In [3]:
```
#Import all the necessary libraries
import pandas as pd
import numpy as np
import os
import seaborn as sns
import matplotlib.pyplot as plt
```

Let us now load the data and check the first 10 rows of the dataframe.

In [4]:
```
df = pd.read_csv("Redwine+Quality.csv")
df.head(10)
```

Out[4]:

	Unnamed: 0	Tartaric Acid	Grape Density	Citric Acid	Residual.sugar	Sodium chloride	Free.sulfur.dioxide	Bound.sulfur.dioxide	Alcohol Density	PH Levels	Potassium chloride	Alcohol Content
0	1	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4
1	2	7.8	0.88	0.00	2.6	0.098	25.0	67.0	0.9968	3.20	0.68	9.8
2	3	7.8	0.76	0.04	2.3	0.092	15.0	54.0	0.9970	3.26	0.65	9.8
3	4	11.2	0.28	0.56	1.9	0.075	17.0	60.0	0.9980	3.16	0.58	9.8
4	5	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4
5	6	7.4	0.66	0.00	1.8	0.075	13.0	40.0	0.9978	3.51	0.56	9.4
6	7	7.9	0.60	0.06	1.6	0.069	15.0	59.0	0.9964	3.30	0.46	9.4
7	8	7.3	0.65	0.00	1.2	0.065	15.0	21.0	0.9946	3.39	0.47	10.0
8	9	7.8	0.58	0.02	2.0	0.073	9.0	18.0	0.9968	3.36	0.57	9.5
9	10	7.5	0.50	0.36	6.1	0.071	17.0	102.0	0.9978	3.35	0.80	10.5

In [5]:
```
df.drop('Unnamed: 0',axis=1,inplace=True)
```

Now, that we have dropped the 'ID' column, let us check the shape and the various data types of the variables of the dataframe.

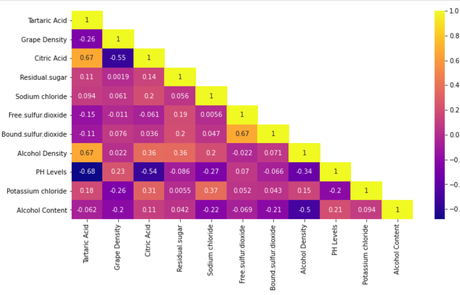
In [6]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1599 entries, 0 to 1598
Data columns (total 11 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   Tartaric Acid         1599 non-null   float64
 1   Grape Density         1599 non-null   float64
 2   Citric Acid           1599 non-null   float64
 3   Residual.sugar        1599 non-null   float64
 4   Sodium chloride       1599 non-null   float64
 5   Free.sulfur.dioxide   1599 non-null   float64
 6   Bound.sulfur.dioxide  1599 non-null   float64
 7   Alcohol Density       1599 non-null   float64
 8   PH Levels             1599 non-null   float64
 9   Potassium chloride    1599 non-null   float64
 10  Alcohol Content       1599 non-null   float64
dtypes: float64(11)
memory usage: 137.5 KB
```

We see that all are numeric variables.

Let us check the correlation between these variables.

In [7]:
```
plt.figure(figsize=(12,6))
sns.heatmap(df.corr(),cmap='plasma',fmt='.2g',annot=True,mask=np.triu(df.corr(),+1))
plt.show()
```



We see that there is some degree of correlation amongst the variables given in the dataframe.

Now, we will scale the data.

In [8]:
```
# All variables are on same scale, hence we can omit scaling.
# But to standardize the process we will do it here

from scipy.stats import zscore
data_scaled=df.apply(zscore)
data_scaled.head()
```

Out[8]:

	Tartaric Acid	Grape Density	Citric Acid	Residual.sugar	Sodium chloride	Free.sulfur.dioxide	Bound.sulfur.dioxide	Alcohol Density	PH Levels	Potassium chloride	Alcohol Content
0	-0.528360	0.961877	-1.391472	-0.453218	-0.243707	-0.466193	-0.379133	0.558274	1.288643	-0.579207	-0.960246
1	-0.298547	1.967442	-1.391472	0.043416	0.223875	0.872638	0.624363	0.028261	-0.719933	0.128950	-0.584777
2	-0.298547	1.297065	-1.186070	-0.169427	0.096353	-0.083669	0.229047	0.134264	-0.331177	-0.048089	-0.584777
3	1.654856	-1.384443	1.484154	-0.453218	-0.264960	0.107592	0.411500	0.664277	-0.979104	-0.461180	-0.584777
4	-0.528360	0.961877	-1.391472	-0.453218	-0.243707	-0.466193	-0.379133	0.558274	1.288643	-0.579207	-0.960246

PCA

Before we go ahead and perform the Principal Component Analysis, let us build the covariance matrix.

In [10]:
```
#Apply PCA taking all features
from sklearn.decomposition import PCA
pca = PCA(n_components=6, random_state=123)
pca_transformed = pca.fit_transform(data_scaled)
```

In [11]:
```
pca_transformed
```

Out[11]:
```
array([[-1.61952988,  0.45095009, -1.77445415,  0.04374031,  0.06701448,
         -0.91392069],
       [-0.79916993,  1.85655306, -0.91169017,  0.54806597, -0.01839156,
          0.92971392],
       [-0.74847909,  0.88203886, -1.17139423,  0.41102067, -0.04353101,
          0.40147313],
       ...,
       [-1.45612897,  0.31174559,  1.12423941,  0.49187676,  0.19371564,
         -0.50640956],
       [-2.27051793,  0.97979111,  0.62796456,  0.63977007,  0.06773549,
         -0.86040762],
       [-0.42697475, -0.53669021,  1.6289552 , -0.39171595,  0.45048209,
          0.49615364]])
```

Using given dataset, Find out the eigenvector of the 5th component

In [12]:
```
#Extract eigen vectors
pca.components_
```

Out[12]:
```
array([[ 0.48931422, -0.23858436,  0.46363166,  0.14610715,  0.21224658,
         -0.03615752,  0.02357485,  0.39535301, -0.43851962,  0.24292133,
         -0.11323207],
       [-0.11050274,  0.27493048, -0.15179136,  0.27208024,  0.14805156,
          0.51356681,  0.56948696,  0.23357549,  0.00671079, -0.03755392,
         -0.38618096],
       [-0.12330157, -0.44996253,  0.23824707,  0.10128338, -0.09261383,
          0.42879287,  0.3224145 , -0.33887135,  0.05769735,  0.27978615,
          0.47167322],
       [-0.22961737,  0.07895978, -0.07941826, -0.37279256,  0.66619476,
         -0.04353782, -0.03457712, -0.17449976, -0.00378775,  0.55087236,
         -0.12218109],
       [-0.08261366,  0.21873452, -0.05857268,  0.73214429,  0.2465009 ,
         -0.15915198, -0.22246456,  0.15707671,  0.26752977,  0.22596222,
          0.35068141],
       [ 0.10147858,  0.41144893,  0.06959338,  0.04915555,  0.30433857,
         -0.01400021,  0.13630755, -0.3911523 , -0.52211645, -0.38126343,
          0.36164504]])
```

In [ ]:
```

```

Using the given dataset, Find out eigenvalues?

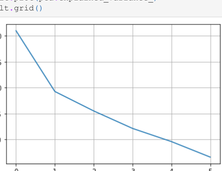
In [13]:
```
#Check the eigen values
#Note: This is always returned in descending order
pca.explained_variance_
```

Out[13]:
```
array([3.10107182, 1.92711489, 1.55151379, 1.21399175, 0.95989238,
       0.66002104])
```

In [16]:
```
a=pca.explained_variance_
```

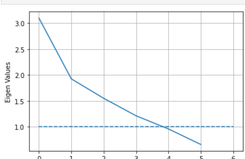
As per given Scree Plot, how many principal components are preferred?

In [14]:
```
plt.plot(pca.explained_variance_)
plt.grid()
```



Plot of eigen values with the number of factors or Principal Components

In [19]:
```
plt.plot(range(0,6),a)
plt.grid()
plt.ylabel('Eigen Values')
plt.xlabel('Factors')
plt.hlines(y=1,xmin=0,xmax=6,linestyles='dashed');
```



In [ ]:
```

```

Using the given dataset, What are explained variances

In [17]:
```
#Check the explained variance for each PC
#Note: Explained variance = (eigen value of each PC)/(sum of eigen values of all PCs)
pca.explained_variance_ratio_
```

Out[17]:
```
array([0.28173931, 0.1750827 , 0.1409585 , 0.11029387, 0.08720837,
       0.05996439])
```

END