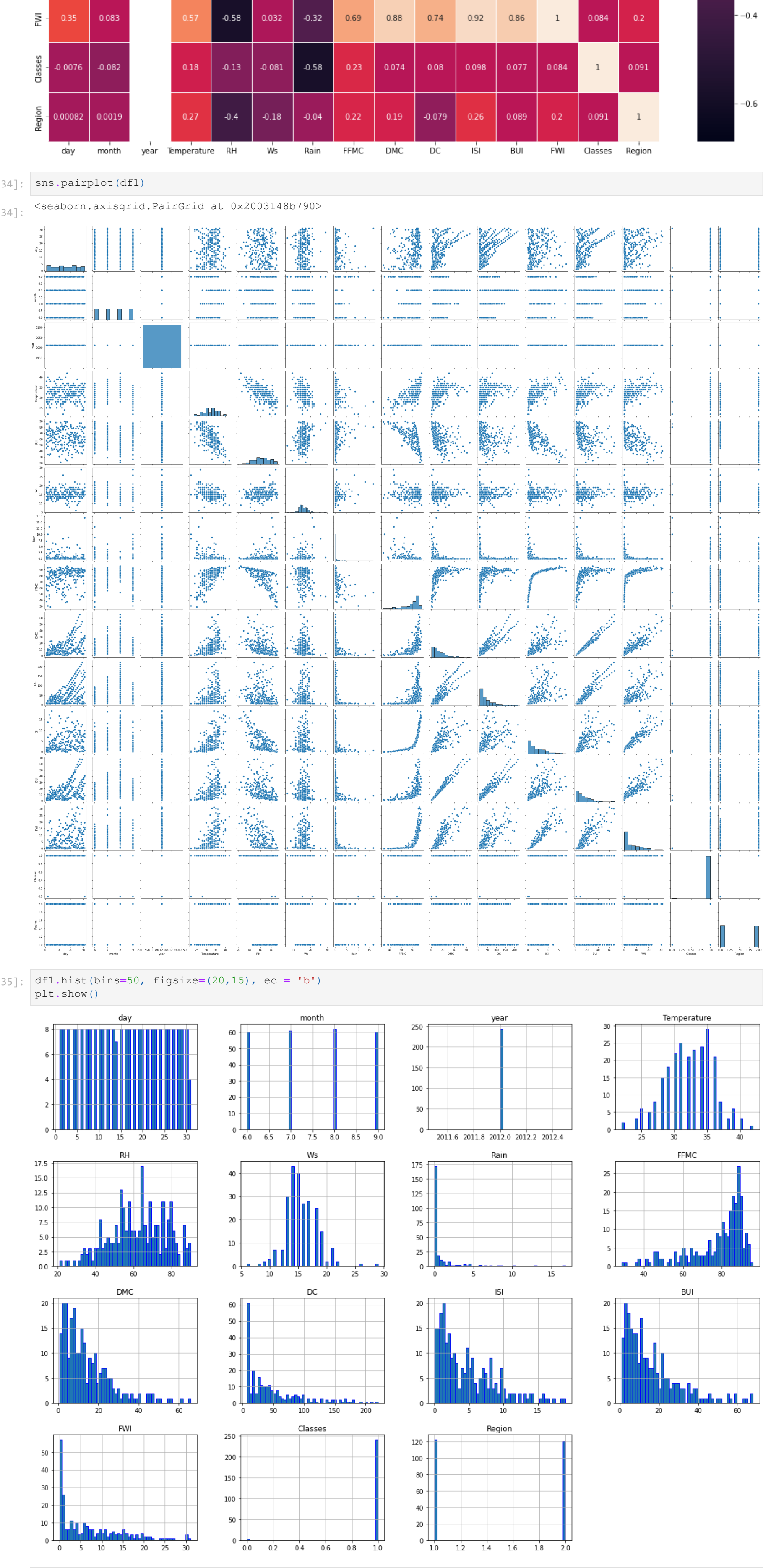
In [32]:
```python
corr = df1.corr(method='pearson')
print("Correlation of the Dataset:",corr)
```
```
Correlation of the Dataset:                   day     month  year  Temperature        RH        Ws  \
day          1.000000 -0.000369   NaN     0.097227 -0.076034  0.047812
month       -0.000369  1.000000   NaN    -0.056781 -0.041252 -0.039880
year              NaN       NaN   NaN          NaN       NaN       NaN
Temperature  0.097227 -0.056781   NaN     1.000000 -0.651400 -0.284510
RH          -0.076034 -0.041252   NaN    -0.651400  1.000000  0.244048
Ws           0.047812 -0.039880   NaN    -0.284510  0.244048  1.000000
Rain        -0.112523  0.034822   NaN    -0.326492  0.222356  0.171506
FFMC         0.224956  0.017030   NaN     0.676568 -0.644873 -0.166548
DMC          0.491514  0.067943   NaN     0.485687 -0.408519 -0.000721
DC           0.527952  0.126511   NaN     0.376284 -0.226941  0.079135
ISI          0.180543  0.065608   NaN     0.603871 -0.686667  0.008532
BUI          0.517117  0.085073   NaN     0.459789 -0.353841  0.031438
FWI          0.350781  0.082639   NaN     0.566670 -0.580957  0.032368
Classes     -0.007626 -0.081717   NaN     0.179959 -0.129027 -0.081375
Region       0.000821  0.001857   NaN     0.269555 -0.402682 -0.181160

                 Rain      FFMC       DMC        DC       ISI       BUI  \
day         -0.112523  0.224956  0.491514  0.527952  0.180543  0.517117
month        0.034822  0.017030  0.067943  0.126511  0.065608  0.085073
year              NaN       NaN       NaN       NaN       NaN       NaN
Temperature -0.326492  0.676568  0.485687  0.376284  0.603871  0.459789
RH           0.222356 -0.644873 -0.408519 -0.226941 -0.686667 -0.353841
Ws           0.171506 -0.166548 -0.000721  0.079135  0.008532  0.031438
Rain         1.000000 -0.543906 -0.288773 -0.298023 -0.347484 -0.299852
FFMC        -0.543906  1.000000  0.603608  0.507397  0.740007  0.592011
DMC         -0.288773  0.603608  1.000000  0.875925  0.680454  0.982248
DC          -0.298023  0.507397  0.875925  1.000000  0.508643  0.941988
ISI         -0.347484  0.740007  0.680454  0.508643  1.000000  0.644093
BUI         -0.299852  0.592011  0.982248  0.941988  0.644093  1.000000
FWI         -0.324422  0.691132  0.875864  0.739521  0.922895  0.857973
Classes     -0.578144  0.231193  0.073516  0.079632  0.097617  0.076928
Region      -0.040013  0.222241  0.192089 -0.078734  0.263197  0.089408

                  FWI   Classes    Region
day          0.350781 -0.007626  0.000821
month        0.082639 -0.081717  0.001857
year              NaN       NaN       NaN
Temperature  0.566670  0.179959  0.269555
RH          -0.580957 -0.129027 -0.402682
Ws           0.032368 -0.081375 -0.181160
Rain        -0.324422 -0.578144 -0.040013
FFMC         0.691132  0.231193  0.222241
DMC          0.875864  0.073516  0.192089
DC           0.739521  0.079632 -0.078734
ISI          0.922895  0.097617  0.263197
BUI          0.857973  0.076928  0.089408
FWI          1.000000  0.084474  0.197102
Classes      0.084474  1.000000  0.090723
Region       0.197102  0.090723  1.000000
```

In [33]:
```python
f,ax = plt.subplots(figsize=(18, 18))
print("Plotting correlation:")
sns.heatmap(corr,annot= True, linewidths=.5)
```
```
Plotting correlation:
```
Out[33]: <AxesSubplot:>

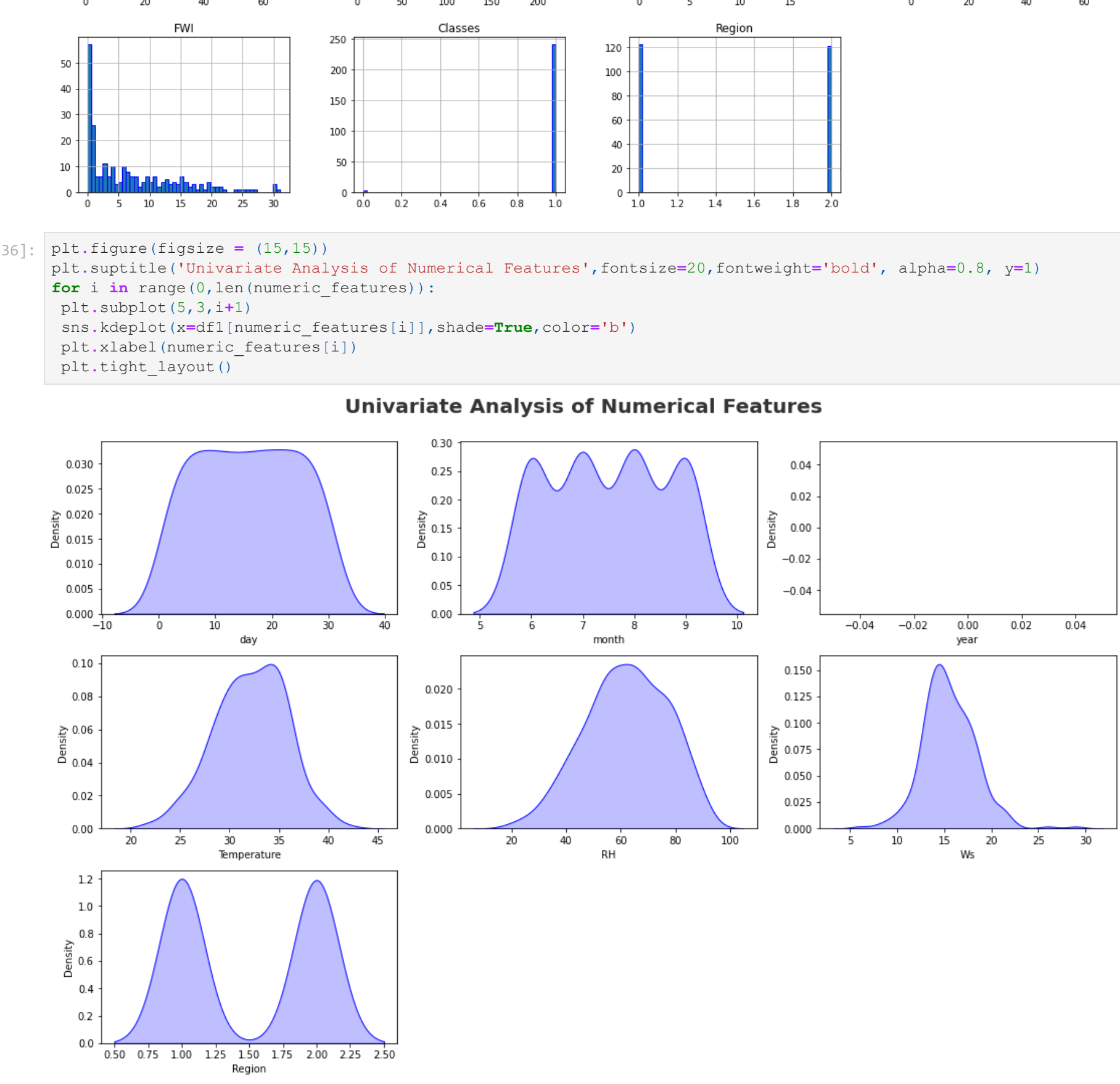


In [34]:
```python
sns.pairplot(df1)
```

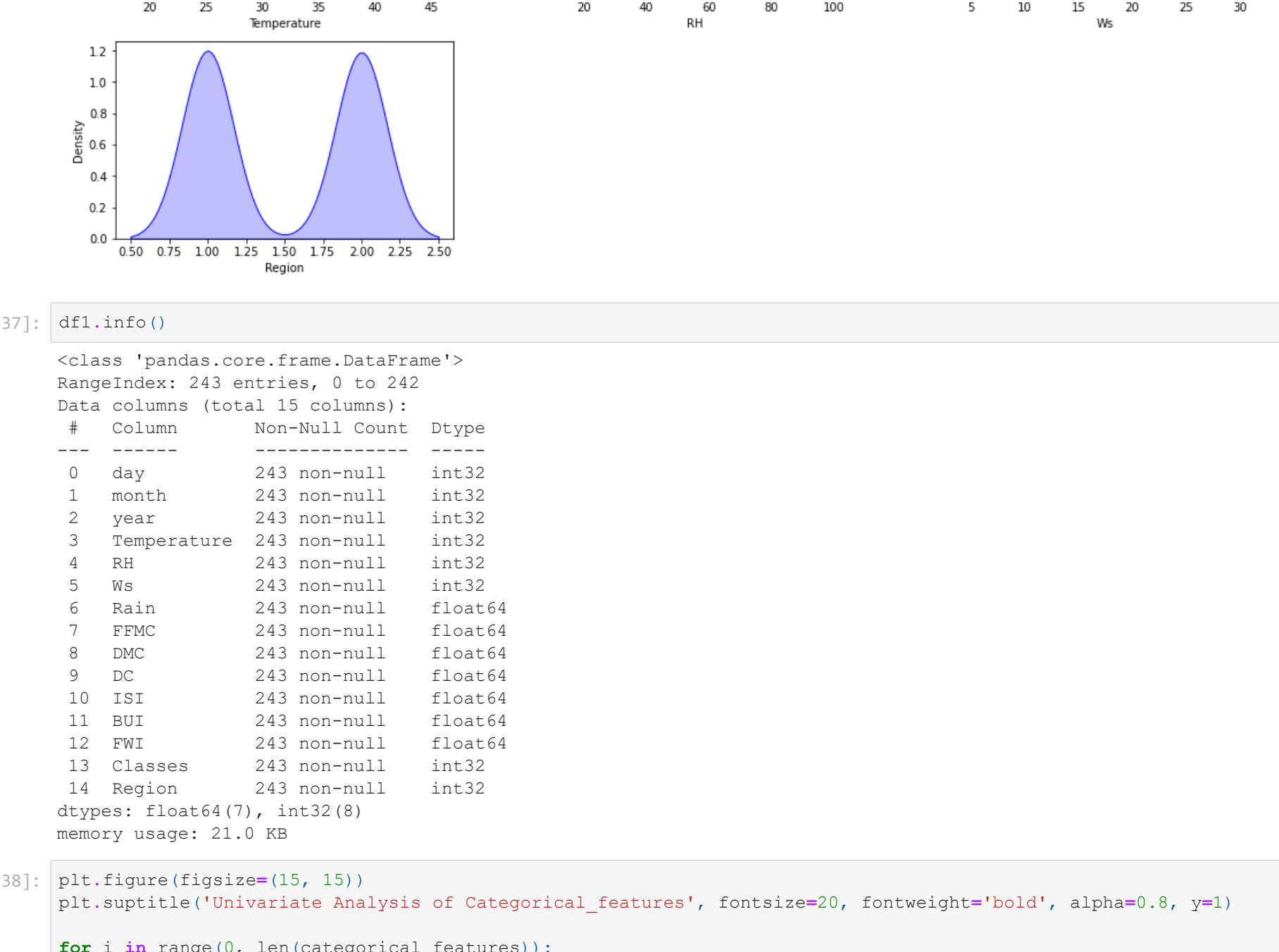
Out[34]: <seaborn.axisgrid.PairGrid at 0x2003148b790>



In [35]:
```python
df1.hist(bins=50, figsize=(20,15), ec = 'b')
plt.show()
```

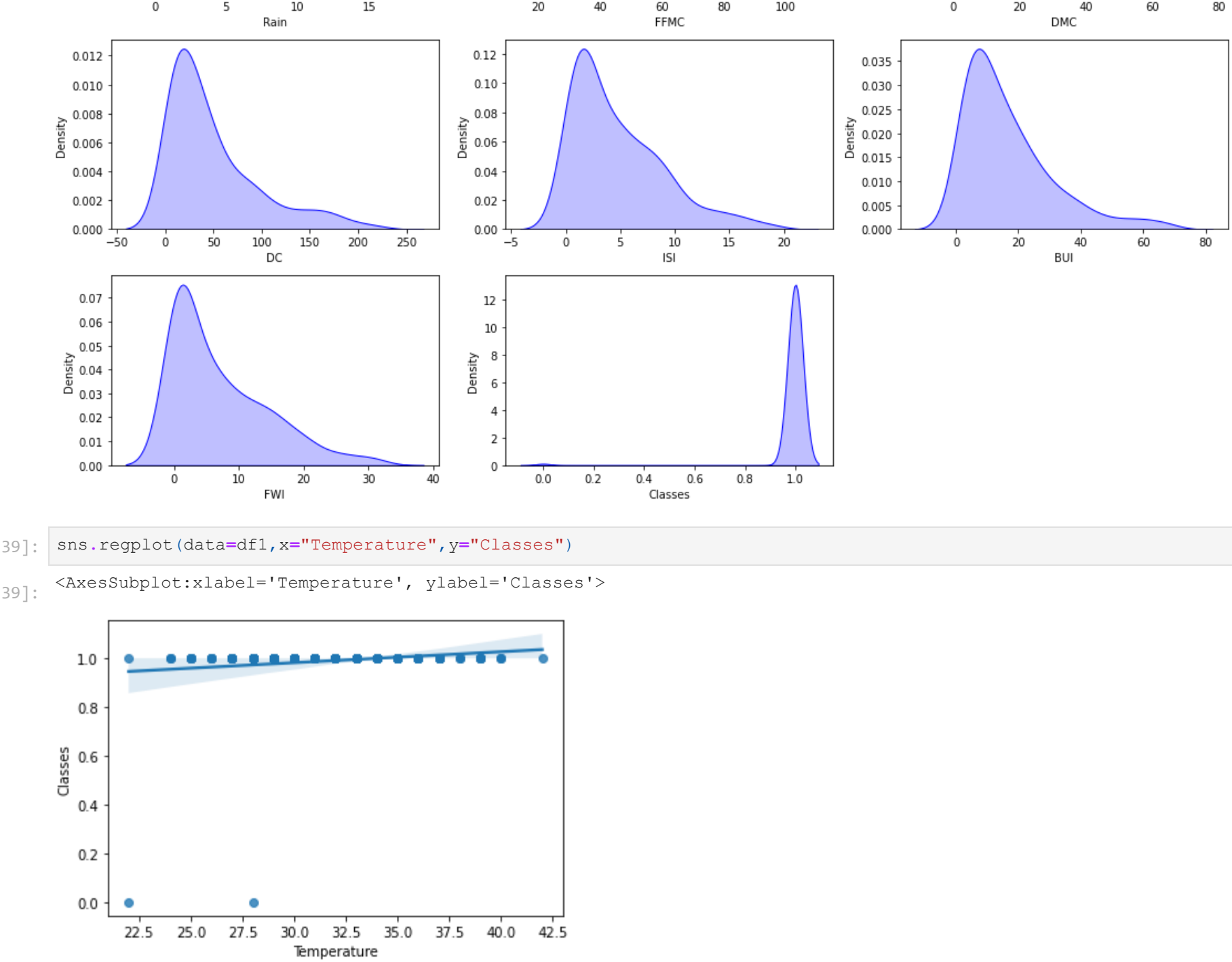


In [36]:
```python
plt.figure(figsize = (15,15))
plt.suptitle('Univariate Analysis of Numerical Features',fontsize=20,fontweight='bold', alpha=0.8, y=1)
for i in range(0,len(numeric_features)):
 plt.subplot(5,3,i+1)
 sns.kdeplot(x=df1[numeric_features[i]],shade=True,color='b')
 plt.xlabel(numeric_features[i])
 plt.tight_layout()
```



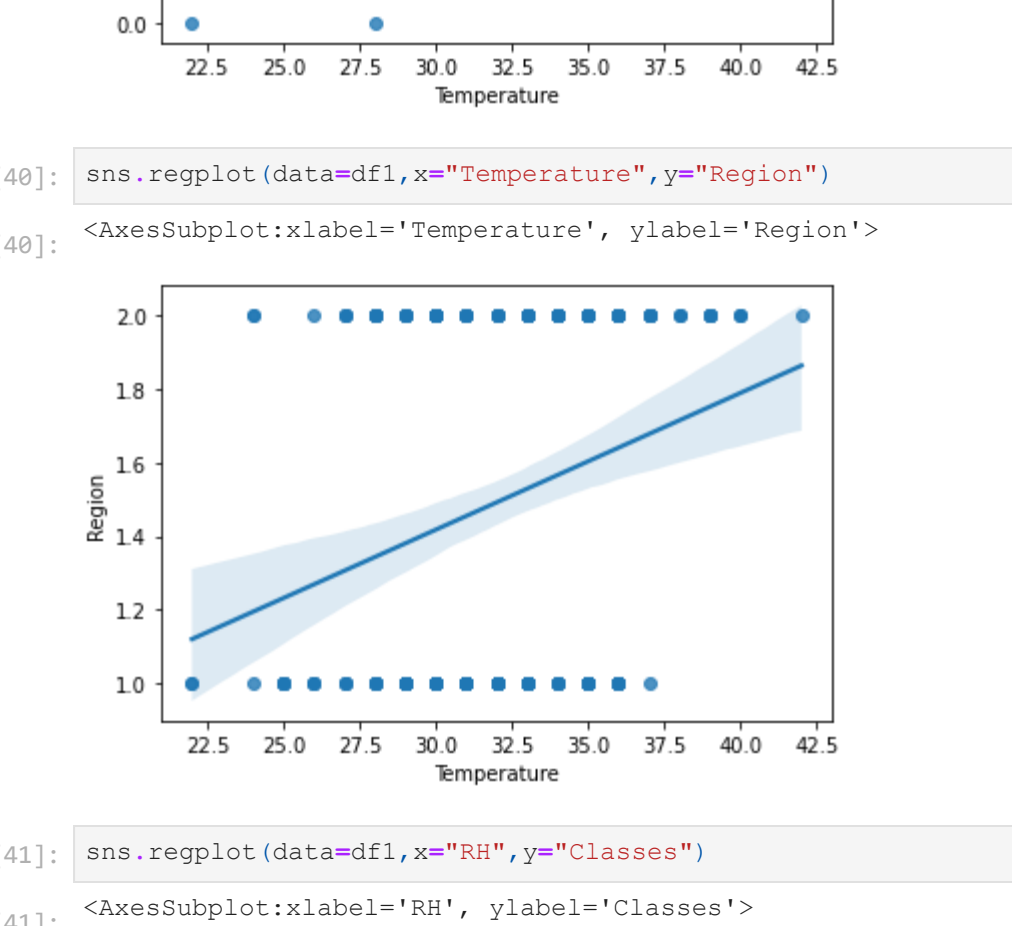
In [37]:
```python
df1.info()
```
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 243 entries, 0 to 242
Data columns (total 15 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   day          243 non-null    int32
 1   month        243 non-null    int32
 2   year         243 non-null    int32
 3   Temperature  243 non-null    int32
 4   RH           243 non-null    int32
 5   Ws           243 non-null    int32
 6   Rain         243 non-null    float64
 7   FFMC         243 non-null    float64
 8   DMC          243 non-null    float64
 9   DC           243 non-null    float64
 10  ISI          243 non-null    float64
 11  BUI          243 non-null    float64
 12  FWI          243 non-null    float64
 13  Classes      243 non-null    int32
 14  Region       243 non-null    int32
dtypes: float64(7), int32(8)
memory usage: 21.0 KB
```

In [38]:
```python
plt.figure(figsize=(15, 15))
plt.suptitle('Univariate Analysis of Categorical_features', fontsize=20, fontweight='bold', alpha=0.8, y=1)

for i in range(0, len(categorical_features)):
    plt.subplot(5, 3, i+1)
    sns.kdeplot(x=df1[categorical_features[i]],shade=True, color='b')
    plt.xlabel(categorical_features[i])
    plt.tight_layout()
```



In [39]:
```python
sns.regplot(data=df1,x="Temperature",y="Classes")
```

Out[39]: <AxesSubplot:xlabel='Temperature', ylabel='Classes'>

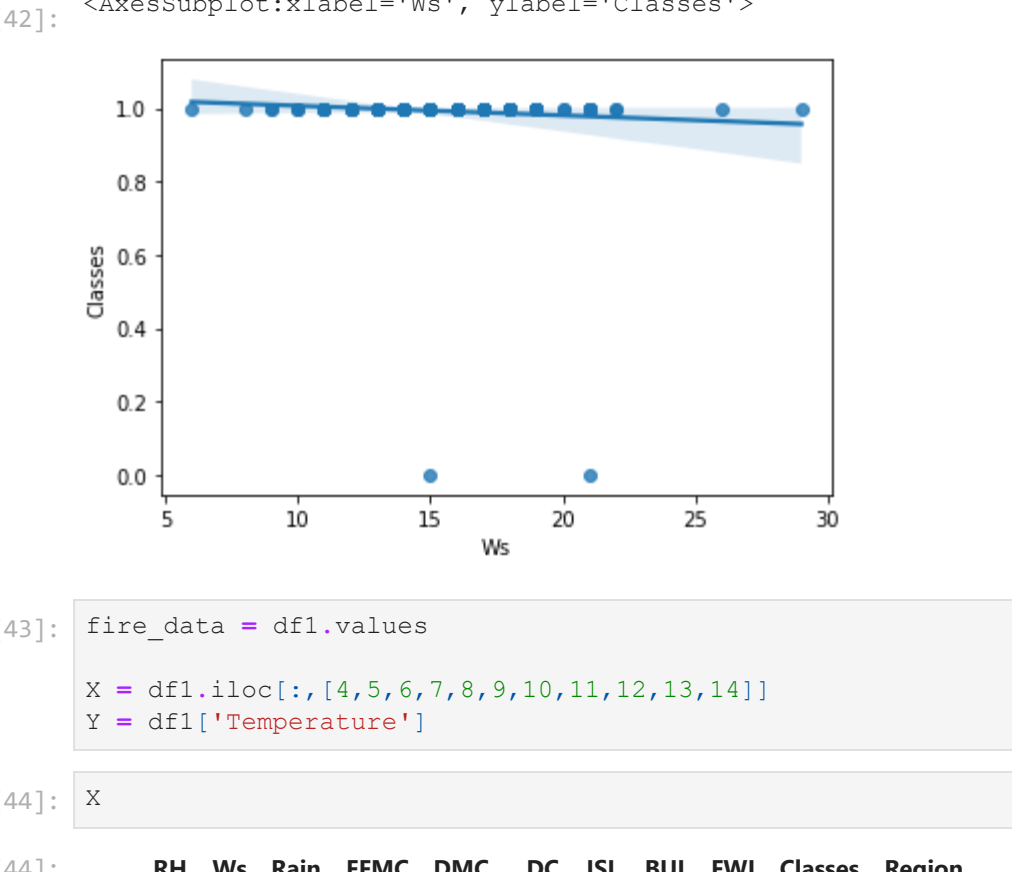


In [40]:
```python
sns.regplot(data=df1,x="Temperature",y="Region")
```

Out[40]: <AxesSubplot:xlabel='Temperature', ylabel='Region'>

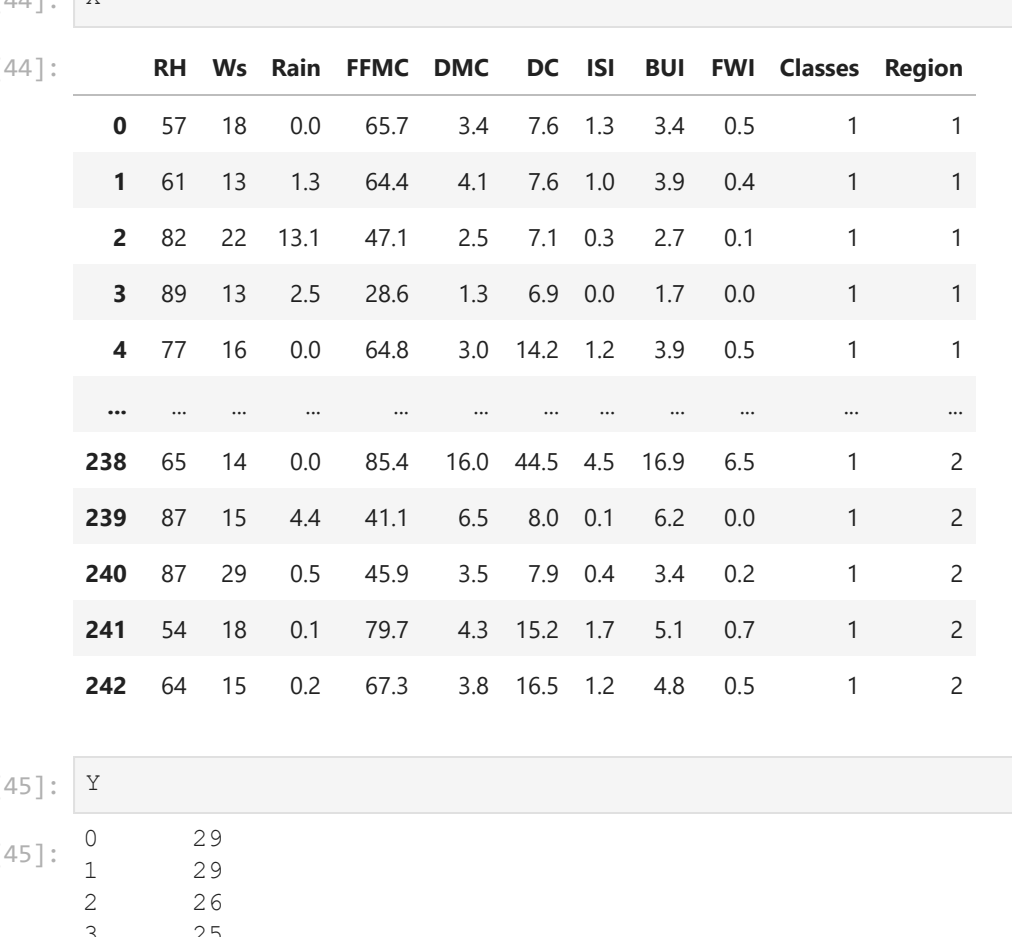
In [41]:
```python
sns.regplot(data=df1,x="RH",y="Classes")
```

Out[41]: <AxesSubplot:xlabel='RH', ylabel='Classes'>



In [42]:
```python
sns.regplot(data=df1,x="Ws",y="Classes")
```

Out[42]: <AxesSubplot:xlabel='Ws', ylabel='Classes'>



In [43]:
```python
fire_data = df1.values

X = df1.iloc[:,[4,5,6,7,8,9,10,11,12,13,14]]
Y = df1['Temperature']
```

In [44]:
```python
X
```

Out[44]:

	RH	Ws	Rain	FFMC	DMC	DC	ISI	BUI	FWI	Classes	Region
0	57	18	0.0	65.7	3.4	7.6	1.3	3.4	0.5	1	1
1	61	13	1.3	64.4	4.1	7.6	1.0	3.9	0.4	1	1
2	82	22	13.1	47.1	2.5	7.1	0.3	2.7	0.1	1	1
3	89	13	2.5	28.6	1.3	6.9	0.0	1.7	0.0	1	1
4	77	16	0.0	64.8	3.0	14.2	1.2	3.9	0.5	1	1
...	...	...	...	...	...	...	...	...	...	...	...
238	65	14	0.0	85.4	16.0	44.5	4.5	16.9	6.5	1	2
239	87	15	4.4	41.1	6.5	8.0	0.1	6.2	0.0	1	2
240	87	29	0.5	45.9	3.5	7.9	0.4	3.4	0.2	1	2
241	54	18	0.1	79.7	4.3	15.2	1.7	5.1	0.7	1	2
242	64	15	0.2	67.3	3.8	16.5	1.2	4.8	0.5	1	2

In [45]:
```python
Y
```

Out[45]:
```
0      29
1      29
2      26
3      25
4      27
       ..
238    30
239    28
240    27
241    24
242    24
Name: Temperature, Length: 243, dtype: int32
```

In [46]:
```python
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test = train_test_split(X,Y,test_size=0.33,random_state=20)
```

In [47]:
```python
from sklearn.linear_model import LinearRegression
from sklearn.linear_model import Lasso
from sklearn.linear_model import Ridge
from sklearn.linear_model import ElasticNet
from sklearn.metrics import explained_variance_score
from sklearn.metrics import mean_absolute_error
```

In [48]:
```python
print("------------------------------------------------Linear Regression-----------------------------------------------")
LR = LinearRegression()
LR.fit(X_train,y_train)
LR_prediction = LR.predict(X_test)
score = explained_variance_score(y_test, LR_prediction)
mae = mean_absolute_error(LR_prediction, y_test)

print("Score:", score)
print("Mean Absolute Error:", mae)
```

```
--------------------------------------------Linear Regression---------------------------------------------
Score: 0.5251004604498852
Mean Absolute Error: 2.077124666699029
```

In [49]:
```python
print(LR.intercept_)
```

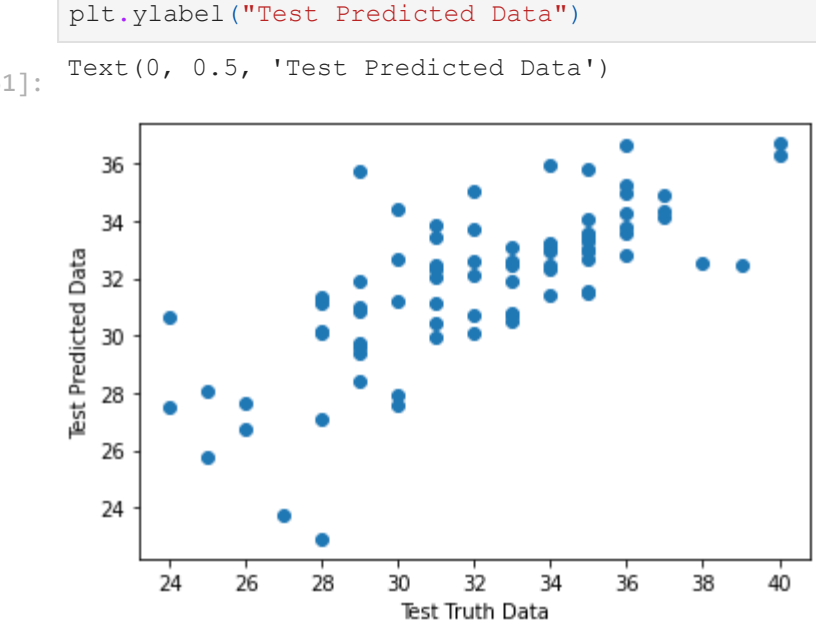
```
28.184265839041736
```

In [50]:
```python
print(LR.coef_)
```

```
[-0.06746213 -0.25284727  0.08301739  0.07893208 -0.03144021  0.01369642
  0.04330166 -0.01305109  0.07763058  4.89642945  0.10477162]
```

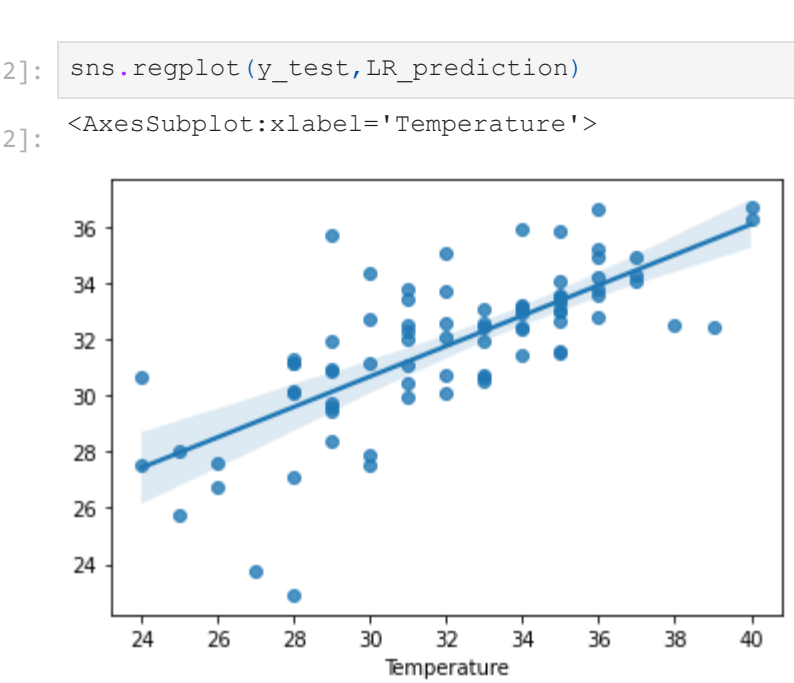
In [51]:
```python
plt.scatter(y_test,LR_prediction)
plt.xlabel("Test Truth Data")
plt.ylabel("Test Predicted Data")
```

Out[51]: Text(0, 0.5, 'Test Predicted Data')



In [52]:
```python
sns.regplot(y_test,LR_prediction)
```

Out[52]: <AxesSubplot:xlabel='Temperature'>



In [53]:
```python
from sklearn.metrics import r2_score
R2_score=R2_score=r2_score(y_test,LR_prediction)
print(R2_score)
```

```
0.5181357540889069
```

In [54]:
```python
## Adjusted R square
#display adjusted R-squared
1 - (1-R2_score)*(len(y_test)-1)/(len(y_test)-X_test.shape[1]-1)
```

Out[54]: 0.44131681633496456

In [55]:
```python
print("------------------------------------------------Lasso Regression------------------------------------------------")
lasso = Lasso()
lasso.fit(X_train,y_train)
prediction_lasso = lasso.predict(X_test)
score = explained_variance_score(y_test, prediction_lasso)
mae = mean_absolute_error(prediction_lasso,y_test)

print("Score:", score)
print("Mean Absolute Error:", mae)
```

```
---------------------------------------------Lasso Regression----------------------------------------------
Score: 0.5473657539905131
Mean Absolute Error: 1.9981009005938106
```

In [56]:
```python
from sklearn.metrics import r2_score
R2_score_lasso=r2_score(y_test,prediction_lasso)
print(R2_score_lasso)
```

```
0.5420886960810642
```

In [57]:
```python
print(lasso.intercept_)
```

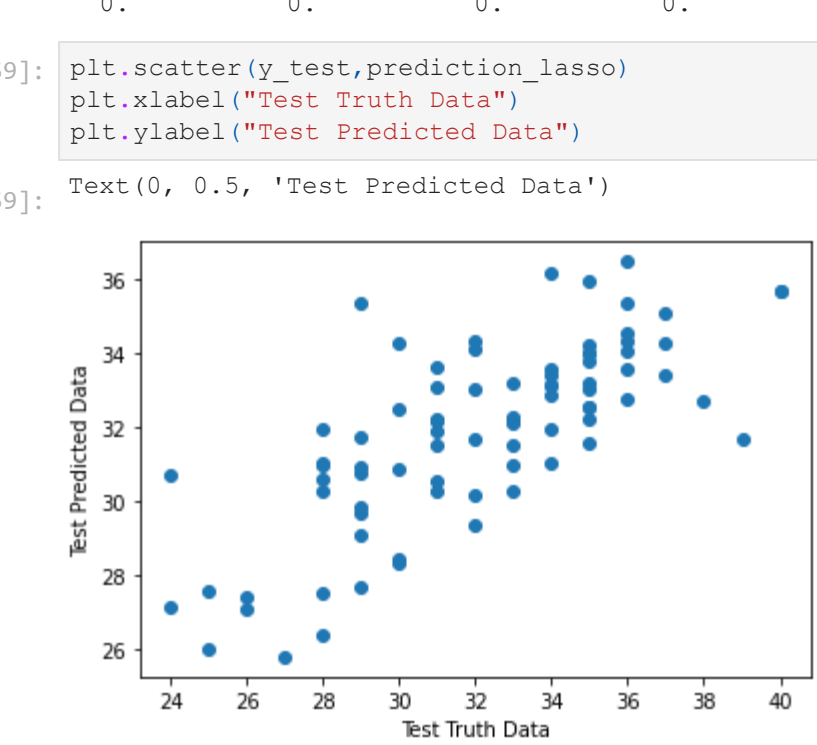
```
31.386610759759506
```

In [58]:
```python
print(lasso.coef_)
```

```
[-0.08738572 -0.06992637 -0.          0.08566883  0.          0.01039541
  0.          0.          0.          0.          0.        ]
```

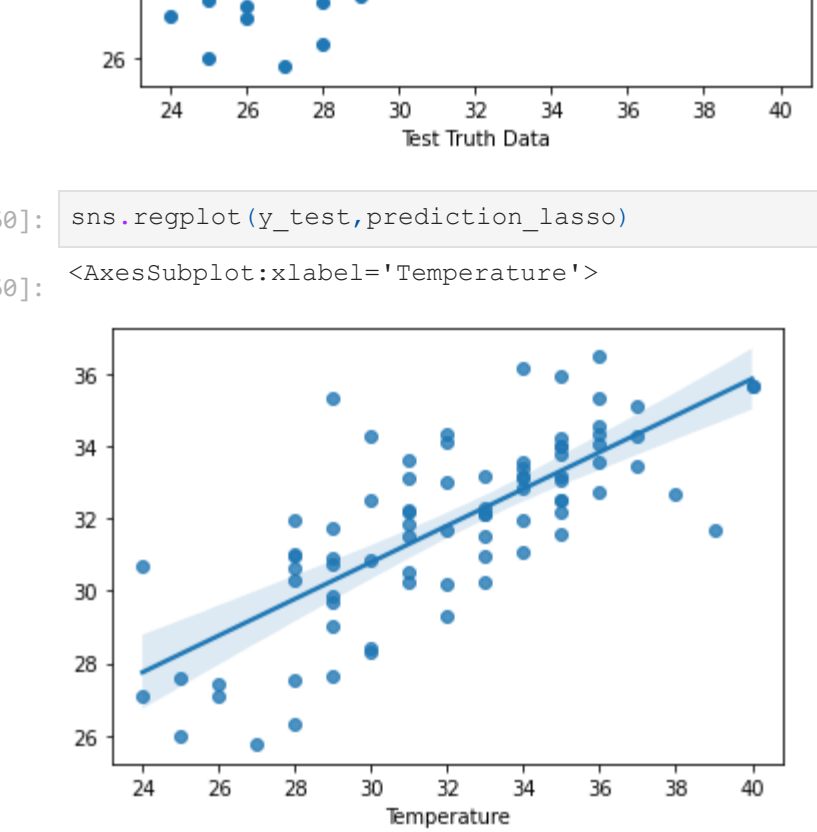
In [59]:
```python
plt.scatter(y_test,prediction_lasso)
plt.xlabel("Test Truth Data")
plt.ylabel("Test Predicted Data")
```

Out[59]: Text(0, 0.5, 'Test Predicted Data')



In [60]:
```python
sns.regplot(y_test,prediction_lasso)
```

Out[60]: <AxesSubplot:xlabel='Temperature'>



In [61]:
```python
## Adjusted R square
#display adjusted R-squared
1 - (1-R2_score_lasso)*(len(y_test)-1)/(len(y_test)-X_test.shape[1]-1)
```

Out[61]: 0.46908834328239335

In [62]:
```python
print("------------------------------------------------Ridge Regression------------------------------------------------")
ridge = Ridge()
ridge.fit(X_train,y_train)
prediction_ridge = ridge.predict(X_test)
score = explained_variance_score(y_test, prediction_ridge)
mae = mean_absolute_error(prediction_ridge, y_test)

print("Score:", score)
print("Mean Absolute Error:", mae)
```

```
-----------------------------------------------Ridge Regression-----------------------------------------------
---
Score: 0.5407207215265188
Mean Absolute Error: 2.0518549452316552
```

In [63]:
```python
from sklearn.metrics import r2_score
R2_score_ridge=r2_score(y_test,prediction_ridge)
print(R2_score_ridge)
```

```
0.5338298995162152
```

In [64]:
```python
print(ridge.intercept_)
```

```
30.827339285335093
```

In [65]:
```python
print(ridge.coef_)
```

```
[-0.06986275 -0.24000484  0.02620679  0.08070387 -0.04336237  0.01113543
  0.02869216  0.00527613  0.07690343  2.12469152  0.12606661]
```

In [66]:
```python
## Adjusted R square
#display adjusted R-squared
1 - (1-R2_score_ridge)*(len(y_test)-1)/(len(y_test)-X_test.shape[1]-1)
```

Out[66]: 0.459512926975322

In [67]:
```python
print("------------------------------------------------Ridge Regression------------------------------------------------")
elasticnet = ElasticNet()
elasticnet.fit(X_train,y_train)
prediction_elasticnet = elasticnet.predict(X_test)
score = explained_variance_score(y_test, prediction_elasticnet)
mae = mean_absolute_error(prediction_elasticnet,y_test)

print("Score:", score)
print("Mean Absolute Error:", mae)
```

```
-----------------------------------------------Ridge Regression-----------------------------------------------
---
Score: 0.5542472845849989
Mean Absolute Error: 1.99767078533837
```

In [68]:
```python
print(elasticnet.intercept_)
```

```
32.03396758251205
```

In [69]:
```python
print(elasticnet.coef_)
```

```
[-0.08152874 -0.13861156 -0.          0.02572269  0.          0.0081089
  0.          0.          0.          0.          0.        ]
```

In [70]:
```python
from sklearn.metrics import r2_score
R2_score_elasticnet=r2_score(y_test,prediction_elasticnet)
print(R2_score_elasticnet)
```

```
0.5488150926085771
```

In [71]:
```python
## Adjusted R square
#display adjusted R-squared
1 - (1-R2_score_elasticnet)*(len(y_test)-1)/(len(y_test)-X_test.shape[1]-1)
```

Out[71]: 0.47668706389400237

In [72]:
```python
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
```

In [73]:
```python
X_train_scaled = scaler.fit_transform(X_train)
```

In [74]:
```python
X_test_scaled = scaler.transform(X_test)
```

In [75]:
```python
X_train_scaled
```

Out[75]:
```
array([[-1.21894177,  0.15920239, -0.38206865, ...,  2.28258606,
         0.07881104,  1.01242284],
       [-0.05919295,  0.92907663,  3.20813094, ..., -0.60799249,
         0.07881104,  1.01242284],
       [-0.20497205,  1.55075528, -0.21155867, ..., -0.44665787,
         0.07881104, -0.9877296 ],
       ...,
       [ 1.82106964, -0.99560898,  0.01578796, ..., -1.01132903,
         0.07881104, -0.9877296 ],
       [ 1.63149995, -0.61067185,  3.31231413, ..., -0.95755083,
         0.07881104,  1.01242284],
       [ 0.76367436,  0.54415951,  0.12986128, ..., -0.95755083,
         0.07881104, -0.9877296 ]])
```

In [76]:
```python
X_test_scaled
```

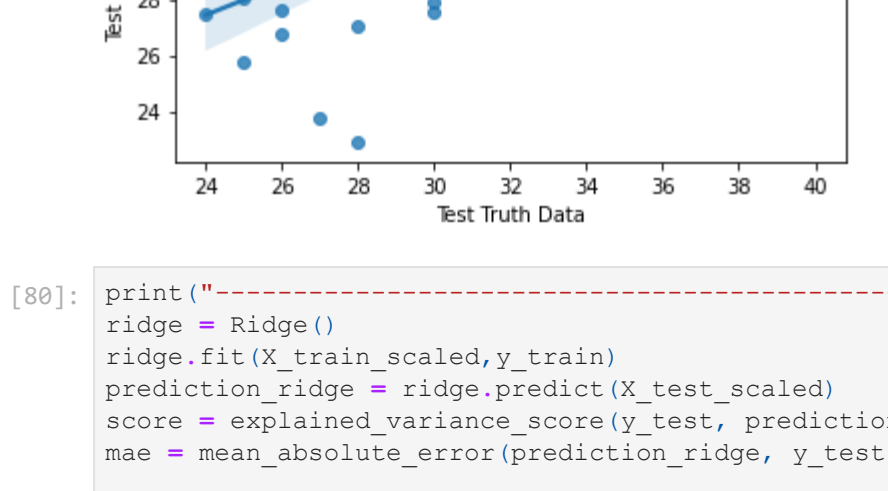
Out[76]:
```
array([[-1.35111618e+00, -2.92029459e+00, -3.25231988e-01,
         3.79910289e-01,  8.32500100e-01,  7.93655659e-01,
        -5.53570332e-01,  8.59789461e-01, -2.58434154e-01,
         7.88110406e-02,  1.01242284e+00],
[illegible]
       [ 8.95848772e-01,  1.59202390e-01, -3.82068646e-01,
         2.63138756e-01, -8.73493265e-01, -5.65090877e-01,
        -4.14173865e-01, -7.95707992e-01, -6.75215247e-01,
         7.88110406e-02,  1.01242284e+00],
       [ 4.99325545e-01, -9.95608976e-01,  1.57879606e-02,
        -8.08411782e-01, -7.40342563e-01, -8.95418235e-01,
        -9.25294244e-01, -8.10166485e-01, -9.44106274e-01,
         7.88110406e-02, -9.87729597e-01]])
```

In [77]:
```python
print("------------------------------------------------Linear Regression with Scaled Data-------------------------------")
LR = LinearRegression()
LR.fit(X_train_scaled,y_train)
LR_prediction = LR.predict(X_test_scaled)
score = explained_variance_score(y_test, LR_prediction)
mae = mean_absolute_error(LR_prediction, y_test)

print("Score:", score)
print("Mean Absolute Error:", mae)
```

```
--------------------------------------------Linear Regression with Scaled Data--------------------------------
---------------
Score: 0.5251004604498851
Mean Absolute Error: 2.077124666699029
```

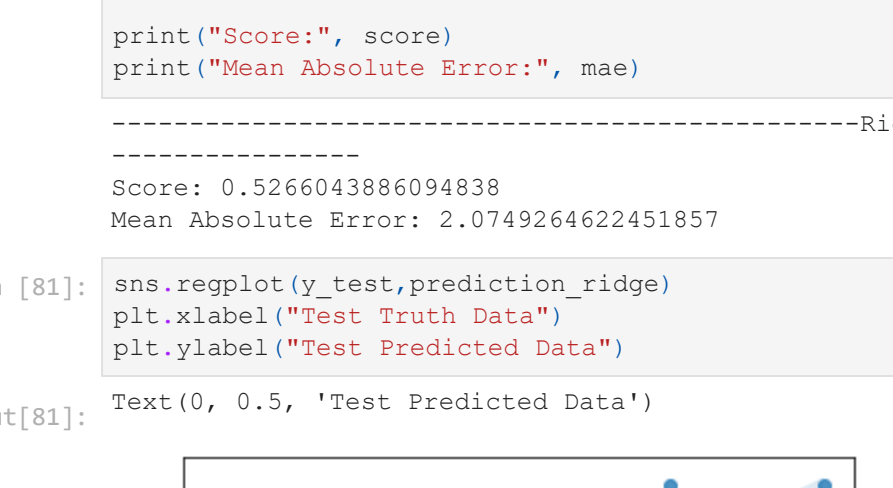
In [78]:
```python
plt.scatter(y_test,LR_prediction)
plt.xlabel("Test Truth Data")
plt.ylabel("Test Predicted Data")
```

Out[78]: Text(0, 0.5, 'Test Predicted Data')



In [79]:
```python
sns.regplot(y_test,LR_prediction)
plt.xlabel("Test Truth Data")
plt.ylabel("Test Predicted Data")
```

Out[79]: Text(0, 0.5, 'Test Predicted Data')

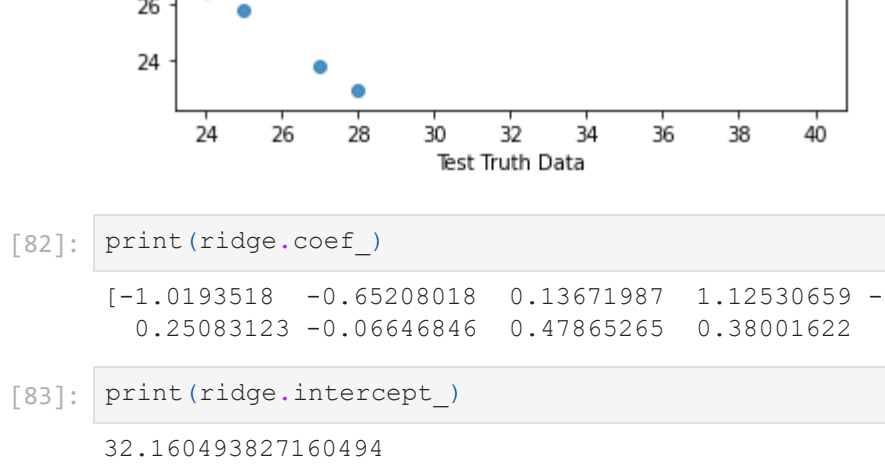


In [80]:
```python
print("------------------------------------------------Ridge Regression with Scaled Data--------------------------------")
ridge = Ridge()
ridge.fit(X_train_scaled,y_train)
prediction_ridge = ridge.predict(X_test_scaled)
score = explained_variance_score(y_test, prediction_ridge)
mae = mean_absolute_error(prediction_ridge, y_test)

print("Score:", score)
print("Mean Absolute Error:", mae)
```

```
-----------------------------------------------Ridge Regression with Scaled Data------------------------------
---------------
Score: 0.5266043886094838
Mean Absolute Error: 2.0749264622451857
```

In [81]:
```python
sns.regplot(y_test,prediction_ridge)
plt.xlabel("Test Truth Data")
plt.ylabel("Test Predicted Data")
```

Out[81]: Text(0, 0.5, 'Test Predicted Data')



In [82]:
```python
print(ridge.coef_)
```

```
[-1.0193518  -0.65208018  0.13671987  1.12530659 -0.37463562  0.55848354
  0.25083123 -0.06646846  0.47865265  0.38001622  0.04529692]
```

In [83]:
```python
print(ridge.intercept_)
```

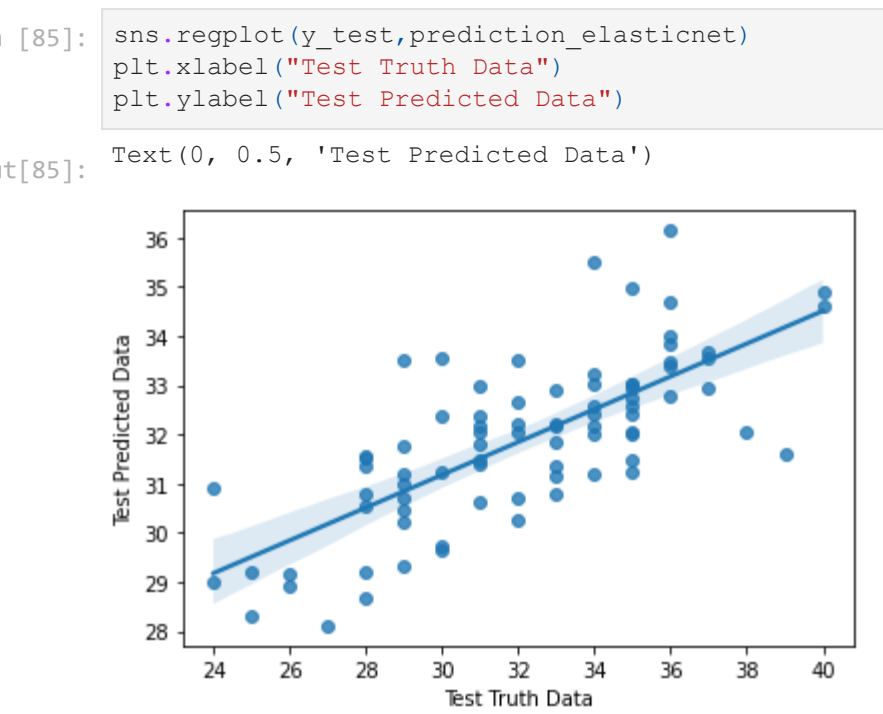
```
32.160493827160494
```

In [84]:
```python
print("------------------------------------------ElasticNet Regression with Scaled Data--------------------------------")
elasticnet = ElasticNet()
elasticnet.fit(X_train_scaled,y_train)
prediction_elasticnet = elasticnet.predict(X_test_scaled)
score = explained_variance_score(y_test, prediction_elasticnet)
mae = mean_absolute_error(prediction_elasticnet,y_test)

print("Score:", score)
print("Mean Absolute Error:", mae)
```

```
--------------------------------------ElasticNet Regression with Scaled Data-----------------------------------
--------------
Score: 0.46022751134240514
Mean Absolute Error: 2.1962111877558033
```

In [85]:
```python
sns.regplot(y_test,prediction_elasticnet)
plt.xlabel("Test Truth Data")
plt.ylabel("Test Predicted Data")
```

Out[85]: Text(0, 0.5, 'Test Predicted Data')



In [86]:
```python
print(elasticnet.coef_)
```

```
[-0.61517078 -0.14551371 -0.          0.681168    0.06881693  0.
  0.31601238  0.05575822  0.28438594  0.          0.        ]
```

In [87]:
```python
print(elasticnet.intercept_)
```

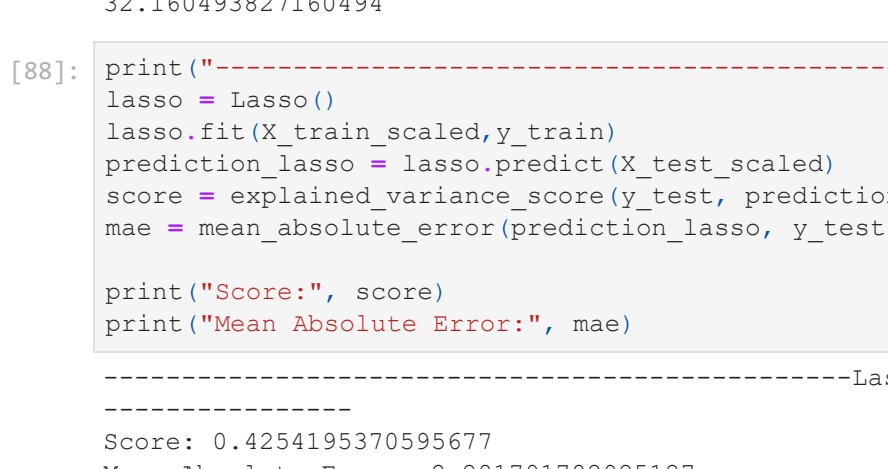
```
32.160493827160494
```

In [88]:
```python
print("------------------------------------------------Lasso Regression with Scaled Data--------------------------------")
lasso = Lasso()
lasso.fit(X_train_scaled,y_train)
prediction_lasso = lasso.predict(X_test_scaled)
score = explained_variance_score(y_test, prediction_lasso)
mae = mean_absolute_error(prediction_lasso, y_test)

print("Score:", score)
print("Mean Absolute Error:", mae)
```

```
-----------------------------------------------Lasso Regression with Scaled Data------------------------------
---------------
Score: 0.4254195370595677
Mean Absolute Error: 2.281791782925127
```

In [89]:
```python
sns.regplot(y_test,prediction_lasso)
plt.xlabel("Test Truth Data")
plt.ylabel("Test Predicted Data")
```

Out[89]: Text(0, 0.5, 'Test Predicted Data')



In [90]:
```python
print(lasso.coef_)
```

```
[-0.66167174 -0.         -0.          0.93435406  0.          0.
  0.          0.          0.12295451  0.          0.        ]
```

In [91]:
```python
print(lasso.intercept_)
```

```
32.160493827160494
```

In [ ]: