TC1002S Herramientas computacionales: el arte de la analítica

This is a notebook with all your work for the final evidence of this course

Niveles de dominio a demostrar con la evidencia

SING0202A

Interpreta interacciones entre variables relevantes en un problema, como base para la construcción de modelos bivariados basados en datos de un fenómeno investigado que le permita reproducir la respuesta del mismo. Es capaz de construir modelos bivariados que expliquen el comportamiento de un fenómeno.

Student information

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Importing libraries

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans
```

PART 1

Use your assigned dataset

A1 Load data

```
# Define where you are running the code: colab or local
RunInColab          = True     # (False: no  | True: yes)

# If running in colab:
if RunInColab:
    # Mount your google drive in google colab
    from google.colab import drive
    drive.mount('/content/drive')

    # Find location
    #!pwd
    #!ls
    #!ls "/content/drive/My Drive/Colab Notebooks/a01637205/NotebooksProfessor/datasets/cartwheel/"

    # Define path del proyecto
    Ruta            = "/content/drive/MyDrive/Colab Notebooks/a01637205/NotebooksProfessor/datasets/"

else:
    # Define path del proyecto
    Ruta            = ""
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive",
```

```
# Dataset url
url = Ruta + "A01637205_X.csv"

# Load the dataset
df = pd.read_csv(url)
```

A2 Data managment

Print the first 7 rows

```
df.head(7)
```

	Unnamed: 0	x1	x2	x3	x4	x5	x6
0	0	-6.108051	-6.710225	7.449982	11.493039	7.067782	-0.210217
1	1	-6.206677	-4.422185	0.354848	8.447279	6.103545	1.712683
2	2	-4.119060	-4.059562	2.284338	7.195207	1.723852	4.215468
3	3	3.489565	4.628838	7.818746	10.116034	-11.198842	3.223121
4	4	5.244161	3.443408	8.664659	6.367069	-12.351509	3.647803
5	5	5.841029	3.994921	9.112804	6.179918	-12.366545	7.905738
6	6	7.291603	5.370260	6.857271	10.527049	-6.234801	6.905511

Next steps: View recommended plots

Print the last 4 rows

```
df.iloc[-4:]
```

	Unnamed: 0	x1	x2	x3	x4	x5	x6
254	254	6.610330	1.273078	4.739605	8.479677	-11.038898	6.556038
255	255	-6.315800	-5.416517	2.278263	10.616842	4.843602	-0.069696
256	256	-8.690065	-5.983323	3.666243	6.443481	7.479635	1.479961
257	257	4.736128	3.230271	5.471063	10.882065	-12.281929	3.685385

How many rows and columns are in your data? Hay 258 filas y 7 columnas

Use the `shape` method

```
df.shape
```

```
(258, 7)
```

Print the name of all columns

Use the `columns` method

```
df.columns
```

```
Index(['Unnamed: 0', 'x1', 'x2', 'x3', 'x4', 'x5', 'x6'], dtype='object')
```

What is the data type in each column

Use the `dtypes` method

```
df.dtypes
```

```
Unnamed: 0      int64
x1            float64
x2            float64
x3            float64
x4            float64
x5            float64
x6            float64
dtype: object
```

What is the meaning of rows and columns?

```
# Your responses here
"""Las filas representan cada medición tomada, iniciando desde la toma 0 hasta la 257.
Las columnas representan distintas variables desconocidas con valores de tipo numéricos,
excepto por la primera (que también es númerica) que representa el número de toma."""
```

```
'Las filas representan cada medición tomada, iniciando desde la toma 0 hasta la
257.\nLas columnas representan distintas variables desconocidas con valores de
tipo numéricos, \nexcepto por la primera (que también es númerica) que represen
ta el número de toma.'
```

Print a statistical summary of your columns

```
df.describe()
```

	Unnamed: 0	x1	x2	x3	x4	x5	x6
count	258.000000	258.000000	258.000000	258.000000	258.000000	258.000000	258.000000
mean	128.500000	0.064710	-1.770579	4.663143	8.955745	-1.484447	3.885241
std	74.622383	5.947367	4.651482	3.241858	1.917292	7.835742	2.467810
min	0.000000	-11.089086	-12.201649	-2.290597	4.610542	-14.691532	-3.683476
25%	64.250000	-5.425028	-5.943322	2.031942	7.669513	-8.952463	2.036746
50%	128.500000	0.694525	-2.055683	4.821210	9.194709	-2.224856	3.867952
75%	192.750000	5.779487	2.647229	7.306805	10.423035	6.188736	5.675709
max	257.000000	10.439700	7.101453	12.102099	13.453821	11.327603	9.459514

```
# 1) What is the minumum and maximum values of each variable
"""
x1:
  min: -11.089086
  max: 10.4397

x2:
  min: -12.201649
  max: 7.101453

x3:
  min: -2.290597
  max: 12.102099

x4:
  min: 4.610542
  max: 13.453821

x5:
  min: -14.691532
  max: 11.327603

x6:
  min: -3.683476
  max: 9.459514


# 2) What is the mean and standar deviation of each variable
x1:
  mean: 0.064710
  std: 5.947367

x2:
  mean: -1.770579
  std: 4.651482

x3:
  mean: 4.663143
  std: 3.241858

x4:
  mean: 8.955745
  std: 1.917292

x5:
  mean: -1.484447
  std: 7.835742

x6:
  mean: 3.885241
  std: 2.467810


# 3) What the 25%, 50% and 75% represent?
x1:
  25%: -5.425028
  50%: 0.694525
  75%: 5.779487

x2:
  25%: -5.943322
  50%: -2.055683
  75%: 2.647229

x3:
  25%: 2.031942
  50%: 4.821210
```

```
  75%: 7.306805

x4:
  25%: 7.669513
  50%: 9.194709
  75%: 10.423035

x5:
  25%: -8.952463
  50%: -2.224856
  75%: 6.188736

x6:
  25%: 2.036746
  50%: 3.867952
  75%: 5.675709


"""
```

```
'\nx1:\n  min: -11.089086\n  max: 10.4397\n\nx2:\n  min: -12.201649\n  max: 7.1
01453\n\nx3:\n  min: -2.290597\n  max: 12.102099\n\nx4:\n  min: 4.610542\n  ma
x: 13.453821\n\nx5:\n  min: -14.691532\n  max: 11.327603\n\nx6:\n  min: -3.6834
76\n  max: 9.459514\n\n\n# 2) What is the mean and standar deviation of each va
riable\nx1:\n  mean: 0.064710\n  std: 5.947367\n\nx2:\n  mean: -1.770579\n  st
d: 4.651482\n\nx3:\n  mean: 4.663143\n  std: 3.241858\n\nx4:\n  mean: 8.955745
\n  std: 1.917292\n\nx5:\n  mean: -1.484447\n  std: 7.835742\n\nx6:\n  mean: 3.
885241\n  std: 2.467810\n\n\n# 3) What the 25%, 50% and 75% represent?\nx1:\n
25%: -5.425028\n  50%: 0.694525\n  75%: 5.779487\n\nx2:\n  25%: -5.943322\n  5
0%: -2.055683\n  75%: 2.647229\n\nx3:\n  25%: 2.031942\n  50%: 4.821210\n  75%:
```

Rename the columns using the same name with capital letters

```
df.rename(columns={"x1": "X1", "x2": "X2", "x3": "X3", "x4": "X4", "x5": "X5", "x6": "X6"})
```

	Unnamed: 0	X1	X2	X3	X4	X5	X6
0	0	-6.108051	-6.710225	7.449982	11.493039	7.067782	-0.210217
1	1	-6.206677	-4.422185	0.354848	8.447279	6.103545	1.712683
2	2	-4.119060	-4.059562	2.284338	7.195207	1.723852	4.215468
3	3	3.489565	4.628838	7.818746	10.116034	-11.198842	3.223121
4	4	5.244161	3.443408	8.664659	6.367069	-12.351509	3.647803
...	...	...	...	...	...	...	...
253	253	-1.660286	-5.035091	1.992441	7.622380	5.400063	3.097290
254	254	6.610330	1.273078	4.739605	8.479677	-11.038898	6.556038
255	255	-6.315800	-5.416517	2.278263	10.616842	4.843602	-0.069696
256	256	-8.690065	-5.983323	3.666243	6.443481	7.479635	1.479961
257	257	4.736128	3.230271	5.471063	10.882065	-12.281929	3.685385

258 rows × 7 columns

Rename the columns to their original names

```
df.rename(columns={"X1": "x1", "X2": "x2", "X3": "x3", "X4": "x4", "X5": "x5", "X6": "x6"})
```

	Unnamed: 0	x1	x2	x3	x4	x5	x6
0	0	-6.108051	-6.710225	7.449982	11.493039	7.067782	-0.210217
1	1	-6.206677	-4.422185	0.354848	8.447279	6.103545	1.712683
2	2	-4.119060	-4.059562	2.284338	7.195207	1.723852	4.215468
3	3	3.489565	4.628838	7.818746	10.116034	-11.198842	3.223121
4	4	5.244161	3.443408	8.664659	6.367069	-12.351509	3.647803
...	...	...	...	...	...	...	...
253	253	-1.660286	-5.035091	1.992441	7.622380	5.400063	3.097290
254	254	6.610330	1.273078	4.739605	8.479677	-11.038898	6.556038
255	255	-6.315800	-5.416517	2.278263	10.616842	4.843602	-0.069696
256	256	-8.690065	-5.983323	3.666243	6.443481	7.479635	1.479961
257	257	4.736128	3.230271	5.471063	10.882065	-12.281929	3.685385

258 rows × 7 columns

Use two different alternatives to get one of the columns

```
df.x1
```

```
0     -6.108051
1     -6.206677
2     -4.119060
3      3.489565
4      5.244161
         ...
253   -1.660286
254    6.610330
255   -6.315800
256   -8.690065
257    4.736128
Name: x1, Length: 258, dtype: float64
```

```
df["x1"]
```

```
0     -6.108051
1     -6.206677
2     -4.119060
3      3.489565
4      5.244161
         ...
253   -1.660286
254    6.610330
255   -6.315800
256   -8.690065
257    4.736128
Name: x1, Length: 258, dtype: float64
```

Get a slice of your data set: second and thrid columns and rows from 62 to 72

```
df.iloc[62:73, 1:3]
```

	x1	x2
62	3.943674	2.654611
63	-4.702927	-12.201649
64	-3.921355	-9.569654
65	-6.327562	-9.988142
66	-3.469076	-4.771871
67	6.381437	2.720978
68	1.555598	3.002049
69	0.415042	-7.419107
70	3.814969	1.950133
71	6.080688	4.129953
72	7.380980	3.411150

For the second and thrid columns, calculate the number of null and not null values and verify that their sum equals the total number of rows

```
#second column
x1nulo = df.x1.isnull().sum()
x1noNulo = df.x1.notnull().sum()

x1total = x1nulo + x1noNulo

print ("Segunda columna: ")
print(x1nulo, "valores nulos")
print(x1noNulo, "valores no nulos")
print(x1total, "valores en total")

#third column
x2nulo = df.x2.isnull().sum()
x2noNulo = df.x2.notnull().sum()

x2total = x2nulo + x2noNulo

print()
print ("Tercera columna: ")
print(x2nulo, "valores nulos")
print(x2noNulo, "valores no nulos")
print(x2total, "valores en total")
```

```
Segunda columna: 
0 valores nulos
258 valores no nulos
258 valores en total

Tercera columna: 
0 valores nulos
258 valores no nulos
258 valores en total
```

Discard the last column

```
df.drop("x6", axis=1, inplace=True)
df
```

	Unnamed: 0	x1	x2	x3	x4	x5
0	0	-6.108051	-6.710225	7.449982	11.493039	7.067782
1	1	-6.206677	-4.422185	0.354848	8.447279	6.103545
2	2	-4.119060	-4.059562	2.284338	7.195207	1.723852
3	3	3.489565	4.628838	7.818746	10.116034	-11.198842
4	4	5.244161	3.443408	8.664659	6.367069	-12.351509
...	...	...	...	...	...	...
253	253	-1.660286	-5.035091	1.992441	7.622380	5.400063
254	254	6.610330	1.273078	4.739605	8.479677	-11.038898
255	255	-6.315800	-5.416517	2.278263	10.616842	4.843602
256	256	-8.690065	-5.983323	3.666243	6.443481	7.479635
257	257	4.736128	3.230271	5.471063	10.882065	-12.281929

258 rows × 6 columns

Next steps: View recommended plots

Questions

Based on the previos results, provide a description of yout dataset

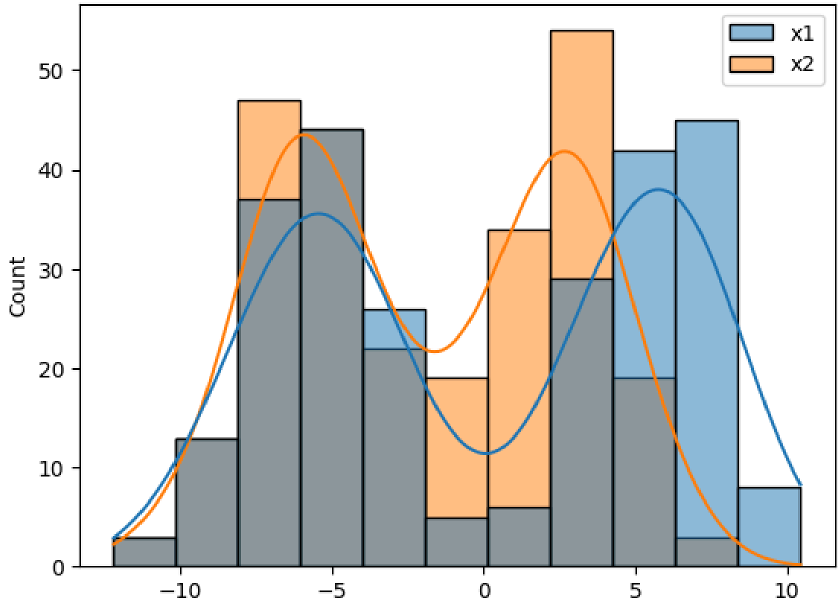
Your response: El dataset tiene 258 mediciones con 6 variables, todas las mediciones son de tipo numérico y sus valores son mayormente pequeños o negativos. Tiene una columna inicial con el número de medición que no tiene nombre.

```
#Reload dataset
df = pd.read_csv(url)
```

A3 Data visualization

Plot in the same figure the histogram of two variables

```
df2plot = df [["x1", "x2"]]
sns.histplot(df2plot, kde = True)
plt.show()
```

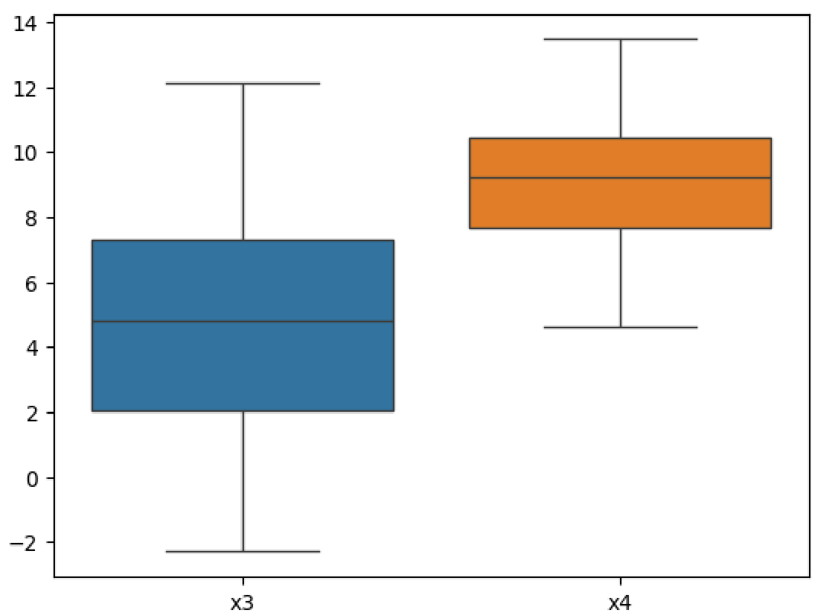


Based on these plots, provide a description of your data:

Your response here: Los datos en estas dos columnas tienen valores muy similares, aunque los de x1 llegan a ser mayores.

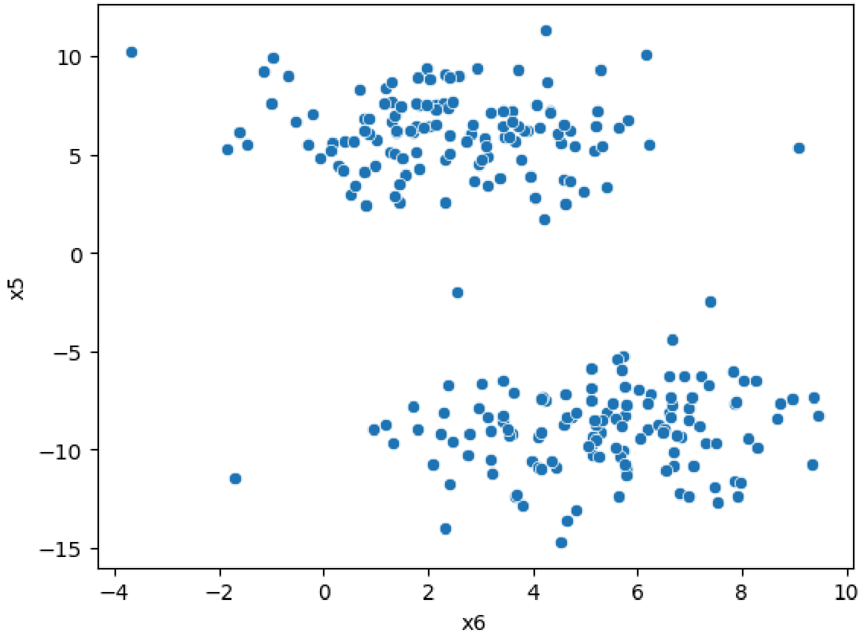
Plot in the same figure the boxplot of two variables

```
df2plot = df [["x3", "x4"]]
sns.boxplot(data = df2plot)
plt.show()
```



Plot the scatter plot of two variables

```
sns.scatterplot(data=df, y="x5", x="x6")
plt.show()
```



Questions

Based on the previos plots, provide a description of yout dataset

Your response: Se puede notar que en x5 y x6 existen 2 grupos muy marcados, que los valores de x4 son mayormente mayores que los de x3, y que los valores de x3 tienen un rango más grande.

A4 Kmeans

```
df.drop("Unnamed: 0", axis=1, inplace=True)
```

```
df
```

	x1	x2	x3	x4	x5	x6
0	-6.108051	-6.710225	7.449982	11.493039	7.067782	-0.210217
1	-6.206677	-4.422185	0.354848	8.447279	6.103545	1.712683
2	-4.119060	-4.059562	2.284338	7.195207	1.723852	4.215468
3	3.489565	4.628838	7.818746	10.116034	-11.198842	3.223121
4	5.244161	3.443408	8.664659	6.367069	-12.351509	3.647803
...	...	...	...	...	...	...
253	-1.660286	-5.035091	1.992441	7.622380	5.400063	3.097290
254	6.610330	1.273078	4.739605	8.479677	-11.038898	6.556038
255	-6.315800	-5.416517	2.278263	10.616842	4.843602	-0.069696
256	-8.690065	-5.983323	3.666243	6.443481	7.479635	1.479961
257	4.736128	3.230271	5.471063	10.882065	-12.281929	3.685385

258 rows × 6 columns

Next steps: View recommended plots

Do Kmeans clustering assuming a number of clusters accorging to your scatter plot

```
# Import sklearn KMeans
from sklearn.cluster import KMeans

# Define number of clusters
K  = 2 # Let's assume there are 2,3,4,5...? clusters/groups

# Create/Initialize the Kmeans box/object
km = KMeans(n_clusters=K, n_init="auto")

# Do K-means clustering (assing each point in the dataset to a cluster)
yestimated = km.fit_predict(df.select_dtypes(include="number"))

# Print estimated cluster of each point in the dataset
yestimated
```

```
array([0, 0, 0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 1, 1,
       0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0,
       1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 0,
       0, 1, 1, 0, 1, 1, 1, 0, 0, 1, 0, 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 0,
       1, 0, 1, 1, 0, 1, 1, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0, 1, 0, 1, 0, 0,
       1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 1, 0, 0, 1, 1,
       1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 1, 1, 0, 1,
       1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 0, 1, 1, 1, 0,
       0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0,
       0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1,
       0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1], dtype=int32)
```

Add to your dataset a column with the estimated cluster to each data point

```
df['yestimated'] = yestimated

df
```

	x1	x2	x3	x4	x5	x6	yestimated
0	-6.108051	-6.710225	7.449982	11.493039	7.067782	-0.210217	0
1	-6.206677	-4.422185	0.354848	8.447279	6.103545	1.712683	0
2	-4.119060	-4.059562	2.284338	7.195207	1.723852	4.215468	0
3	3.489565	4.628838	7.818746	10.116034	-11.198842	3.223121	1
4	5.244161	3.443408	8.664659	6.367069	-12.351509	3.647803	1
...	...	...	...	...	...	...	...
253	-1.660286	-5.035091	1.992441	7.622380	5.400063	3.097290	0
254	6.610330	1.273078	4.739605	8.479677	-11.038898	6.556038	1
255	-6.315800	-5.416517	2.278263	10.616842	4.843602	-0.069696	0
256	-8.690065	-5.983323	3.666243	6.443481	7.479635	1.479961	0
257	4.736128	3.230271	5.471063	10.882065	-12.281929	3.685385	1

258 rows × 7 columns

Next steps: View recommended plots

Print the number associated to each cluster

```
df.yestimated.unique()
```

```
array([0, 1], dtype=int32)
```

Print the centroids

```
km.cluster_centers_
```

```
array([[-5.49262402, -5.96483008,  2.00902767,  8.73520327,  6.06770761,
         2.42031194],
       [ 5.62204333,  2.42367169,  7.31725831,  9.17628592, -9.03660087,
         5.35016908]])
```

Print the intertia metric

```
km.inertia_
```

```
6035.8623477806295
```

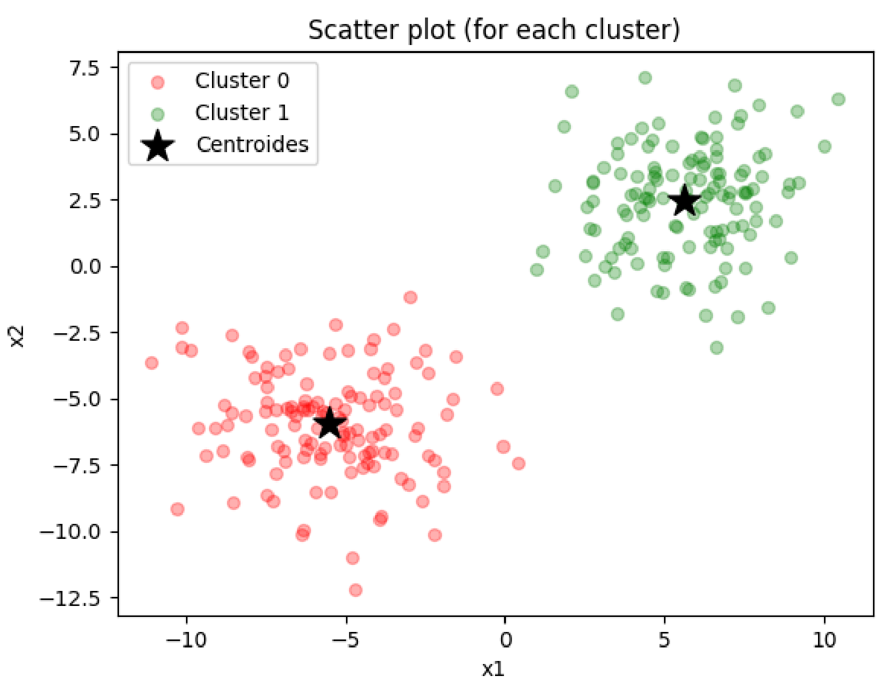
Plot a scatter plot of your data using different color for each cluster. Also plot the centroids

```
# Get a dataframe with the data of each cluster
df1 = df[df.yestimated==0]
df2 = df[df.yestimated==1]

# Scatter plot of each cluster
plt.scatter(df1.x1, df1.x2, label='Cluster 0', c='r', marker='o', s=32, alpha=0.3)
plt.scatter(df2.x1, df2.x2, label='Cluster 1', c='g', marker='o', s=32, alpha=0.3)

# Plot centrodides
plt.scatter(km.cluster_centers_[:,0], km.cluster_centers_[:,1], color='black', marker='*', label='Centroides', s

plt.title('Scatter plot (for each cluster)')
plt.xlabel('x1')
plt.ylabel('x2')
plt.legend()
plt.show()
```



Questions

Provides a detailed description of your results

Your response: El dataset tiene 2 clusters o grupos evidentes, por lo que se puede asumir que los datos pertenecen a dos grupos.

A5 Elbow plot

Compute the Elbow plot

```
# Intialize a list to hold sum of squared error (sse)
sse = []

# Define values of k
k_rng = range(1,10)
```