In [293]:

```
import pandas as pd
import numpy as np
import sklearn
import matplotlib.pyplot as plt
import seaborn as sb
import time

from sklearn.decomposition import PCA
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import DBSCAN
from sklearn.cluster import KMeans
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score
```

In [294]:

```
df = pd.read_csv('winequalityN.csv')
df = df.dropna()
df.columns
```

Out[294]:

```
Index(['type', 'fixed acidity', 'volatile acidity', 'citric acid',
       'residual sugar', 'chlorides', 'free sulfur dioxide',
       'total sulfur dioxide', 'density', 'pH', 'sulphates', 'alcohol',
       'quality'],
      dtype='object')
```

In [295]:

```
#df_wine = pd.DataFrame(df,
#                columns=['type','fixed acidity', 'volatile acidity', 'citric acid',
#       'residual sugar', 'chlorides', 'free sulfur dioxide',
#       'total sulfur dioxide', 'density', 'pH', 'sulphates', 'alcohol', 'quality'])
df_wine = pd.DataFrame(df)
```

In [296]:

```
df_wine.isnull().sum()
df_wine.head()
```

Out[296]:

	type	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphat
0	white	7.0	0.27	0.36	20.7	0.045	45.0	170.0	1.0010	3.00	0.
1	white	6.3	0.30	0.34	1.6	0.049	14.0	132.0	0.9940	3.30	0.
2	white	8.1	0.28	0.40	6.9	0.050	30.0	97.0	0.9951	3.26	0.
3	white	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.9956	3.19	0.
4	white	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.9956	3.19	0.

In [297]:

```
def myfunctiontype(t):
    if t == "red":
        return 0
    elif t == "white":
        return 1
    else:
        return 2

df_wine["type"] = df_wine["type"].apply(myfunctiontype)
df_wine.head(10)
```

Out[297]:

	type	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphate
0	1	7.0	0.27	0.36	20.7	0.045	45.0	170.0	1.0010	3.00	0.4
1	1	6.3	0.30	0.34	1.6	0.049	14.0	132.0	0.9940	3.30	0.4
2	1	8.1	0.28	0.40	6.9	0.050	30.0	97.0	0.9951	3.26	0.4
3	1	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.9956	3.19	0.4
4	1	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.9956	3.19	0.4
5	1	8.1	0.28	0.40	6.9	0.050	30.0	97.0	0.9951	3.26	0.4
6	1	6.2	0.32	0.16	7.0	0.045	30.0	136.0	0.9949	3.18	0.4
7	1	7.0	0.27	0.36	20.7	0.045	45.0	170.0	1.0010	3.00	0.4
8	1	6.3	0.30	0.34	1.6	0.049	14.0	132.0	0.9940	3.30	0.4
9	1	8.1	0.22	0.43	1.5	0.044	28.0	129.0	0.9938	3.22	0.4

In [298]:

```
def myfunctionquality(q):
    if q >=0 and q < 4:
        return 0
    elif q > 4 and q <7:
        return 1
    else:
        return 2

df_wine["quality"] = df_wine["quality"].apply(myfunctionquality)
df_wine.head(10)
```

Out[298]:

	type	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphate
0	1	7.0	0.27	0.36	20.7	0.045	45.0	170.0	1.0010	3.00	0.4
1	1	6.3	0.30	0.34	1.6	0.049	14.0	132.0	0.9940	3.30	0.4
2	1	8.1	0.28	0.40	6.9	0.050	30.0	97.0	0.9951	3.26	0.4
3	1	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.9956	3.19	0.4
4	1	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.9956	3.19	0.4
5	1	8.1	0.28	0.40	6.9	0.050	30.0	97.0	0.9951	3.26	0.4
6	1	6.2	0.32	0.16	7.0	0.045	30.0	136.0	0.9949	3.18	0.4
7	1	7.0	0.27	0.36	20.7	0.045	45.0	170.0	1.0010	3.00	0.4
8	1	6.3	0.30	0.34	1.6	0.049	14.0	132.0	0.9940	3.30	0.4
9	1	8.1	0.22	0.43	1.5	0.044	28.0	129.0	0.9938	3.22	0.4

In [299]:

```
df_wine.head()
```

Out[299]:

	type	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphate
0	1	7.0	0.27	0.36	20.7	0.045	45.0	170.0	1.0010	3.00	0.4
1	1	6.3	0.30	0.34	1.6	0.049	14.0	132.0	0.9940	3.30	0.4
2	1	8.1	0.28	0.40	6.9	0.050	30.0	97.0	0.9951	3.26	0.4
3	1	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.9956	3.19	0.4
4	1	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.9956	3.19	0.4

In [300]:

```
df_wine.tail()
```

Out[300]:

	type	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulp
6491	0	6.8	0.620	0.08	1.9	0.068	28.0	38.0	0.99651	3.42	
6492	0	6.2	0.600	0.08	2.0	0.090	32.0	44.0	0.99490	3.45	
6494	0	6.3	0.510	0.13	2.3	0.076	29.0	40.0	0.99574	3.42	
6495	0	5.9	0.645	0.12	2.0	0.075	32.0	44.0	0.99547	3.57	
6496	0	6.0	0.310	0.47	3.6	0.067	18.0	42.0	0.99549	3.39	

In [301]:

```
df_wine.type.value_counts()
```

Out[301]:

```
1    4870
0    1593
Name: type, dtype: int64
```

In [302]:

```
df_wine.dtypes
```

Out[302]:

```
type                    int64
fixed acidity         float64
volatile acidity      float64
citric acid           float64
residual sugar        float64
chlorides             float64
free sulfur dioxide   float64
total sulfur dioxide  float64
density               float64
pH                    float64
sulphates             float64
alcohol               float64
quality                 int64
dtype: object
```

In [303]:

```
x = df_wine.iloc[:,1:12]

y = df_wine['quality']
x
```

Out[303]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates
0	7.0	0.270	0.36	20.7	0.045	45.0	170.0	1.00100	3.00	0.45
1	6.3	0.300	0.34	1.6	0.049	14.0	132.0	0.99400	3.30	0.49
2	8.1	0.280	0.40	6.9	0.050	30.0	97.0	0.99510	3.26	0.44
3	7.2	0.230	0.32	8.5	0.058	47.0	186.0	0.99560	3.19	0.40
4	7.2	0.230	0.32	8.5	0.058	47.0	186.0	0.99560	3.19	0.40
...	...	...	...	...	...	...	...	...	...	...
6491	6.8	0.620	0.08	1.9	0.068	28.0	38.0	0.99651	3.42	0.82
6492	6.2	0.600	0.08	2.0	0.090	32.0	44.0	0.99490	3.45	0.58
6494	6.3	0.510	0.13	2.3	0.076	29.0	40.0	0.99574	3.42	0.75
6495	5.9	0.645	0.12	2.0	0.075	32.0	44.0	0.99547	3.57	0.71
6496	6.0	0.310	0.47	3.6	0.067	18.0	42.0	0.99549	3.39	0.66

6463 rows × 11 columns

Visualization

In [304]:

```
#to view data as csv after binning
#df_wine.to_csv('winetest.csv')
df_wine.head()
```

Out[304]:

	type	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphate
0	1	7.0	0.27	0.36	20.7	0.045	45.0	170.0	1.0010	3.00	0.4
1	1	6.3	0.30	0.34	1.6	0.049	14.0	132.0	0.9940	3.30	0.4
2	1	8.1	0.28	0.40	6.9	0.050	30.0	97.0	0.9951	3.26	0.4
3	1	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.9956	3.19	0.4
4	1	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.9956	3.19	0.4

PCA

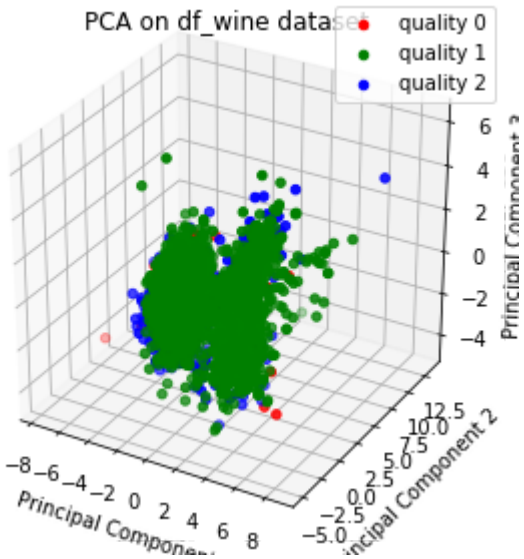
In [305]:

```
#sb.pairplot (df_wine, hue='quality', bw=1.5)
#plt.show()
```

In [306]:

```
y = df_wine.loc[:,'quality'].values
x = StandardScaler().fit_transform(df_wine.iloc[:,0:12])

pca = PCA(n_components=6)
pc = pca.fit_transform(x)

print(pca.explained_variance_ratio_)
print(pca.explained_variance_ratio_.sum())

colors = 'rgbmykc'

fig = plt.figure(figsize=(5, 5))
ax = plt.axes(projection='3d')

for i in np.unique(y):
    ax.scatter3D(pc[y==i,0], pc[y==i,1],
             pc[y==i,2], color=colors[i],
               label='quality ' + str(i))

ax.set_xlabel("Principal Component 1")
ax.set_ylabel("Principal Component 2")
ax.set_zlabel("Principal Component 3")

plt.legend()
plt.title('PCA on df_wine dataset')
plt.show()
```

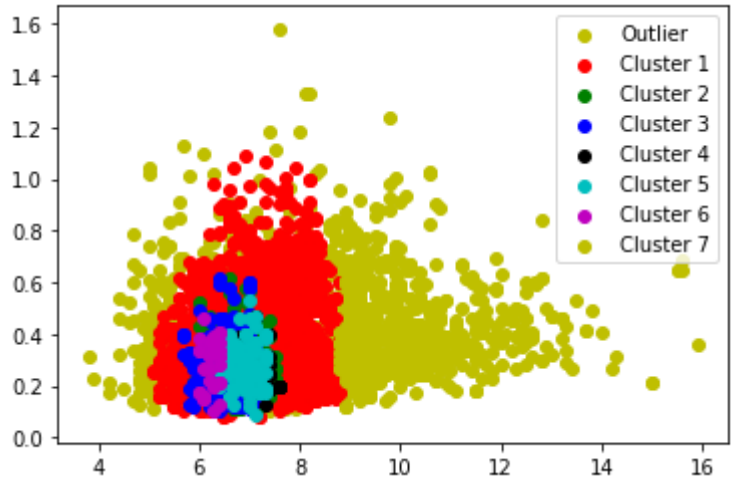
```
[0.3176715  0.21069888 0.12999856 0.08094213 0.06034393 0.0510322 ]
0.8506871987742373
```



DBSCAN

In [307]:

```
x = df_wine.iloc[:, [1,2,3,4,5]].values

dbscan = DBSCAN(eps=0.35, min_samples = 50)
clusters = dbscan.fit_predict(x)

colors = 'rgbkcmy'

for i in np.unique(clusters):
    label = 'Outlier' if i == -1 else 'Cluster ' + str(i + 1)
    plt.scatter(x[clusters==i,0], x[clusters==i,1],
                color=colors[i], label=label)

plt.legend()
plt.show()
```

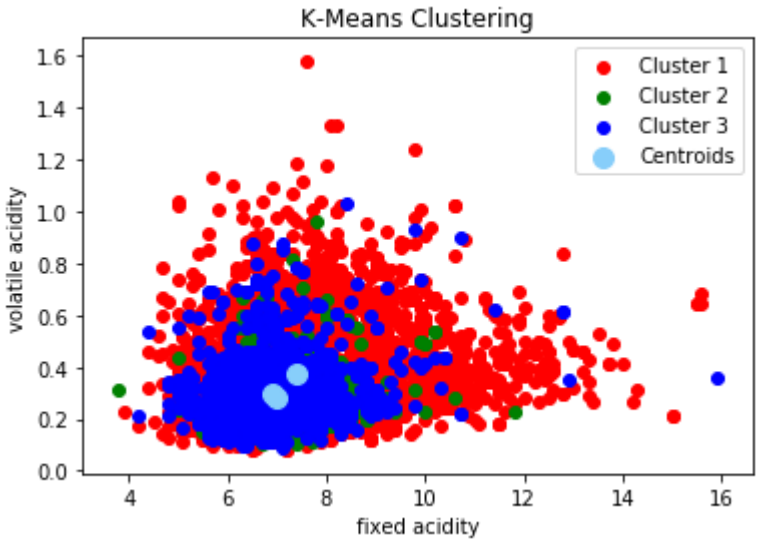


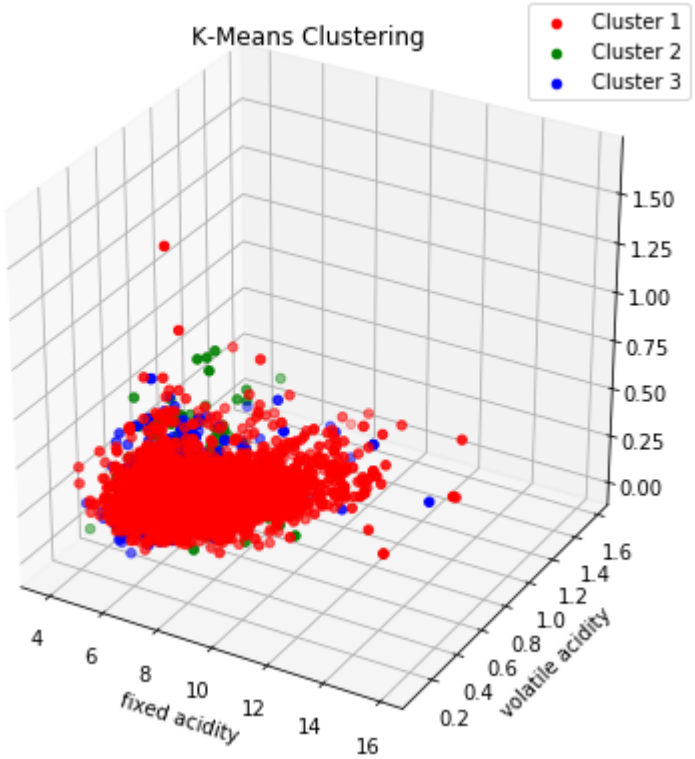
Kmeans

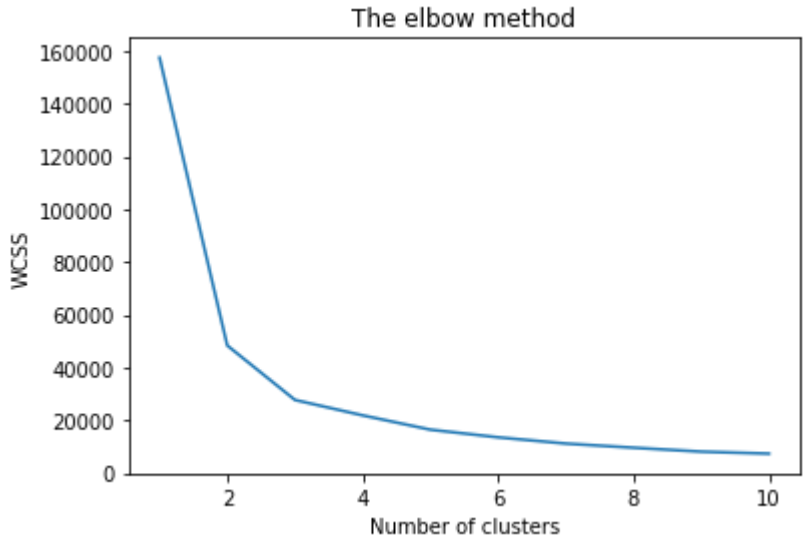
In [308]:

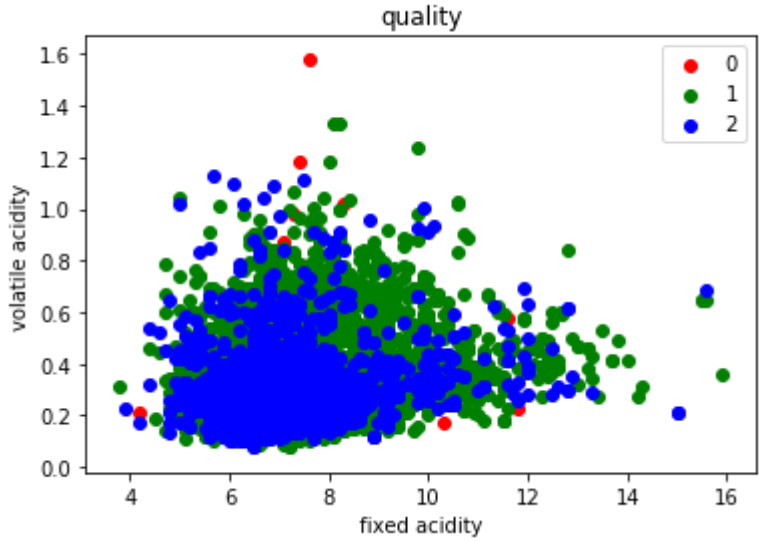
```
#Part 1
x = df_wine.iloc[:, [1,2,3,4]].values

#Applying kmeans to the dataset / Creating the kmeans classifier
kmeans = KMeans(n_clusters = 3)
clusters = kmeans.fit_predict(x)

#2D plot
colors = 'rgbkcmy'

for i in np.unique(clusters):
    plt.scatter(x[clusters==i,0], x[clusters==i,1],
                color=colors[i], label='Cluster ' + str(i + 1))

#Plotting the centroids of the clusters
plt.scatter(kmeans.cluster_centers_[:, 0], kmeans.cluster_centers_[:,1],
            s=100, c='lightskyblue', label='Centroids')
plt.legend()
plt.title('K-Means Clustering')
plt.xlabel(df_wine.columns[1])
plt.ylabel(df_wine.columns[2])
plt.show()


#3D plot
fig = plt.figure(figsize=(7, 7))
ax = plt.axes(projection='3d')

for i in np.unique(clusters):
    ax.scatter3D(x[clusters==i,0],
             x[clusters==i,1],
             x[clusters==i,2],
                 color=colors[i], label='Cluster ' + str(i + 1))

ax.set_xlabel(df_wine.columns[1])
ax.set_ylabel(df_wine.columns[2])

plt.legend()
plt.title('K-Means Clustering')
plt.show()



#Part 2: Find the optimum number of clusters for k-means
from sklearn.cluster import KMeans

wcss = []

# Trying kmeans for k=1 to k=10
for i in range(1, 11):
    kmeans = KMeans(n_clusters=i, init='k-means++')
    kmeans.fit(x)
    wcss.append(kmeans.inertia_)

# Plotting the results onto a line graph, allowing us to observe 'The elbow'
plt.plot(range(1, 11), wcss)
plt.title('The elbow method')
plt.xlabel('Number of clusters')
plt.ylabel('WCSS')  # within cluster sum of squares
```

```
plt.show()


# Part 3: Actual Categorization
quality = np.reshape(df_wine.loc[:, ['quality']].values, (-1,))
i = 0
for label in np.unique(quality):
    plt.scatter(x[quality==label,0], x[quality==label,1],
                color=colors[i], label=label)
    i += 1

plt.legend()
plt.title('quality')
plt.xlabel(df_wine.columns[1])
plt.ylabel(df_wine.columns[2])
plt.show()
```


K-Means Clustering
Cluster 1
Cluster 2
Cluster 3
Centroids
volatile acidity
fixed acidity
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
4
6
8
10
12
14
16


K-Means Clustering
Cluster 1
Cluster 2
Cluster 3
fixed acidity
volatile acidity
0.00
0.25
0.50
0.75
1.00
1.25
1.50
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
4
6
8
10
12
14
16





Model Training

Predicting for quality

In [311]:

```
#this is for predicting quality

from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression

x_train, x_test, y_train, y_test = train_test_split(x, y, random_state = 100, train_siz
e=0.7)
```

In [312]:

```
x_train.head()
```

```
---------------------------------------------------------------------------
-
AttributeError                            Traceback (most recent call las
t)
<ipython-input-312-3c4ecc6cd86a> in <module>
----> 1 x_train.head()

AttributeError: 'numpy.ndarray' object has no attribute 'head'
```

In [313]:

```
knn_model = KNeighborsClassifier(n_neighbors = 50)

knn_model.fit(x_train, y_train)
```

Out[313]:

```
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                     metric_params=None, n_jobs=None, n_neighbors=50, p=2,
                     weights='uniform')
```

In [314]:

```
y_pred = knn_model.predict(x_test)
```

In [315]:

```
print(accuracy_score(y_test, y_pred))
```

```
0.7648272305312016
```

In [ ]:

```
print(y_pred)
```

Predicting for Type

In [316]:

```
x2 = df_wine.iloc[:, 0:12]
y2 = df_wine['type']
x2
```

Out[316]:

	type	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulp
0	1	7.0	0.270	0.36	20.7	0.045	45.0	170.0	1.00100	3.00	
1	1	6.3	0.300	0.34	1.6	0.049	14.0	132.0	0.99400	3.30	
2	1	8.1	0.280	0.40	6.9	0.050	30.0	97.0	0.99510	3.26	
3	1	7.2	0.230	0.32	8.5	0.058	47.0	186.0	0.99560	3.19	
4	1	7.2	0.230	0.32	8.5	0.058	47.0	186.0	0.99560	3.19	
...	...	...	...	...	...	...	...	...	...	...	
6491	0	6.8	0.620	0.08	1.9	0.068	28.0	38.0	0.99651	3.42	
6492	0	6.2	0.600	0.08	2.0	0.090	32.0	44.0	0.99490	3.45	
6494	0	6.3	0.510	0.13	2.3	0.076	29.0	40.0	0.99574	3.42	
6495	0	5.9	0.645	0.12	2.0	0.075	32.0	44.0	0.99547	3.57	
6496	0	6.0	0.310	0.47	3.6	0.067	18.0	42.0	0.99549	3.39	

6463 rows × 12 columns

In [317]:

```
#this is for predicting type

from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression

x2_train, x2_test, y2_train, y2_test = train_test_split(x2, y2, random_state = 100, tra
in_size=0.7)
```

In [318]:

```
knn_model = KNeighborsClassifier(n_neighbors = 50)

knn_model.fit(x2_train, y2_train)
```

Out[318]:

```
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                     metric_params=None, n_jobs=None, n_neighbors=50, p=2,
                     weights='uniform')
```

In [319]:

```
y2_pred = knn_model.predict(x2_test)
```

In [320]:

```
print(accuracy_score(y2_test, y2_pred))
```

```
0.9283135636926251
```

In [ ]:

```

```