Principal Component Analysis (PCA) And Kmeans

Importing the libraries

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

Importing the dataset

```
dataset = pd.read_csv(r'D:\Collage\TERM 4\Machine Learning\Machine project\Data\heart.csv')
```

```
dataset.head
```

```
<bound method NDFrame.head of      age  sex  cp  trestbps  chol  fbs  restecg  thalach
0     63    1   3       145   233    1        0      150      0      2.3
1     37    1   2       130   250    0        1      187      0      3.5
2     41    0   1       130   204    0        0      172      0      1.4
3     56    1   1       120   236    0        1      178      0      0.8
4     57    0   0       120   354    0        1      163      1      0.6
..   ...  ...  ..       ...   ...  ...      ...      ...    ...      ...
298   57    0   0       140   241    0        1      123      1      0.2
299   45    1   3       110   264    0        1      132      0      1.2
300   68    1   0       144   193    1        1      141      0      3.4
301   57    1   0       130   131    0        1      115      1      1.2
302   57    0   1       130   236    0        0      174      0      0.0

     slope  ca  thal  target
0        0   0     1       1
1        0   0     2       1
2        2   0     2       1
3        2   0     2       1
4        2   0     2       1
..     ...  ..   ...     ...
298      1   0     3       0
299      1   0     3       0
300      1   2     3       0
301      1   1     3       0
302      1   1     2       0

[303 rows x 14 columns]>
```

```
dataset.shape
```

```
(303, 14)
```

```
dataset.isnull().sum()
```

```
age         0
sex         0
cp          0
trestbps    0
chol        0
fbs         0
restecg     0
thalach     0
exang       0
oldpeak     0
slope       0
ca          0
thal        0
target      0
dtype: int64
```

```
len (dataset[dataset.duplicated()])
```

```
1
```

```
dataset.drop_duplicates()
```

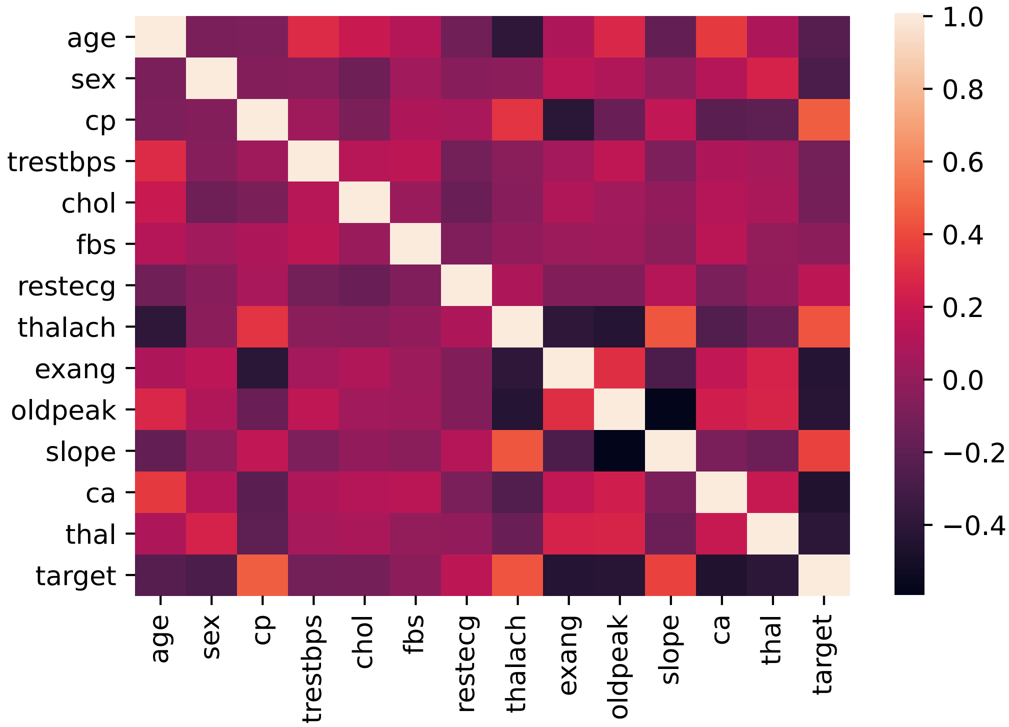
```
dataset.describe()
```

	age	sex	cp	trestbps	chol	fbs	res
count	303.000000	303.000000	303.000000	303.000000	303.000000	303.000000	303.00
mean	54.366337	0.683168	0.966997	131.623762	246.264026	0.148515	0.52
std	9.082101	0.466011	1.032052	17.538143	51.830751	0.356198	0.52
min	29.000000	0.000000	0.000000	94.000000	126.000000	0.000000	0.00
25%	47.500000	0.000000	0.000000	120.000000	211.000000	0.000000	0.00
50%	55.000000	1.000000	1.000000	130.000000	240.000000	0.000000	1.00
75%	61.000000	1.000000	2.000000	140.000000	274.500000	0.000000	1.00
max	77.000000	1.000000	3.000000	200.000000	564.000000	1.000000	2.00

302 rows × 14 columns

```
sns.heatmap(dataset.corr(method='spearman', min_periods=1))
```

<AxesSubplot:>

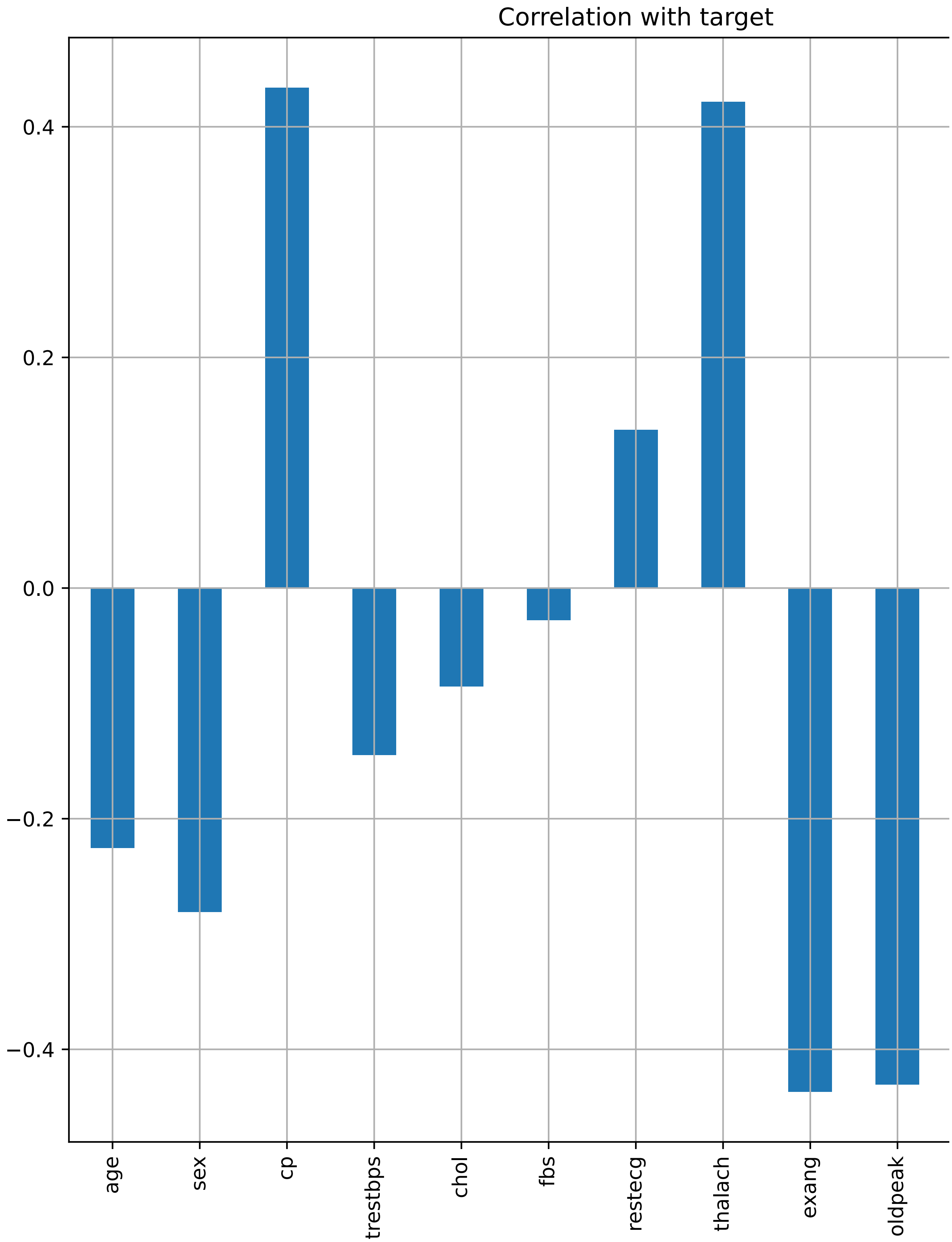


form the heat-map notice there may be a cooralltion between target and three factors CP, Thalach and Slope

```
X = dataset.drop('target', axis=1)
```

```
y = dataset['target']
X.corrwith(y).plot(kind='bar', grid=True, figsize=(10, 10), title="Correlation with target")
```

```
<AxesSubplot:title={'center':'Correlation with target'}>
```



we can use this data to eliminate simmilar coolarting attributes

```
X=dataset.iloc[:,:-1]
y=dataset.iloc[:,-1]
```

Feature Scaling

```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
X = sc.fit_transform(X)
print(X , X.shape)
print(y)
```

```
[[ 0.9521966   0.68100522  1.97312292 ... -2.27457861 -0.71442887
  -2.14887271]
 [-1.91531289  0.68100522  1.00257707 ... -2.27457861 -0.71442887
  -0.51292188]
 [-1.47415758 -1.46841752  0.03203122 ...  0.97635214 -0.71442887
  -0.51292188]
 ...
 [ 1.50364073  0.68100522 -0.93851463 ... -0.64911323  1.24459328
   1.12302895]
 [ 0.29046364  0.68100522 -0.93851463 ... -0.64911323  0.26508221
   1.12302895]
 [ 0.29046364 -1.46841752  0.03203122 ... -0.64911323  0.26508221
  -0.51292188]] (303, 13)
0      1
1      1
2      1
3      1
4      1
      ..
298    0
299    0
300    0
301    0
302    0
Name: target, Length: 303, dtype: int64
```

Training the Kmeans cluster model on the Training set

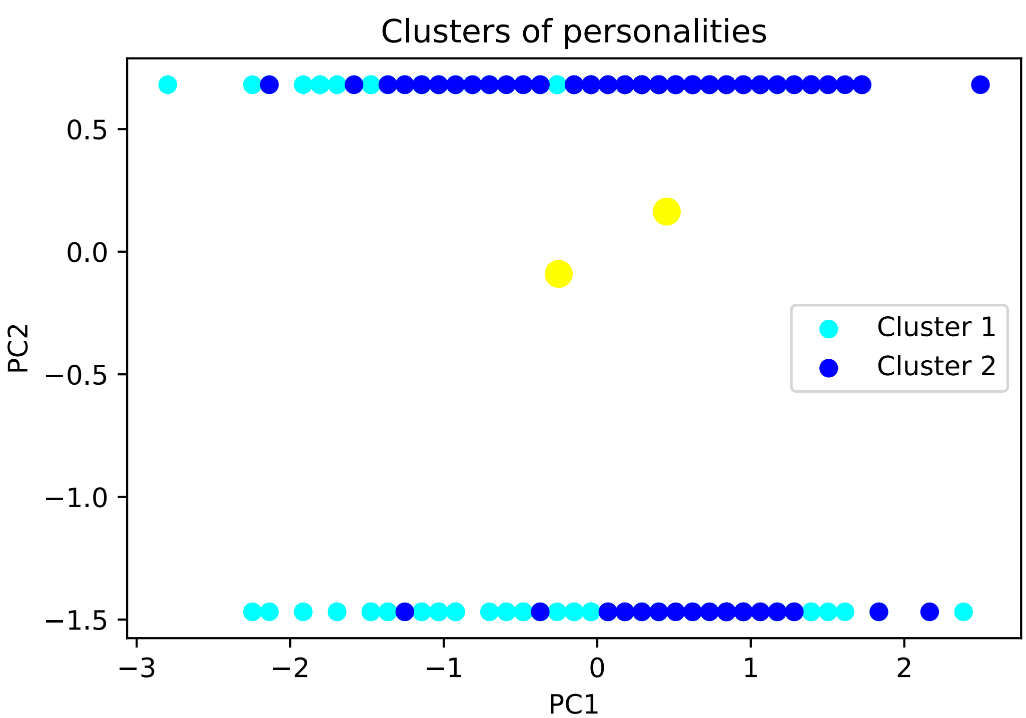
```
from sklearn.cluster import KMeans
kmeans = KMeans(n_clusters = 2, init = 'k-means++', random_state = 42)
y_kmeans_normal= kmeans.fit_predict(X)
print(y_kmeans_normal)
```

```
[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1
```

```
 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0
 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 1 1 1 1 1 0 0 0 0 1 1 1 0 1 1 1 1 0 0 1
 0 1 1 0 0 1 1 1 1 0 1 0 1 1 0 0 1 1 1 1 0 1 1 1 1 0 1 0 1 1 1 1 1 1 1 1 1
 0 1 1 1 1 1 0 1 0 1 1 1 1 1 0 1 1 0 1 1 1 1 1 0 1 1 0 1 1 1 1 1 0 1 1 1 1
 0 1 0 1 1 1 1 1 0 1 1 0 0 1 0 1 0 1 0 0 1 1 0 0 0 1 1 0 0 1 1 0 1 1 0 1 1
 1 1 1 0 1 1 0]
```

```
plt.scatter(X[y_kmeans_normal == 0, 0], X[y_kmeans_normal == 0, 1], c = 'cyan', label = 'Clus
plt.scatter(X[y_kmeans_normal == 1, 0], X[y_kmeans_normal == 1, 1], c = 'blue', label = 'Clus


centroids = kmeans.cluster_centers_
plt.scatter(centroids[:, 0], centroids[:, 1] ,s=90,
            color="yellow")
plt.title('Clusters of personalities')
plt.xlabel('PC1')
plt.ylabel('PC2')
plt.legend()
plt.show()
```




```
counter = 0
for i in range(303):
    if y[i] != y_kmeans_normal[i]:
        counter = counter+1


print ('accuarcy of kmeans without PCA = ',(counter/303)*100)
```

```
 accuarcy of kmeans without PCA =  81.51815181518151
```

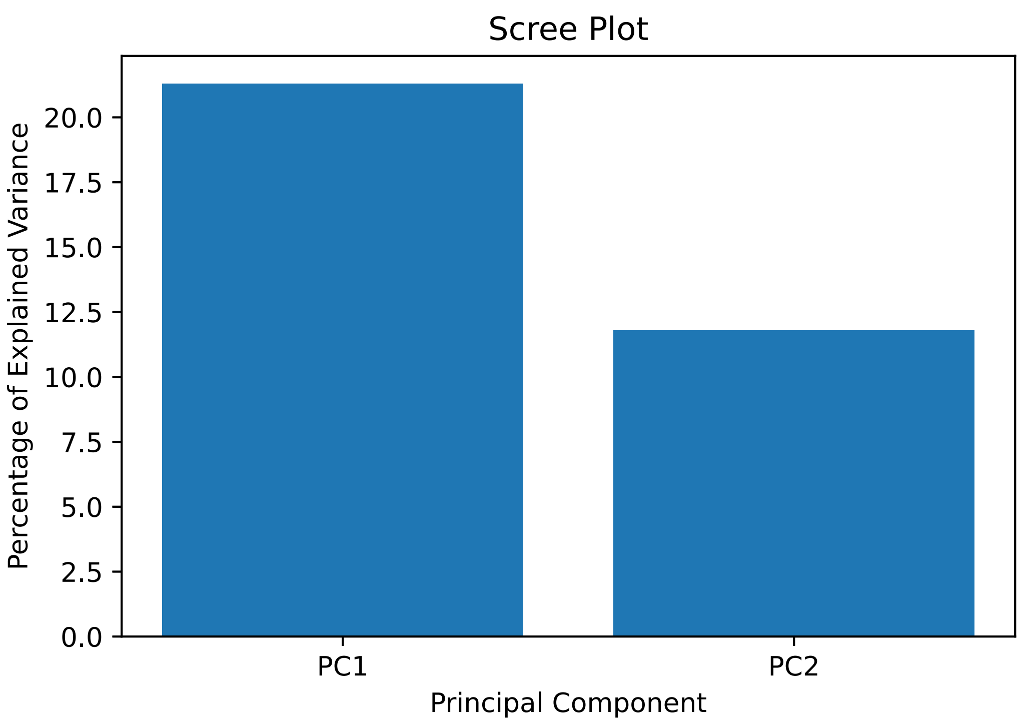
Applying PCA

```
from sklearn.decomposition import PCA
pca = PCA(n_components=2)
X_pca= pca.fit_transform(X)
print(pca.explained_variance_ratio_*100)
```

```
[21.25405312 11.82070772]
```

```
# percentage variation
per_var = np.round(pca.explained_variance_ratio_*100, decimals =1)
labels = ['PC' + str(x) for x in range (1, len(per_var)+1)]

# plot the percentage of explained variance by principal component
plt.bar(x=range(1,len(per_var)+1), height=per_var, tick_label = labels)
plt.ylabel('Percentage of Explained Variance')
plt.xlabel('Principal Component')
plt.title('Scree Plot')
plt.show()
```



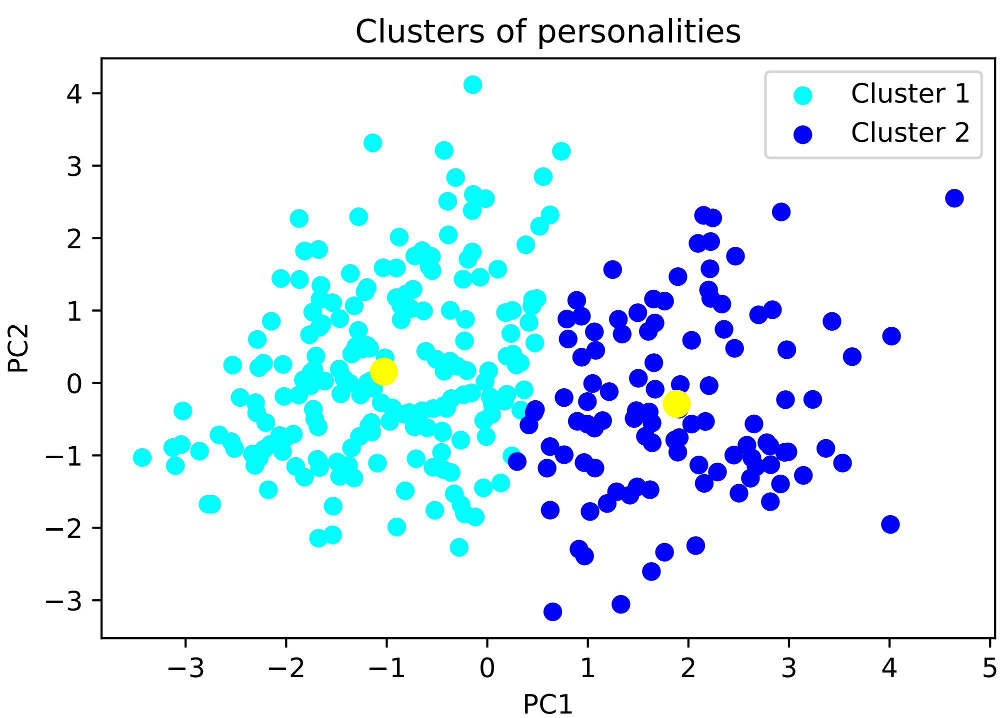

```
from sklearn.cluster import KMeans
kmeans = KMeans(n_clusters = 2, init = 'k-means++', random_state = 42)
```

```
y_kmeans_PCA = kmeans.fit_predict(X_pca)
print(y_kmeans_PCA)
```

```
[0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0
 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 1 1 1 1 1 0 0 0 0 1 1 1 0 1 1 1 1 0 0 1
 0 1 1 0 0 1 1 1 1 0 1 0 1 1 0 0 1 1 1 1 0 1 1 1 0 0 1 0 1 1 1 1 1 1 1 1 1
 0 1 1 1 1 1 0 1 0 1 1 1 1 0 0 1 1 0 1 1 1 1 1 0 1 1 0 1 1 1 1 1 0 1 1 1 1
 0 1 0 1 1 1 1 1 0 1 1 0 0 1 0 1 0 1 0 0 1 1 0 0 0 1 1 0 0 1 1 0 1 1 0 1 1
 1 1 1 0 1 1 0]
```

```
plt.scatter(X_pca[y_kmeans_PCA == 0, 0], X_pca[y_kmeans_PCA == 0, 1], c = 'cyan', label = 'Cl
plt.scatter(X_pca[y_kmeans_PCA == 1, 0], X_pca[y_kmeans_PCA == 1, 1], c = 'blue', label = 'Cl


centroids = kmeans.cluster_centers_
plt.scatter(centroids[:, 0], centroids[:, 1] ,s=90,
            color="yellow")
plt.title('Clusters of personalities')
plt.xlabel('PC1')
plt.ylabel('PC2')
plt.legend()
plt.show()
```




```
counter = 0
for i in range(303):
    if y[i] != y_kmeans_PCA[i]:
        counter = counter+1
```

```
print ('accuarcy of kmeans after pca = ',(counter/303)*100)
```

```
accuarcy of kmeans after pca =  80.52805280528052
```

Using LDA in clasfication

```
X.shape
```

```
(303, 13)
```

```
from sklearn.model_selection import train_test_split

# Choose your test size to split between training and testing sets:
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, random_state=42)
print(X_test.shape,X_train,y_test,y_train)
```

```
(76, 13) [[ 0.29046364  0.68100522  0.03203122 ...  0.97635214  0.26508221
  -0.51292188]
 [ 0.5110413   0.68100522  1.00257707 ... -0.64911323  0.26508221
  -2.14887271]
 [ 1.39335191  0.68100522 -0.93851463 ... -0.64911323  1.24459328
   1.12302895]
 ...
 [ 1.61392956  0.68100522  1.97312292 ... -0.64911323  0.26508221
  -0.51292188]
 [-0.92271345  0.68100522 -0.93851463 ...  0.97635214 -0.71442887
   1.12302895]
 [ 0.9521966  -1.46841752  0.03203122 ...  0.97635214  1.24459328
  -0.51292188]] 179    0
228    0
111    1
246    0
60     1
      ..
22     1
258    0
56     1
242    0
114    1
Name: target, Length: 76, dtype: int64 287    0
282    0
197    0
158    1
164    1
      ..
188    0
71     1
106    1
270    0
```

```
102    1
Name: target, Length: 227, dtype: int64
```

```
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis
lda = LinearDiscriminantAnalysis(n_components=1)
X_lda = lda.fit_transform(X_train, y_train)
print("After LDA:\n")
print("Features of size: ", X_lda.shape)
print(X_lda)
```

```
After LDA:

Features of size:  (227, 1)
[[ 0.30962152]
 [ 0.62846124]
 [-1.09585506]
 [-1.80586787]
 [-0.13471137]
 [-1.50617284]
 [ 0.37071832]
 [ 0.3038056 ]
 [ 0.35237919]
 [-1.56788959]
 [-3.67393347]
 [ 1.28333572]
 [ 0.45015629]
 [-0.33447716]
 [ 1.52935295]
 [ 2.70341003]
 [ 1.23801646]
 [ 1.5586627 ]
 [ 0.40184487]
 [-0.13471137]
 [ 0.63222217]
 [-1.12904636]
 [ 1.33357231]
 [-0.67992379]
 [ 0.34908855]
 [ 2.39074077]
 [ 0.70686352]
 [-1.79968905]
 [-0.10908848]
 [ 1.1081908 ]
 [ 1.67743378]
 [ 1.50730318]
 [ 0.07005389]
 [-2.00583721]
 [ 1.73957905]
 [ 1.68723912]
 [-2.74614127]
 [ 0.343336  ]
 [-0.01246514]
 [ 0.21101369]
 [-0.49612589]
 [ 1.76295212]
 [ 0.39166766]
 [-1.92518918]
```

```
[-1.0626381 ]
[-1.94921453]
[-2.12670496]
[ 0.02898172]
[-2.39632027]
[-2.29164699]
[ 0.52171031]
[-1.38727235]
[-0.65233535]
[-0.25209574]
[ 0.10932014]
[ 1.84027103]
```

```
prediction = lda.predict(X_test)
counter = 0
for i in range(76):
    if prediction[i]==y_test.iloc[i]:
        counter = counter + 1


print("accuracy = ",(counter/76)*100)
```

```
accuracy =  86.8421052631579
```