CS5710 – Machine Learning

Assignment-2

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Github Link: https://github.com/viboppan/ML_Assignment-2 (https://github.com/viboppan/ML_Assignment-2)

Importing required Modules/libraries for the Assignment

In [1]:
```
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import numpy as np
import random as rnd

# loading the warnings module
import warnings
# setting a filter to ignore warnings that gets generated by the code
warnings.filterwarnings("ignore")

# Data Visualization Modules
import seaborn as sns
import matplotlib.pyplot as plt

# machine learning modules
from sklearn.svm import SVC, LinearSVC
from sklearn.naive_bayes import GaussianNB
from sklearn import preprocessing

# function is used to split the data into training and testing sets fo
from sklearn.model_selection import train_test_split

# importing functions used to evaluate the performance of machine lear
from sklearn.metrics import accuracy_score, confusion_matrix, classifi
```

1. Pandas

In [3]:

```
# Reading the CSV file using read_csv( ) function
df = pd.read_csv('data.csv')

# Printing the first 5 rows of the DataFrame
df.head()
```

Out[3]:

	Duration	Pulse	Maxpulse	Calories
0	60	110	130	409.1
1	60	117	145	479.0
2	60	103	135	340.0
3	45	109	175	282.4
4	45	117	148	406.0

Question 2

Show the basic statistical description about the data.

In [5]:

```
# Getting the basic statistical description about the data
description = df.describe()

# Printing the description
description
```

Out[5]:

	Duration	Pulse	Maxpulse	Calories
count	169.000000	169.000000	169.000000	164.000000
mean	63.846154	107.461538	134.047337	375.790244
std	42.299949	14.510259	16.450434	266.379919
min	15.000000	80.000000	100.000000	50.300000
25%	45.000000	100.000000	124.000000	250.925000
50%	60.000000	105.000000	131.000000	318.600000
75%	60.000000	111.000000	141.000000	387.600000
max	300.000000	159.000000	184.000000	1860.400000

Question 3

Check if the data has null values.

In [6]:

```
print('Are there any null values: ', df.isnull().values.any())

# Checking for null values in the DataFrame
null_values = df.isnull().sum()

# Printing the number of null values for each column
null_values
```

```
Are there any null values:  True
```

Out[6]:

```
Duration    0
Pulse       0
Maxpulse    0
Calories    5
dtype: int64
```

    a. Replace the null values with the mean

In [7]:

```
# Replacing null values with the mean of the respective column
mean_values = df.mean()
df.fillna(mean_values, inplace=True)

print('Are there any null values after replacing: ', df.isnull().value

# Checking for null values in the DataFrame (should return all 0s)
null_values = df.isnull().sum()

# Printing the number of null values for each column
null_values
```

```
Are there any null values after replacing:  False
```

Out[7]:

```
Duration    0
Pulse       0
Maxpulse    0
Calories    0
dtype: int64
```

Question 4

Select at least two columns and aggregate the data using: min, max, count, mean.

In [8]:

```python
# Selecting two columns maxpulse, calories and aggregating using min,
agg_df = df.agg({'Maxpulse': ['min', 'max', 'count', 'mean'],
                 'Calories': ['min', 'max', 'count', 'mean']})

# Printing the aggregated data
agg_df
```

Out[8]:

	Maxpulse	Calories
min	100.000000	50.300000
max	184.000000	1860.400000
count	169.000000	169.000000
mean	134.047337	375.790244

Question 5

Filter the dataframe to select the rows with calories values between 500 and 1000.

In [9]:
```
# Filtering the DataFrame to select rows with calorie values between 5
filtered_df = df.loc[(df['Calories'] >= 500) & (df['Calories'] <= 1000

# Printing the filtered DataFrame
filtered_df
```

Out[9]:

	Duration	Pulse	Maxpulse	Calories
51	80	123	146	643.1
62	160	109	135	853.0
65	180	90	130	800.4
66	150	105	135	873.4
67	150	107	130	816.0
72	90	100	127	700.0
73	150	97	127	953.2
75	90	98	125	563.2
78	120	100	130	500.4
83	120	100	130	500.0
90	180	101	127	600.1
99	90	93	124	604.1
101	90	90	110	500.0
102	90	90	100	500.0
103	90	90	100	500.4
106	180	90	120	800.3
108	90	90	120	500.3

Question 6

Filter the dataframe to select the rows with calories values > 500 and pulse < 100.

In [8]:

```
# Filtering the DataFrame to select rows with calorie values > 500 and
filtered_df = df.loc[(df['Calories'] > 500) & (df['Pulse'] < 100)]

# Printing the filtered DataFrame
filtered_df
```

Out[8]:

	Duration	Pulse	Maxpulse	Calories
65	180	90	130	800.4
70	150	97	129	1115.0
73	150	97	127	953.2
75	90	98	125	563.2
99	90	93	124	604.1
103	90	90	100	500.4
106	180	90	120	800.3
108	90	90	120	500.3

Question 7

Create a new “df_modified” dataframe that contains all the columns from df except for “Maxpulse”.

In [10]:

```
# Droping the 'Maxpulse' column and creating a new DataFrame
df_modified = df.drop(columns=['Maxpulse'])

# Printing the first 5 rows of new DataFrame
df_modified.head()
```

Out[10]:

	Duration	Pulse	Calories
0	60	110	409.1
1	60	117	479.0
2	60	103	340.0
3	45	109	282.4
4	45	117	406.0

Question 8

Delete the “Maxpulse” column from the main df dataframe

In [11]:

```
# Droping the 'Maxpulse' column from the original DataFrame
df.drop(columns=['Maxpulse'], inplace=True)

#printing the modified dataframe
df.head()
```

Out[11]:

	Duration	Pulse	Calories
0	60	110	409.1
1	60	117	479.0
2	60	103	340.0
3	45	109	282.4
4	45	117	406.0

Question 9

Convert the datatype of Calories column to int datatype.

In [12]:

```
# astype() function is used to convert the data type
df['Calories'] = df['Calories'].astype('int64')
df.dtypes
```

Out[12]:

```
Duration    int64
Pulse       int64
Calories    int64
dtype: object
```

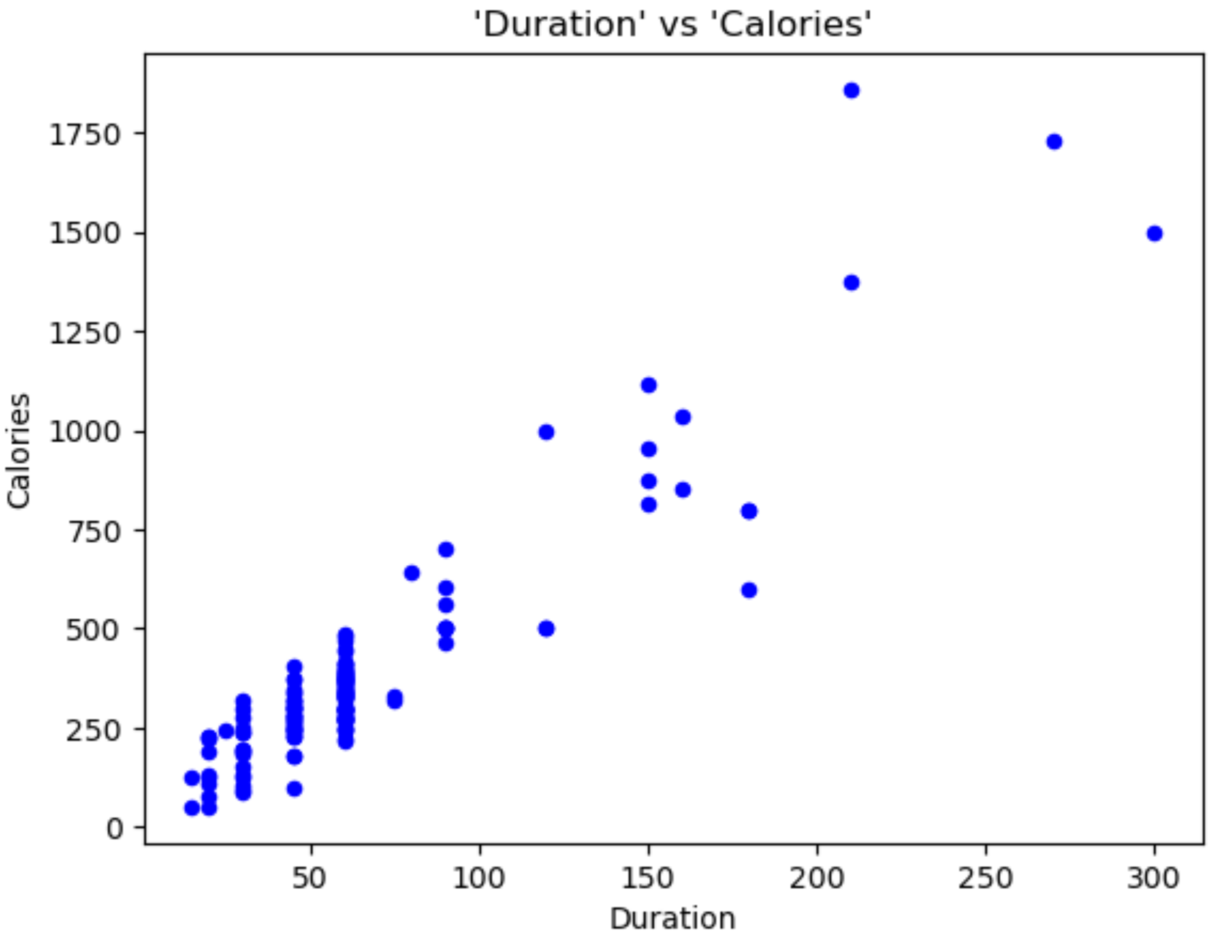
Question 10

Using pandas create a scatter plot for the two columns (Duration and Calories).

In [13]:

```
# Creating a scatter plot for 'Duration' vs 'Calories'
df.plot(x = 'Duration',
        y = 'Calories',
        kind = 'scatter',
        title = "'Duration' vs 'Calories'",
        c = 'blue')

# displaying the plot
plt.show()
```



2.Scikit-learn

Naïve Bayes method using scikit-learn library.

Question 1

Implement Naïve Bayes method using scikit-learn library.

```
a. Use the glass dataset available in Link also provided in your assignment.
```

In [16]:
```
# Loading the dataset
glass_df = pd.read_csv("glass.csv")
glass_df.head()
```

Out[16]:

	RI	Na	Mg	Al	Si	K	Ca	Ba	Fe	Type
0	1.52101	13.64	4.49	1.10	71.78	0.06	8.75	0.0	0.0	1
1	1.51761	13.89	3.60	1.36	72.73	0.48	7.83	0.0	0.0	1
2	1.51618	13.53	3.55	1.54	72.99	0.39	7.78	0.0	0.0	1
3	1.51766	13.21	3.69	1.29	72.61	0.57	8.22	0.0	0.0	1
4	1.51742	13.27	3.62	1.24	73.08	0.55	8.07	0.0	0.0	1

```
b. Use train_test_split to create training and testing part.
```

In [17]:
```
x1 = glass_df.iloc[:,:-1].values
y1 = glass_df['Type'].values

# Splitting the dataset into training and testing sets
x_train, x_test, y_train, y_test=train_test_split(x1, y1, test_size =
```

Question 2

Evaluate the model on testing part using score and

```
classification_report(y_true, y_pred)
```

In [18]:

```
# GaussianNB()- function creates an instance of the Gaussian Naive Bay
classifier1 = GaussianNB()

# Training the classifier using the training data
classifier1.fit(x_train, y_train)

# Making predictions on the testing data and storing in y_pred
y_pred = classifier1.predict(x_test)

# generates a confusion matrix that summarizes the number of TP, FP, T
print('Confusion Matrix:\n', confusion_matrix(y_test, y_pred))

# accuracy of the classifier by comparing features (x_test) with true 
print("\n\t Accuracy by score:", classifier1.score(x_test, y_test))

# accuracy of the classifier by comparing the predicted values (y_pred
print('\nAccuracy by accuracy_score:', accuracy_score(y_pred, y_test))

'''generating a summary of the predictions made by the classifier, inc
recall, and F1-score for each class, as well as an overall accuracy sc
print('\n',classification_report(y_test, y_pred))
```

```
Confusion Matrix:
 [[18  1  0  0  1  1]
 [21  3  1  1  0  0]
 [ 7  0  0  0  0  0]
 [ 0  2  0  0  0  0]
 [ 0  0  0  0  2  0]
 [ 0  0  0  0  0  7]]

         Accuracy by score: 0.46153846153846156

Accuracy by accuracy_score: 0.46153846153846156

               precision    recall  f1-score   support

           1       0.39      0.86      0.54        21
           2       0.50      0.12      0.19        26
           3       0.00      0.00      0.00         7
           5       0.00      0.00      0.00         2
           6       0.67      1.00      0.80         2
           7       0.88      1.00      0.93         7

    accuracy                           0.46        65
   macro avg       0.41      0.50      0.41        65
weighted avg       0.44      0.46      0.37        65
```

Linear SVM method using scikit library.

Question 1

Implement linear SVM method using scikit library

```
a. Use the glass dataset available in Link also provided in your assignment.
b. Use train_test_split to create training and testing part.
```

`Ans` : Using the loaded dataset and the split done previously for Naïve Bayes method.

Question 2

Evaluate the model on testing part using score and

```
classification_report(y_true, y_pred)
```

In [19]:

```
# LinearSVC( ) - function creates an instance of the Linear support ve
classifier2 = LinearSVC(random_state = 1)

# Training the classifier using the training data
classifier2.fit(x_train, y_train)

# Making predictions on the testing data and storing in y_pred
y_pred2 = classifier2.predict(x_test)

# generates a confusion matrix that summarizes the number of TP, FP, T
print('Confusion Matrix:\n',confusion_matrix(y_test, y_pred2))

# accuracy of the classifier by comparing features (x_test) with true
print("\n\t Accuracy by score:", classifier2.score(x_test, y_test))

# accuracy of the classifier by comparing the predicted values (y_pred
print('\nAccuracy by accuracy_score:', accuracy_score(y_pred2, y_test)

'''generating a summary of the predictions made by the classifier, inc
recall, and F1-score for each class, as well as an overall accuracy sc
print('\n',classification_report(y_test, y_pred))
```

```
Confusion Matrix:
 [[10 11  0  0  0  0]
 [ 8 18  0  0  0  0]
 [ 2  5  0  0  0  0]
 [ 0  2  0  0  0  0]
 [ 0  2  0  0  0  0]
 [ 0  6  0  0  0  1]]

	 Accuracy by score: 0.4461538461538462

Accuracy by accuracy_score: 0.4461538461538462

               precision    recall  f1-score   support

           1       0.39      0.86      0.54        21
           2       0.50      0.12      0.19        26
           3       0.00      0.00      0.00         7
           5       0.00      0.00      0.00         2
           6       0.67      1.00      0.80         2
           7       0.88      1.00      0.93         7

    accuracy                           0.46        65
   macro avg       0.41      0.50      0.41        65
weighted avg       0.44      0.46      0.37        65
```

Do at least two visualizations to describe or show correlations in the Glass Dataset.

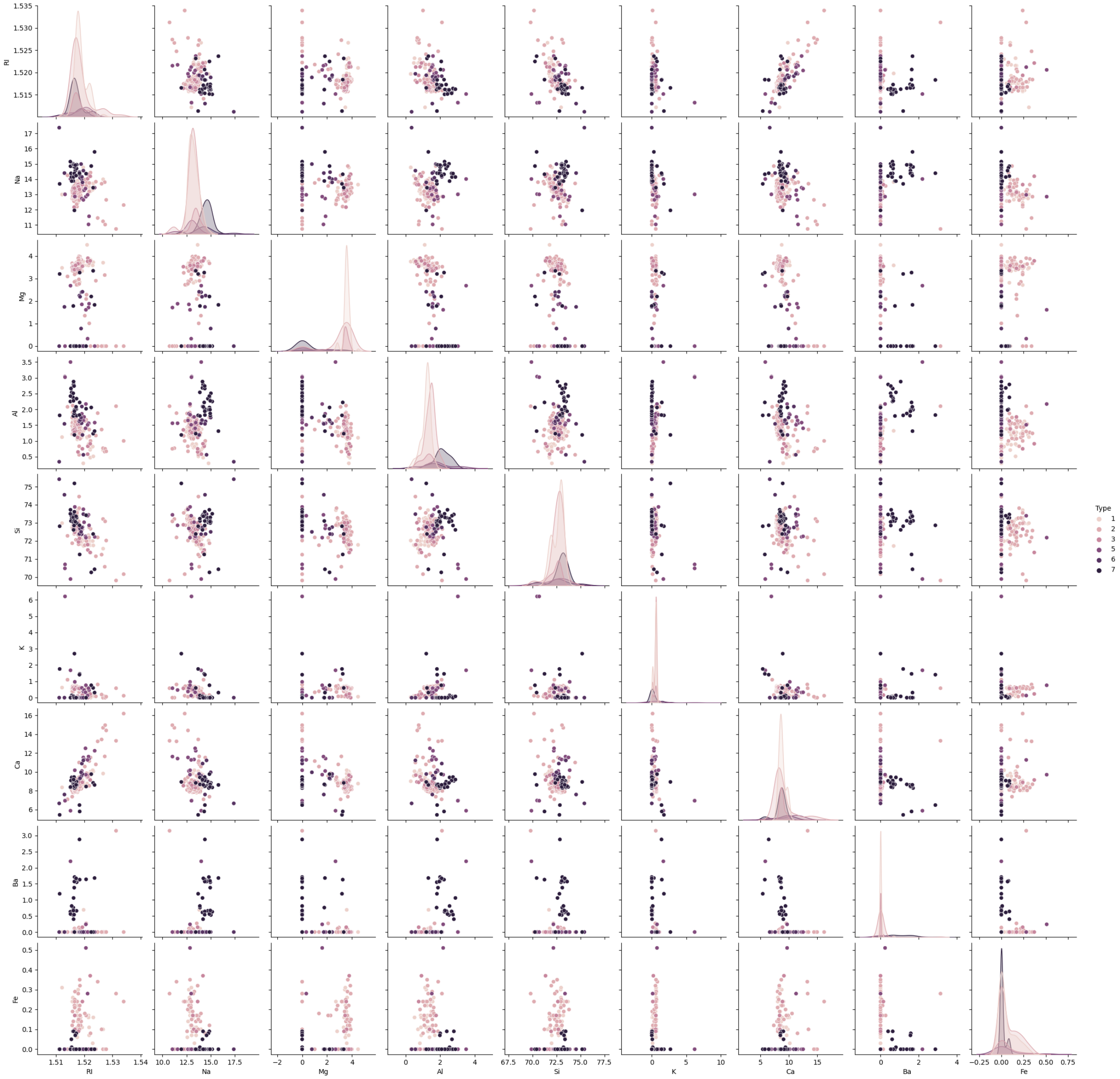
Visualization 1: Scatter Plot Matrix

In [20]:

```
# scatter plot matrix - shows the pairwise scatter plots of multiple v
# as the hue parameter is set to 'Type', it colors the scatter plot po
sns.pairplot(glass_df, hue='Type')
```

Out[20]:

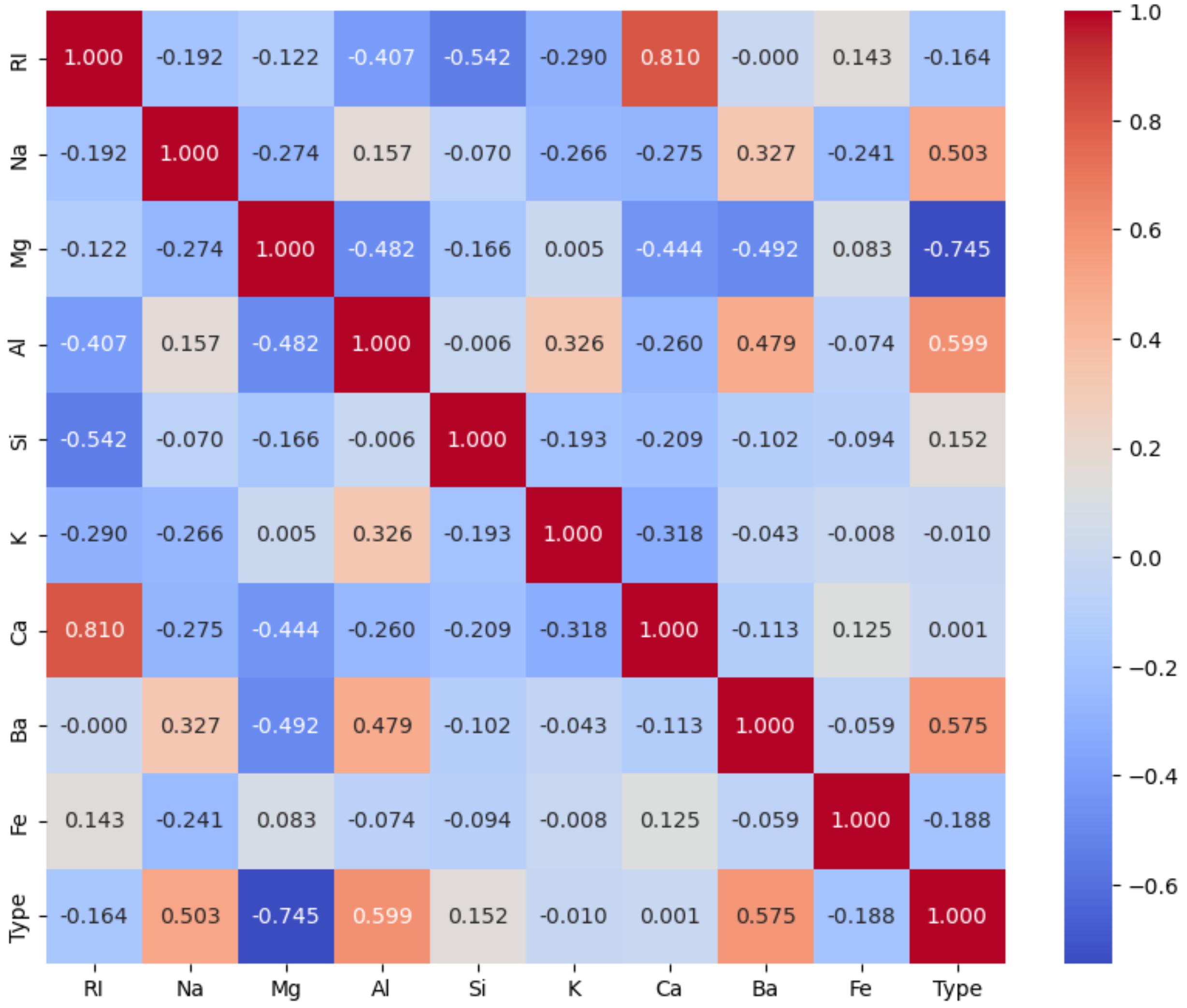
```
<seaborn.axisgrid.PairGrid at 0x7f7abba4bdc0>
```



Visualization 2: Heatmap

In [21]:
```
plt.figure(figsize=(10, 8))
corr = glass_df.corr()

#Heatmap: shows the correlation between pairs of variables, with a col
sns.heatmap(corr, annot=True, cmap='coolwarm', fmt='.3f')
plt.show()
```



	RI	Na	Mg	Al	Si	K	Ca	Ba	Fe	Type
RI	1.000	-0.192	-0.122	-0.407	-0.542	-0.290	0.810	-0.000	0.143	-0.164
Na	-0.192	1.000	-0.274	0.157	-0.070	-0.266	-0.275	0.327	-0.241	0.503
Mg	-0.122	-0.274	1.000	-0.482	-0.166	0.005	-0.444	-0.492	0.083	-0.745
Al	-0.407	0.157	-0.482	1.000	-0.006	0.326	-0.260	0.479	-0.074	0.599
Si	-0.542	-0.070	-0.166	-0.006	1.000	-0.193	-0.209	-0.102	-0.094	0.152
K	-0.290	-0.266	0.005	0.326	-0.193	1.000	-0.318	-0.043	-0.008	-0.010
Ca	0.810	-0.275	-0.444	-0.260	-0.209	-0.318	1.000	-0.113	0.125	0.001
Ba	-0.000	0.327	-0.492	0.479	-0.102	-0.043	-0.113	1.000	-0.059	0.575
Fe	0.143	-0.241	0.083	-0.074	-0.094	-0.008	0.125	-0.059	1.000	-0.188
Type	-0.164	0.503	-0.745	0.599	0.152	-0.010	0.001	0.575	-0.188	1.000

Which algorithm you got better accuracy? Can you justify why?

Ans:

The accuracy scores for both classifiers are very low. Considering the accuracy scores, Naïve Bayes classifier performed slightly better than the Linear SVC classifier.

```
Justification:
```

Naive Bayes analysis works well with probabilistic concepts where as Linear SVM works better with linear regression logics. But to perform more accurately, SVM requires large amounts of data to train and test the data.

So, based on the amount of data given, Naive Bayes algorithm gives better accuracy compared to Linear SVM.