EECS738_HW1

March 1, 2021

1 EECS 738 Homework 1

1.1 1. INDUSTRY

Botanical and beverage industry is chosen.

1.2 2. SOURCE

2.1. SOURCE: The dataset is from UCI Machine Learning Database.

DESCRIPTION: The dataset contains about one hundred fify data with attributes related to sepal, petal and species. The following attributes are from the dataset.

Attribute	Datatype
Id	int64
SepalLengthCm	float64
SepalWidthCm	float64
PetalLengthCm	float64
PetalWidthCm	float64
Species	object

2.2. SOURCE: The dataset is from UCI Machine Learning database.

DESCRIPTION: The dataset contains about two thousand data with attributes related to red wine quality. The following attributes are from the dataset.

Attribute	Datatype
fixed acidity	object
volatile acidity	object
citric acid	object
residual sugar	object
chlorides	object
free sulfur dioxide	object
total sulfur dioxide	object
density	object
pH	object
sulphates	object
alcohol	object

Attribute	Datatype
quality	object

1.2.1 3. MODELS FOR THE DATASETS

3.1. To perform k-means clustering using an user defined function with number of clusters, features and iterations as arguments.

3.2. To perform histogram analysis using an user defined function to understand data distribution.

1.2.2 4. Importing libraries

[71]:

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

1.2.3 5. K-Means Clustering Function

1.2.4 5.1. Finding Centroid for K-Means clustering

[72]:

```
def find_centroid(count,data,num_clusters):
     if count==0:
        secure_random = secrets.SystemRandom()
        to_group = list(data.index)
        num_of_groups = num_clusters
        list_of_random_items = secure_random.sample(to_group, num_of_groups)
        #print(list_of_random_items)
        centroids=np.array(data.loc[list_of_random_items])
        #print(centroids[0])
        return centroids
     else:
        centroids_mean=data.groupby(['cluster']).mean()
        centroids=np.array(centroids_mean)
        #print(centroids[0])
        return centroids
```

1.2.5 5.2. K-Means Clustering with number of clusters, features and iterations as function arguments

[73]:

```
def k_means_manual(num_clusters, features,iterations):
    df=features;
    count_centroid=0
    while count_centroid<iterations:
        centroids=find_centroid(count_centroid,df,num_clusters)
        #print(centroids)
        df = df.drop(['cluster'], axis=1, errors='ignore')
        df_arr=np.array(df)
        #print(df_arr)
        for k in range(0,len(centroids)):
            col_name="centroid_"+str(k+1)
            df[str(col_name)]=""
            #print(centroids[k])
            for i in range(0,len(df)):
                df.loc[i,col_name]=np.sqrt(sum((df_arr[i]-centroids[k])**2))
        centroids_cols = [col for col in df.columns if "centroid_" in col]
        #print(list(centroids_cols))
        df_centroids=df.loc[:, df.columns.isin(centroids_cols)]
        #print(df_centroids.head())
        #print(df_centroids.dtypes)
        df_centroids = df_centroids.apply(pd.to_numeric, errors='coerce')
        df_centroids["min"] = df_centroids.idxmin(axis=1, skipna=True)
        #print(df_centroids.head())
        df_centroids["min"]=df_centroids["min"].astype(str)
        #print(df_centroids.dtypes)
        df_centroids["min"]=df_centroids["min"].str[9:]
        #print(df_centroids.head())
        for k in range(0,len(centroids)):
            col_name="centroid_"+str(k+1)
            del(df[col_name])
        df["cluster"]=df_centroids["min"].astype(int)
        #print(df.head())
        #print(df.groupby(['cluster']).mean())
        count_centroid=count_centroid+1
        print('\n Centroids: '+ str(centroids))
        plt.figure(figsize=(20,10))
        plt.scatter(np.array(centroids)[:, 0], np.array(centroids)[:, 1],␣
↪color='blue',marker='X')
        plt.scatter(df.iloc[:, 0],df.iloc[:, 1],color='grey',alpha=0.5)
        plt.title("n = "+str(count_centroid))
        plt.show()
        print('\n')
```

1.2.6 6. Histogram function with data and title as arguments

[74]:
```
def histogram_manual(data, title):
    df=list(data);
    unique_values = []
    unique_values_count=[]
    for x in data:
        if x not in unique_values:
            unique_values.append(x)
    #print(unique_values)
    for y in unique_values:
        count=0
        for x in data:
            if x == y:
                count=count+1;
        unique_values_count.append(count)
    #print(unique_values_count)
    plt.figure(figsize=(20,10))
    plt.bar(unique_values, unique_values_count, 0.05)
    plt.title("Histogram for "+str(title))
    plt.xlabel("Values")
    plt.ylabel("Frequency")
```

1.3 7. Loading, Preparing and Visualizing the dataset 1

1.3.1 7.1. Importing dataset 1

[75]:

```
df_1 = pd.read_csv('Iris.csv')
df_1.head()
```

[75]:

```
   Id  SepalLengthCm  SepalWidthCm  PetalLengthCm  PetalWidthCm      Species
0   1            5.1           3.5            1.4           0.2  Iris-setosa
1   2            4.9           3.0            1.4           0.2  Iris-setosa
2   3            4.7           3.2            1.3           0.2  Iris-setosa
3   4            4.6           3.1            1.5           0.2  Iris-setosa
4   5            5.0           3.6            1.4           0.2  Iris-setosa
```

1.3.2 7.2. Understanding the data types in the dataset

[76]:

```
print(df_1.dtypes)
print('Dimension before data cleaning'+str(df_1.shape))
df_1.dropna()
print('Dimension before data cleaning'+str(df_1.shape))
```

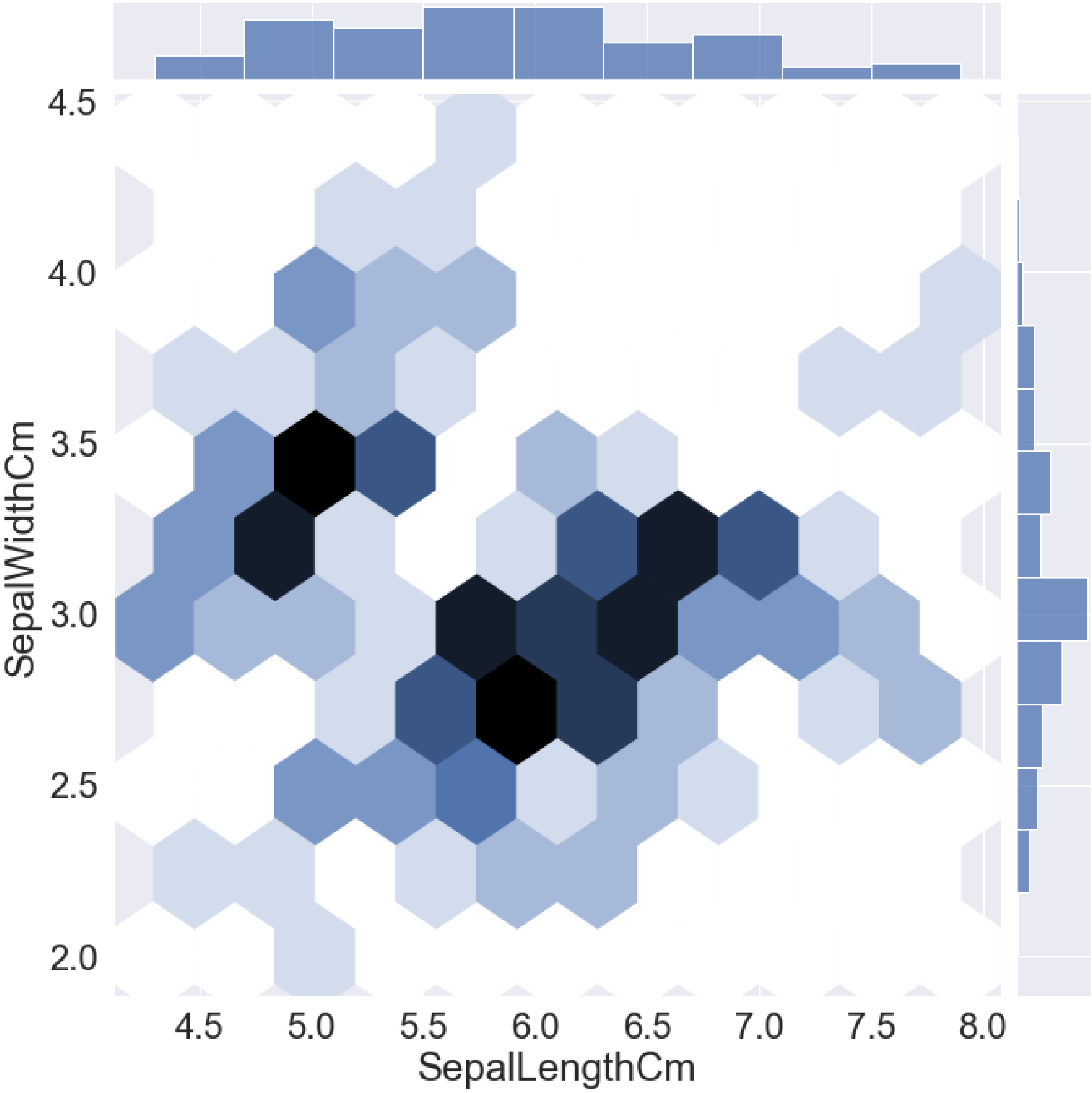
```
Id                 int64
SepalLengthCm    float64
SepalWidthCm     float64
PetalLengthCm    float64
PetalWidthCm     float64
Species           object
dtype: object
Dimension before data cleaning(150, 6)
Dimension before data cleaning(150, 6)
```

1.3.3 7.3. Jointplot of sepal length and sepal width

[77]:

```
plt.figure(figsize=(30,50))
graph=sns.jointplot(x='SepalLengthCm', y='SepalWidthCm', data=df_1,␣
 ↪kind="hex",height=10, ratio=10);
graph.x = df_1['SepalLengthCm']
graph.y = df_1['SepalWidthCm']
```

```
<Figure size 2160x3600 with 0 Axes>
```

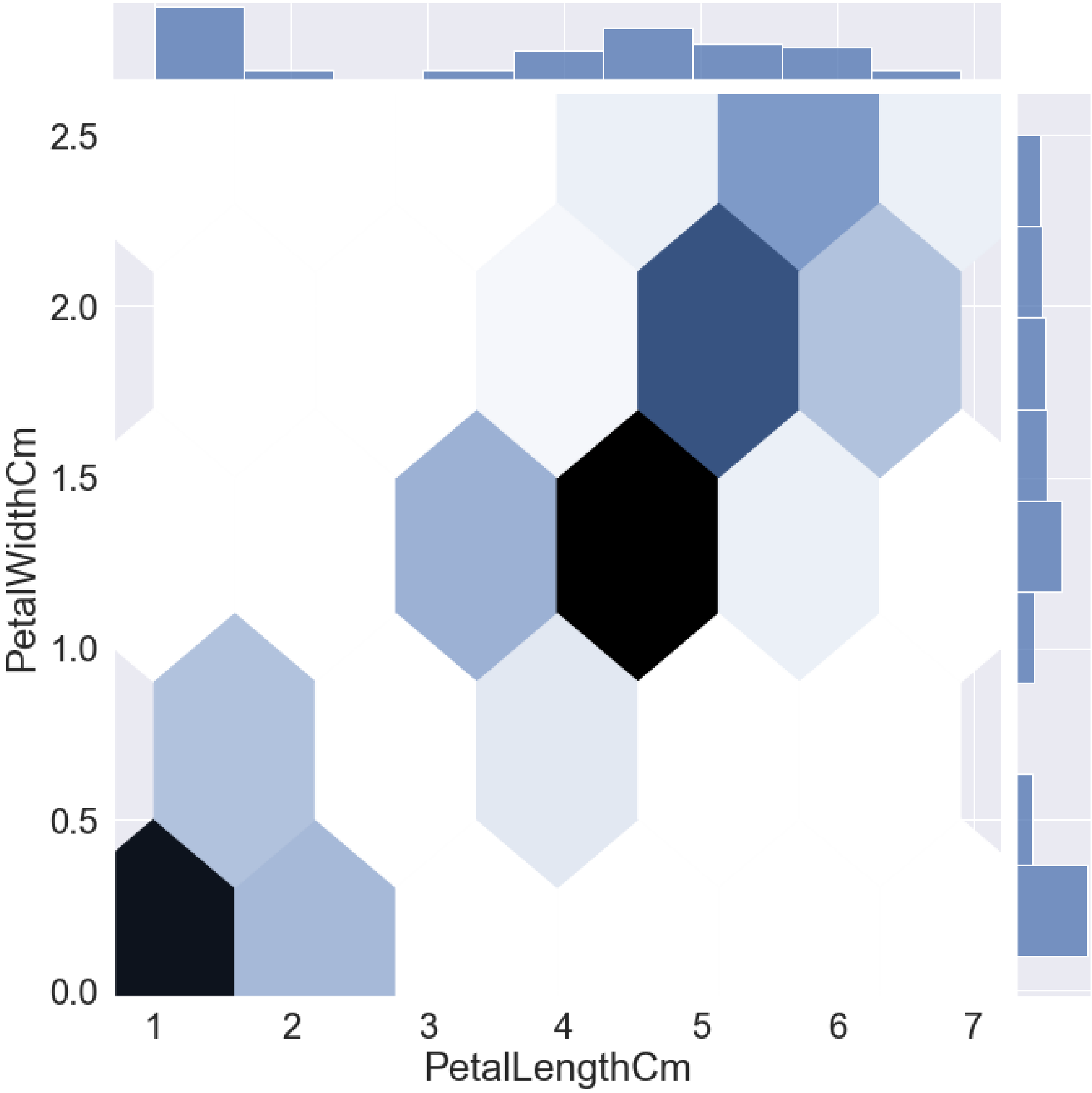


There are more flowers with sepal length 6 to 6.5 cm and sepal width 2.5 to 3 cm.

1.3.4 7.4. Jointplot of petal length and petal width

[78]:
```
plt.figure(figsize=(30,50))
graph=sns.jointplot(x='PetalLengthCm', y='PetalWidthCm', data=df_1,␣
 ↪kind="hex",height=10, ratio=10);
graph.x = df_1['PetalLengthCm']
graph.y = df_1['PetalWidthCm']
```

```
<Figure size 2160x3600 with 0 Axes>
```



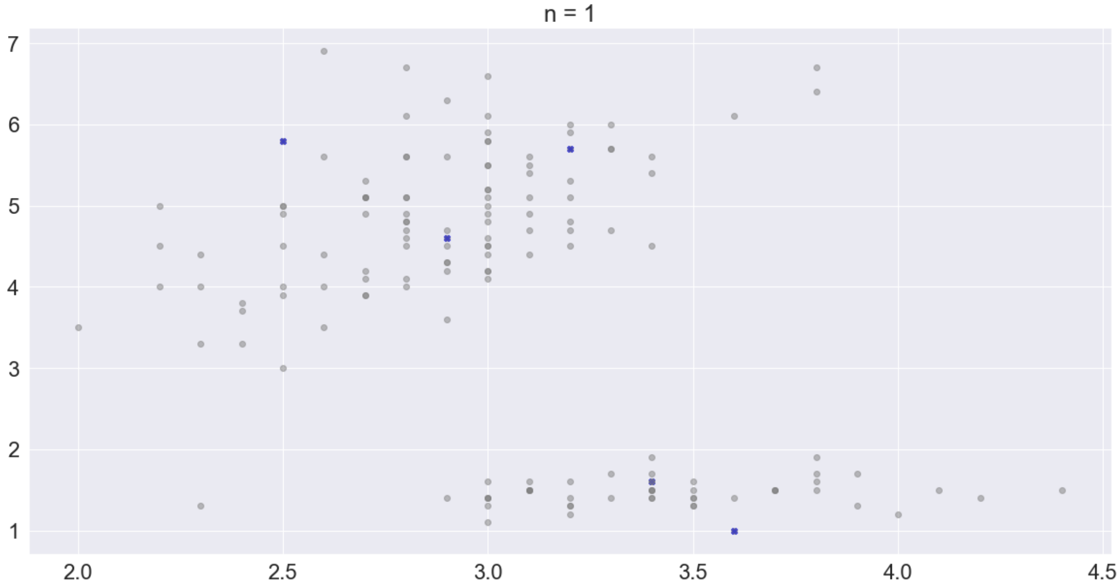
There are more flowers with 1. petal length 4 to 5cm and petal width 1 to 1.5 cm 2. petal length 0 to 1.5cm and petal width 0 to 0.5 cm

1.4 8. K-Means and Histogram for dataset 1

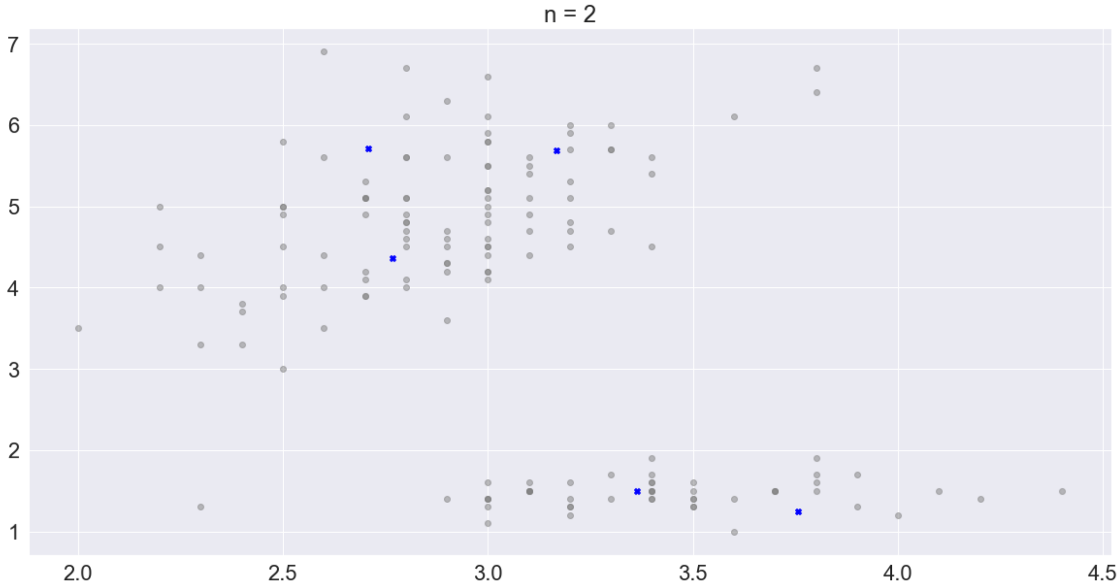
1.4.1 8.1 Feature Extraction for K__Means

[79]:
```
features= df_1[df_1.columns[2:5]]
features
k_means_manual(5,features,3)
```

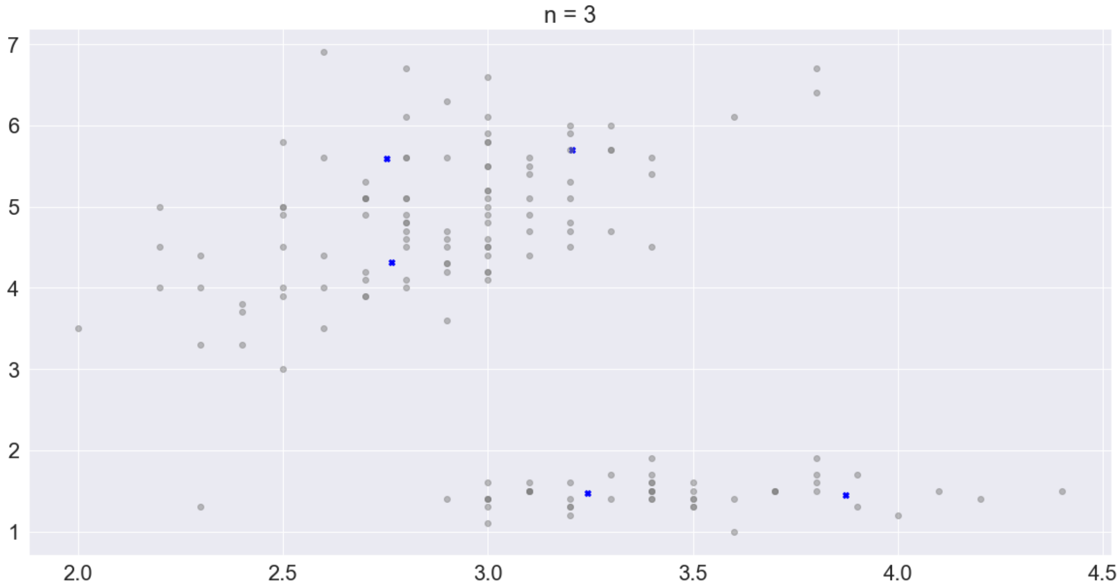
```
Centroids: [[3.4 1.6 0.2]
[2.5 5.8 1.8]
[3.2 5.7 2.3]
[2.9 4.6 1.3]
[3.6 1.  0.2]]
```



```
Centroids: [[3.3627907  1.5        0.24418605]
[2.70769231 5.71538462 1.86153846]
[3.16785714 5.68928571 2.19285714]
[2.76779661 4.3559322  1.38983051]
[3.75714286 1.24285714 0.24285714]]
```

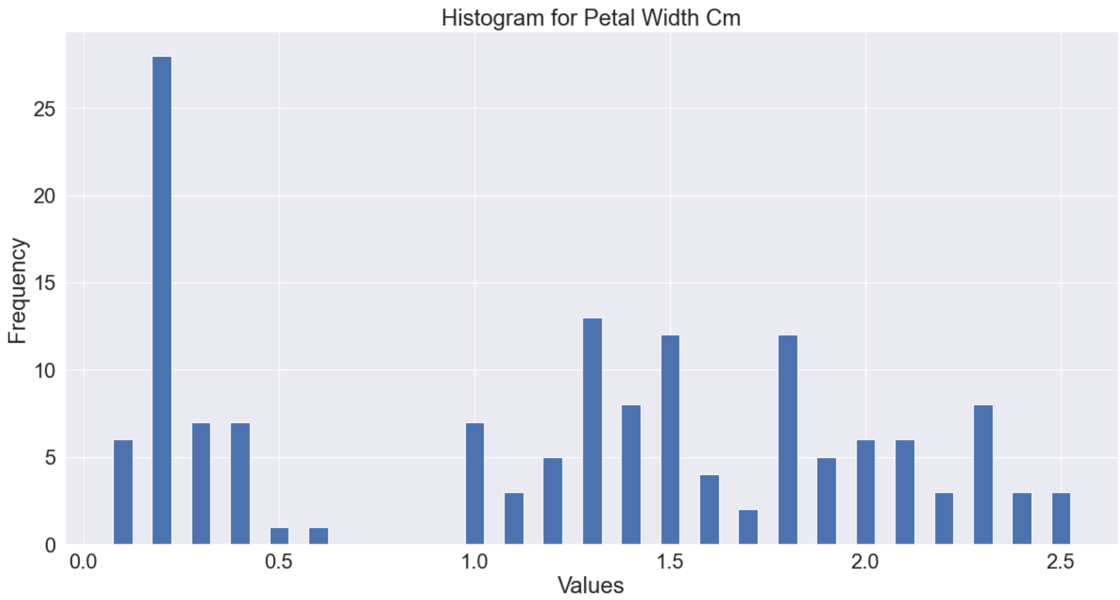


```
Centroids: [[3.24166667 1.46944444 0.23611111]
[2.75263158 5.59473684 1.85263158]
[3.204      5.704      2.212     ]
[2.76428571 4.31607143 1.37678571]
[3.87142857 1.45       0.26428571]]
```



1.4.2 8.2 Histogram for data visualization

```
[80]: histogram_manual(df_1["PetalWidthCm"],"Petal Width Cm")
```



1.5 9. Loading, Preparing and Visualizing the dataset 2

1.5.1 9.1 Importing dataset 2

```
[81]: with open('winequality-red.csv', 'r') as file:
          reader = csv.reader(file, delimiter=";")
          df_2=pd.DataFrame(reader)
      df_2.head()
```

```
[81]:              0                 1            2               3          4  \
      0  fixed acidity  volatile acidity  citric acid  residual sugar  chlorides
      1            7.4               0.7            0             1.9      0.076
      2            7.8              0.88            0             2.6      0.098
      3            7.8              0.76         0.04             2.3      0.092
      4           11.2              0.28         0.56             1.9      0.075

                           5                     6        7     8          9  \
      0  free sulfur dioxide  total sulfur dioxide  density    pH  sulphates
      1                   11                    34   0.9978  3.51       0.56
      2                   25                    67   0.9968   3.2       0.68
      3                   15                    54    0.997  3.26       0.65
```

```
4                   17                    60     0.998  3.16       0.58

        10       11
0  alcohol  quality
1      9.4        5
2      9.8        5
3      9.8        5
4      9.8        6
```

1.5.2 9.2 Correcting the column header

[82]:

```
column_header = df_2.iloc[0]
df_2 = df_2[1:]
df_2.columns = column_header
df_2=df_2.reset_index()
del(df_2["index"])
df_2.head()
```

[82]:

```
0 fixed acidity volatile acidity citric acid residual sugar chlorides  \
0            7.4                0.7           0              1.9     0.076
1            7.8               0.88           0              2.6     0.098
2            7.8               0.76        0.04              2.3     0.092
3           11.2               0.28        0.56              1.9     0.075
4            7.4                0.7           0              1.9     0.076

0 free sulfur dioxide total sulfur dioxide density    pH sulphates alcohol  \
0                   11                   34  0.9978  3.51      0.56     9.4
1                   25                   67  0.9968   3.2      0.68     9.8
2                   15                   54   0.997  3.26      0.65     9.8
3                   17                   60   0.998  3.16      0.58     9.8
4                   11                   34  0.9978  3.51      0.56     9.4

0 quality
0       5
1       5
2       5
3       6
4       5
```

1.5.3 9.3. Understanding the data types in the dataset

[83]:

```
print(df_2.dtypes)
print('Dimension before data cleaning'+str(df_2.shape))
df_2.dropna()
print('Dimension before data cleaning'+str(df_2.shape))
```

```
0
```

```
fixed acidity           object
volatile acidity        object
citric acid             object
residual sugar          object
chlorides               object
free sulfur dioxide     object
total sulfur dioxide    object
density                 object
pH                      object
sulphates               object
alcohol                 object
quality                 object
dtype: object
Dimension before data cleaning(1599, 12)
Dimension before data cleaning(1599, 12)
```

1.5.4 9.4. Making the datatypes to numeric

[84]:

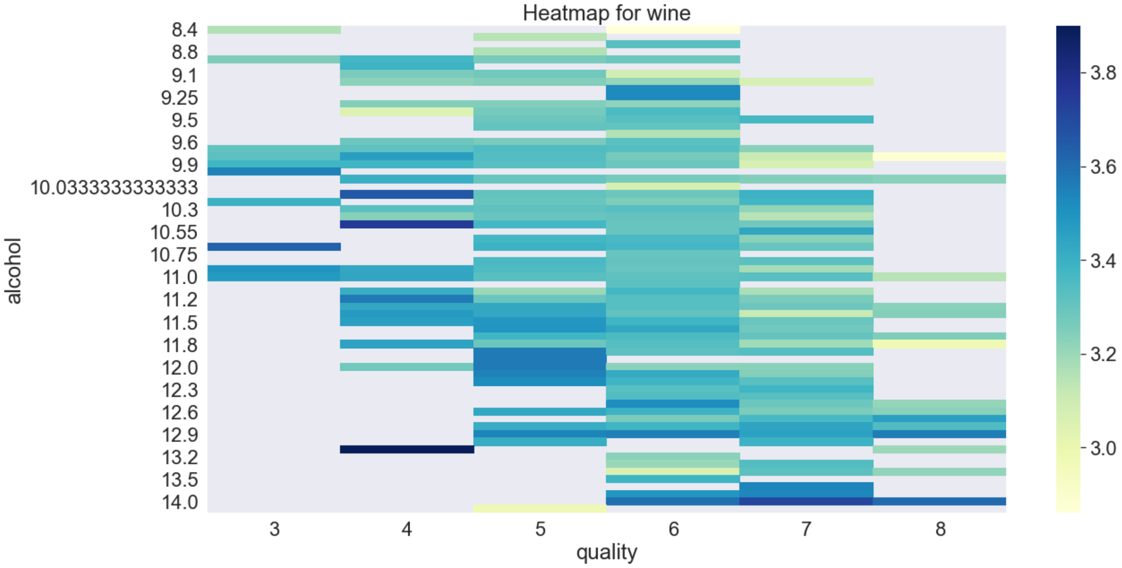
```
df_2=df_2.apply(pd.to_numeric)
print(df_2.dtypes)
```

```
0
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
```

1.5.5 9.5. Heatmap of sugar, density and pH

[85]:

```
plt.figure(figsize=(20,10))
sns.set(font_scale=2)
alcohol_data = pd.pivot_table(df_2, values='pH',
                     index=['alcohol'],
                     columns='quality')
sns.heatmap(alcohol_data, cmap="YlGnBu").set_title('Heatmap for wine');
```



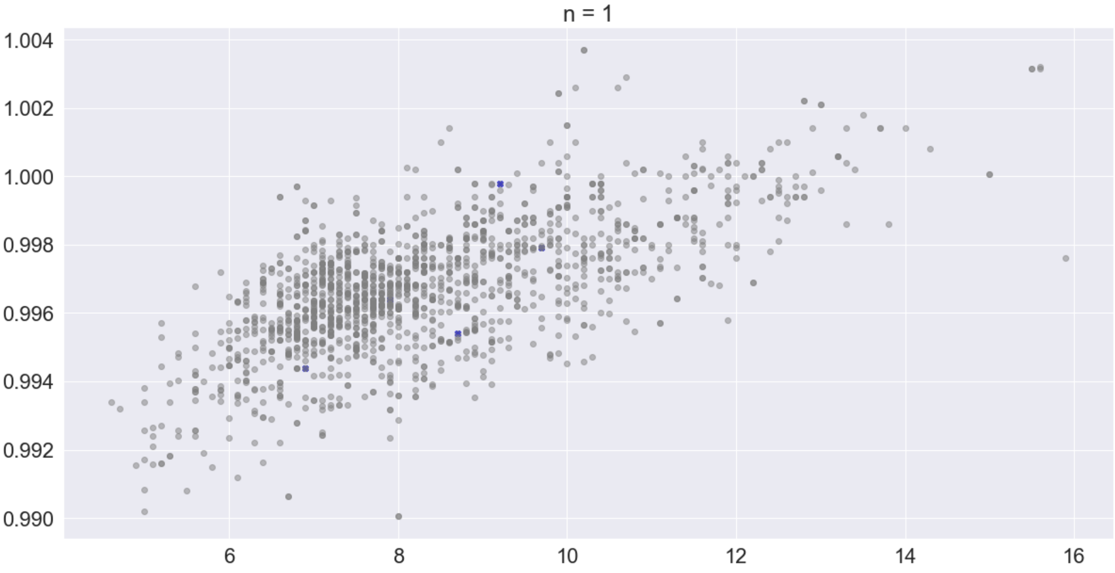
1. Wine with high quality always has alcohol level more than 9.6.
2. Wine with highest alcohol is average quality.

1.6 10. K-Means and Histogram for dataset 2

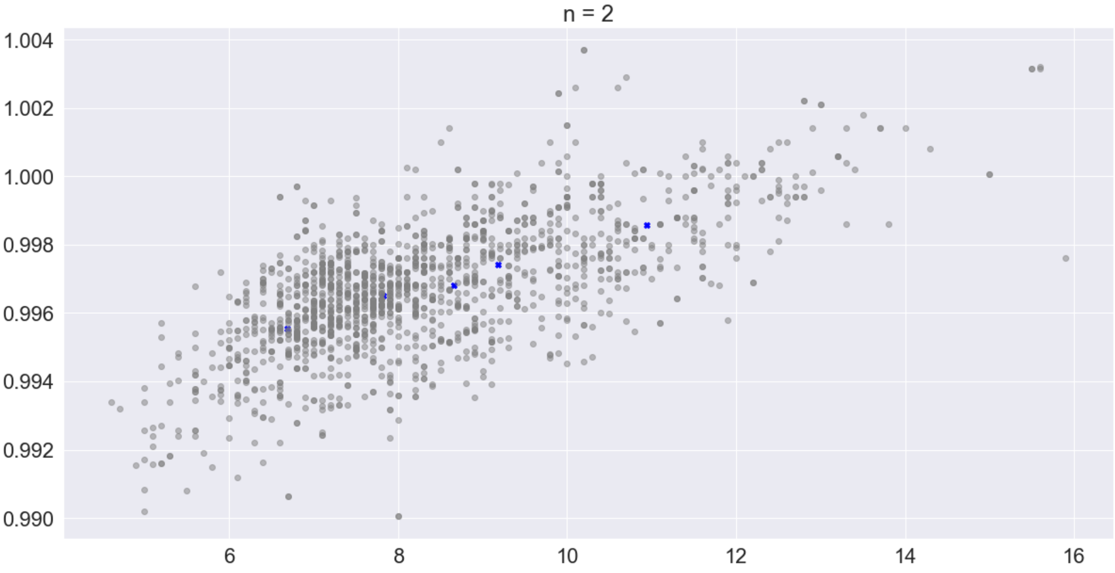
1.6.1 10.1 Feature Extraction for K__Means

[86]:
```
features= df_2[['fixed acidity','density']]
features
k_means_manual(5,features,3)
```

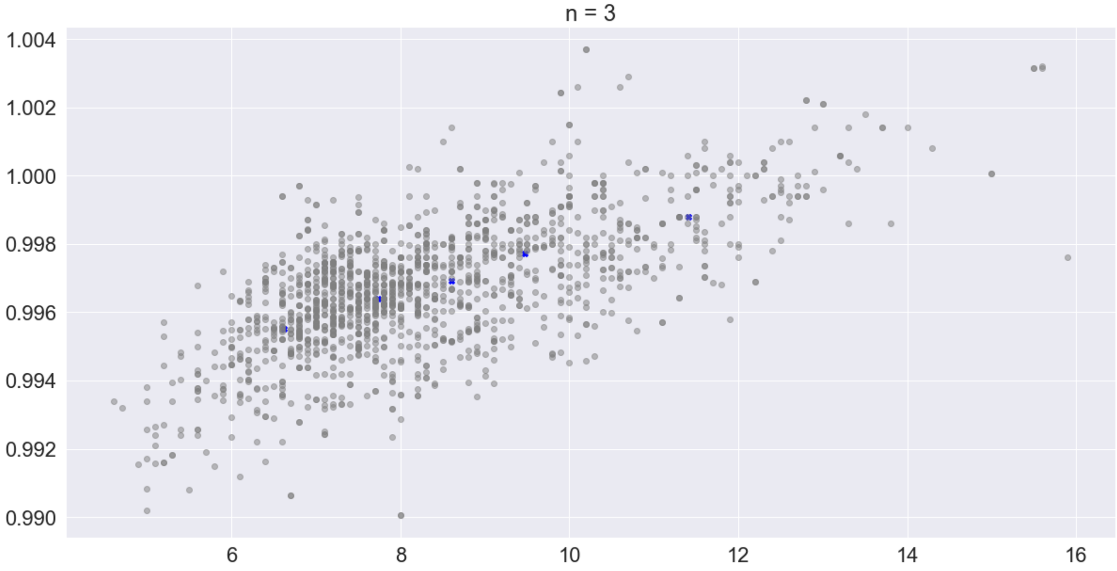
```
Centroids: [[9.2     0.9998 ]
[8.7     0.9954 ]
[9.7     0.9979 ]
[7.9     0.9964 ]
[6.9     0.99438]]
```



```
Centroids: [[ 9.17727273  0.99741373]
[ 8.65823529  0.99682076]
[10.93977591  0.99857588]
[ 7.82447059  0.99651249]
[ 6.6867784   0.99555587]]
```

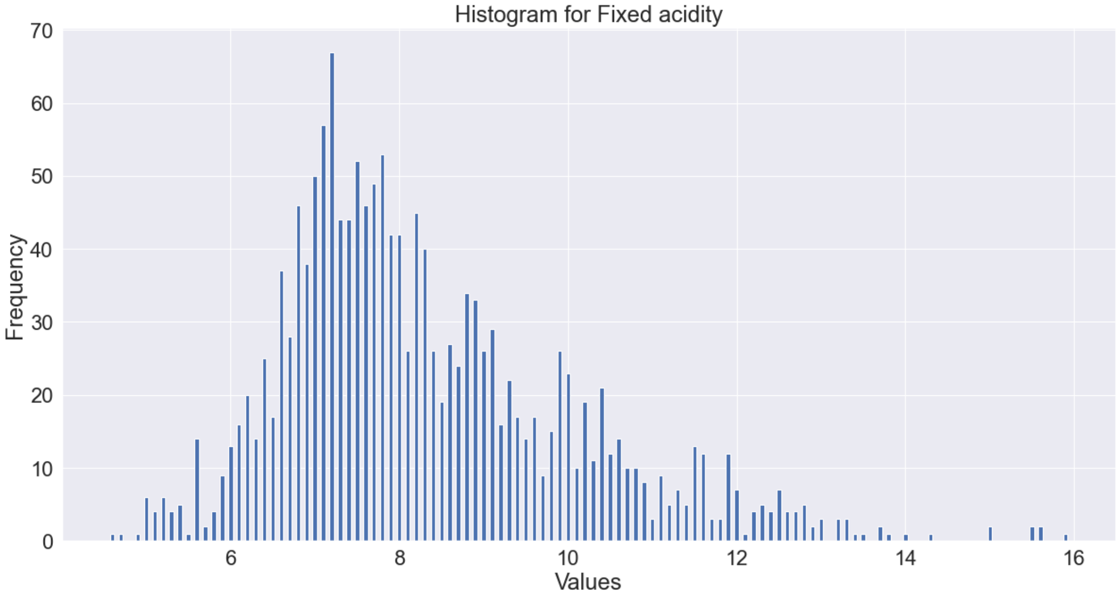


```
Centroids: [[ 9.47383178  0.99772874]
[ 8.6         0.99693502]
[11.41343874  0.99878715]
[ 7.73024831  0.99638447]
[ 6.62098765  0.99550352]]
```



1.6.2 10.2. Histogram for data visualization

[87]:
```
histogram_manual(df_2["fixed acidity"],"Fixed acidity")
```


Histogram for Fixed acidity
Frequency
0
10
20
30
40
50
60
70
6
8
10
12
14
16
Values