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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- My carreer: ITC

Importing libraries

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
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/MachineLearningWithPython/"

    # Define path del proyecto
    Ruta            = "/content/drive/My Drive/Colab Notebooks/NotebooksProfessor"

else:
    # Define path del proyecto
    Ruta            = ""

# url string that hosts our .csv file
url = Ruta + "/A01637972_X.csv"
# Read the .csv file and store it as a pandas Data Frame
df = pd.read_csv(url)
```

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

A2 Data managment

Print the first 7 rows

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

	Unnamed: 0	x1	x2	x3	x4	x5	x6	x7	
0	0	2.785038	-0.320253	-0.366829	5.489520	0.589037	-11.627570	-5.194364	10.
1	1	1.512058	-2.787632	-4.509219	3.012480	2.089651	-10.785743	-3.284605	5.
2	2	-6.791266	2.265681	0.173605	3.318990	-4.902140	1.059345	6.573512	8.
3	3	1.473462	-1.301713	-3.486627	7.179560	-0.288922	-10.038305	-7.998483	4.
4	4	0.897142	0.066026	-2.561047	7.156621	2.912814	-12.696372	-8.889818	9.
5	5	0.575540	7.738205	4.555532	9.184514	3.660133	7.006963	0.444127	-8.
6	6	-0.644227	3.046310	-11.089312	6.724682	-0.042115	-0.013711	-1.609492	-2.

Pasos siguientes: Generar código con df | Ver gráficos recomendados | New interactive sheet

Print the last 4 rows

```
df.tail(4)
```

	Unnamed: 0	x1	x2	x3	x4	x5	x6	x7	
684	684	4.485890	-0.039411	-1.934012	6.487421	-0.906070	-14.807169	-7.917795	
685	685	-3.195834	5.120192	4.269957	11.082383	0.331762	7.270322	3.399509	-
686	686	-4.962794	3.358656	-8.345166	-0.635303	-7.994467	2.674455	4.409376	
687	687	4.042040	-1.441539	-4.966627	9.078894	6.333406	-9.660980	-6.995774	

How many rows and columns are in your data?

Use the `shape` method

```
df.shape
```

```
(688, 12)
```

Print the name of all columns

Use the `columns` method

```
print(df.columns)
```

```
Index(['Unnamed: 0', 'x1', 'x2', 'x3', 'x4', 'x5', 'x6', 'x7', 'x8', 'x9',
       'x10', 'x11'],
      dtype='object')
```

What is the data type in each column

Use the `dtypes` method

```
df.dtypes
```

	0
Unnamed: 0	int64
x1	float64
x2	float64
x3	float64
x4	float64
x5	float64
x6	float64
x7	float64
x8	float64
x9	float64
x10	float64
x11	float64

dtype: object

What is the meaning of rows and columns?

```
# Your responses here

# 1) La columna Sin nombre: 0 parece servir como índice o identificador de fila.

# 2) Los valores numéricos, que pueden representar características o variables en un conjunto de datos (de una simulación o un entorno exper

# 3) Los valores que nos ofrecen, a excepción de la columna 0, son flotantes.

#...
```

Print a statistical summary of your columns

```
df.describe()
```

	Unnamed: 0	x1	x2	x3	x4	x5	x6
count	688.000000	688.000000	688.000000	688.000000	688.000000	688.000000	688.000000
mean	343.500000	-0.105347	2.084932	-3.347256	4.453295	0.638853	1.019980
std	198.752778	4.715224	3.262176	4.447138	3.503670	3.514833	6.256647
min	0.000000	-11.775726	-6.143589	-12.642436	-3.578235	-9.409284	-14.807169
25%	171.750000	-3.539439	-0.228382	-7.061557	1.798448	-0.847392	-0.706199
50%	343.500000	0.522833	2.510665	-3.643168	3.934802	1.501607	2.498624
75%	515.250000	3.358323	4.441846	0.541884	6.872078	3.097808	5.083720
max	687.000000	10.852477	9.448350	7.085676	14.943987	8.991008	13.148945

```
# 1) What is the minumum and maximum values of each variable
#df.max()
df.min()
```

	0
unnamed: 0	0.000000
x1	-11.775726
x2	-6.143589
x3	-12.642436
x4	-3.578235
x5	-9.409284
x6	-14.807169
x7	-10.644848
x8	-13.873049
x9	-15.844362
x10	-11.556889
cluster	0.000000

dtype: float64

```
# 2) What is the mean and standar deviation of each variable
df.mean()
df.std()
```

	0
unnamed: 0	198.752778
x1	4.715224
x2	3.262176
x3	4.447138
x4	3.503670
x5	3.514833
x6	6.256647
x7	4.506726
x8	7.516520
x9	5.662991
x10	6.249799
cluster	1.086786

dtype: float64

```
# 3) What the 25%, 50% and 75% represent?
df.quantile(0.25)
df.quantile(0.5)
df.quantile(0.75)
```

	0.75
unnamed: 0	515.250000
x1	3.358323
x2	4.441846
x3	0.541884
x4	6.872078
x5	3.097808
x6	5.083720
x7	1.707453
x8	6.788140
x9	4.690047
x10	6.125021
cluster	2.000000

dtype: float64

Rename the columns using the same name with capital letters

```
df.columns = [x.upper() for x in df.columns]
df
```

	UNNAMED: 0	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
0	0	2.785038	-0.320253	-0.366829	5.489520	0.589037	-11.627570	-5.194364	10.221068	-10.330072	6.425405	0.335253
1	1	1.512058	-2.787632	-4.509219	3.012480	2.089651	-10.785743	-3.284605	5.555869	-5.119256	6.116187	-0.524283
2	2	-6.791266	2.265681	0.173605	3.318990	-4.902140	1.059345	6.573512	8.931859	-0.911567	7.811470	4.544058
3	3	1.473462	-1.301713	-3.486627	7.179560	-0.288922	-10.038305	-7.998483	4.292517	-9.015017	8.299924	-2.282707
4	4	0.897142	0.066026	-2.561047	7.156621	2.912814	-12.696372	-8.889818	9.609494	-15.232169	5.411228	-0.657676
...	...	...	...	...	...	...	...	...	...	...	...	...
683	683	-10.408806	5.830878	-6.951139	-0.778323	-6.302301	4.111784	4.652592	6.520621	-2.838583	8.315989	1.632904
684	684	4.485890	-0.039411	-1.934012	6.487421	-0.906070	-14.807169	-7.917795	9.482359	-6.547273	5.686055	-3.531208
685	685	-3.195834	5.120192	4.269957	11.082383	0.331762	7.270322	3.399509	-7.838998	2.456319	-5.032645	-9.714281
686	686	-4.962794	3.358656	-8.345166	-0.635303	-7.994467	2.674455	4.409376	8.770110	0.063100	6.748839	4.594317
687	687	4.042040	-1.441539	-4.966627	9.078894	6.333406	-9.660980	-6.995774	7.279895	-13.650498	5.505477	-1.103193

688 rows × 12 columns

Pasos siguientes: Generar código con df | Ver gráficos recomendados | New interactive sheet

Rename the columns to their original names

```
df.columns = [x.lower() for x in df.columns]
df
```

	unnamed: 0	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11
0	0	2.785038	-0.320253	-0.366829	5.489520	0.589037	-11.627570	-5.194364	10.221068	-10.330072	6.425405	0.335253
1	1	1.512058	-2.787632	-4.509219	3.012480	2.089651	-10.785743	-3.284605	5.555869	-5.119256	6.116187	-0.524283
2	2	-6.791266	2.265681	0.173605	3.318990	-4.902140	1.059345	6.573512	8.931859	-0.911567	7.811470	4.544058
3	3	1.473462	-1.301713	-3.486627	7.179560	-0.288922	-10.038305	-7.998483	4.292517	-9.015017	8.299924	-2.282707
4	4	0.897142	0.066026	-2.561047	7.156621	2.912814	-12.696372	-8.889818	9.609494	-15.232169	5.411228	-0.657676
...	...	...	...	...	...	...	...	...	...	...	...	...
683	683	-10.408806	5.830878	-6.951139	-0.778323	-6.302301	4.111784	4.652592	6.520621	-2.838583	8.315989	1.632904
684	684	4.485890	-0.039411	-1.934012	6.487421	-0.906070	-14.807169	-7.917795	9.482359	-6.547273	5.686055	-3.531208
685	685	-3.195834	5.120192	4.269957	11.082383	0.331762	7.270322	3.399509	-7.838998	2.456319	-5.032645	-9.714281
686	686	-4.962794	3.358656	-8.345166	-0.635303	-7.994467	2.674455	4.409376	8.770110	0.063100	6.748839	4.594317
687	687	4.042040	-1.441539	-4.966627	9.078894	6.333406	-9.660980	-6.995774	7.279895	-13.650498	5.505477	-1.103193

688 rows × 12 columns

Pasos siguientes: Generar código con df | Ver gráficos recomendados | New interactive sheet

Use two different alternatives to get one of the columns

```
# Alternative 1: Using dot notation
df.x1
```

	x1
0	2.785038
1	1.512058
2	-6.791266
3	1.473462
4	0.897142
...	...
683	-10.408806
684	4.485890
685	-3.195834
686	-4.962794
687	4.042040

688 rows × 1 columns

dtype: float64

```
# Alternative 2: Using bracket notation
df['x1']
```

	x1
0	2.785038
1	1.512058
2	-6.791266
3	1.473462
4	0.897142
...	...
683	-10.408806
684	4.485890
685	-3.195834
686	-4.962794
687	4.042040

688 rows × 1 columns

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	-1.074474	4.433935
63	-1.618958	5.280154
64	-0.466137	3.459783
65	2.782683	-1.526594
66	0.523998	4.867162
67	2.369896	0.442358
68	2.791381	2.415206
69	1.584969	2.154850
70	2.585383	4.678572
71	1.630003	1.063027
72	-3.872007	3.867513

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

```
df.iloc[:,1:3].isnull().sum()
```

	0
x1	0
x2	0

dtype: int64

Discard the last column

```
df = df.iloc[:,:-1]
df
```

	unnamed: 0	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
0	0	2.785038	-0.320253	-0.366829	5.489520	0.589037	-11.627570	-5.194364	10.221068	-10.330072	6.425405
1	1	1.512058	-2.787632	-4.509219	3.012480	2.089651	-10.785743	-3.284605	5.555869	-5.119256	6.116187
2	2	-6.791266	2.265681	0.173605	3.318990	-4.902140	1.059345	6.573512	8.931859	-0.911567	7.811470
3	3	1.473462	-1.301713	-3.486627	7.179560	-0.288922	-10.038305	-7.998483	4.292517	-9.015017	8.299924
4	4	0.897142	0.066026	-2.561047	7.156621	2.912814	-12.696372	-8.889818	9.609494	-15.232169	5.411228
...	...	...	...	...	...	...	...	...	...	...	...
683	683	-10.408806	5.830878	-6.951139	-0.778323	-6.302301	4.111784	4.652592	6.520621	-2.838583	8.315989
684	684	4.485890	-0.039411	-1.934012	6.487421	-0.906070	-14.807169	-7.917795	9.482359	-6.547273	5.686055
685	685	-3.195834	5.120192	4.269957	11.082383	0.331762	7.270322	3.399509	-7.838998	2.456319	-5.032645
686	686	-4.962794	3.358656	-8.345166	-0.635303	-7.994467	2.674455	4.409376	8.770110	0.063100	6.748839
687	687	4.042040	-1.441539	-4.966627	9.078894	6.333406	-9.660980	-6.995774	7.279895	-13.650498	5.505477

688 rows × 11 columns

Pasos siguientes: Generar código con df | Ver gráficos recomendados | New interactive sheet

Questions

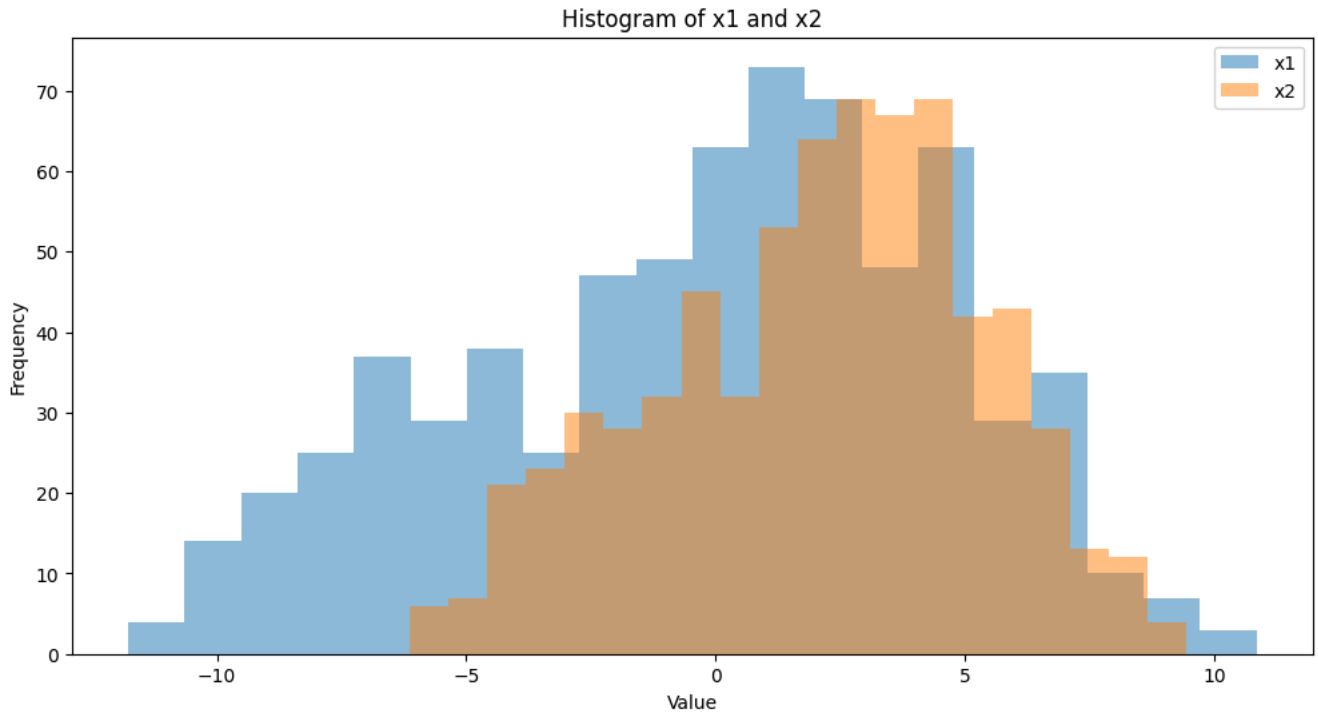
Based on the previos results, provide a description of yout dataset

Your response:

A3 Data visualization

Plot in the same figure the histogram of two variables

```
plt.figure(figsize=(12, 6))
plt.hist(df['x1'], bins=20, alpha=0.5, label='x1')
plt.hist(df['x2'], bins=20, alpha=0.5, label='x2')
plt.xlabel('Value')
plt.ylabel('Frequency')
plt.title('Histogram of x1 and x2')
plt.legend()
plt.show()
```

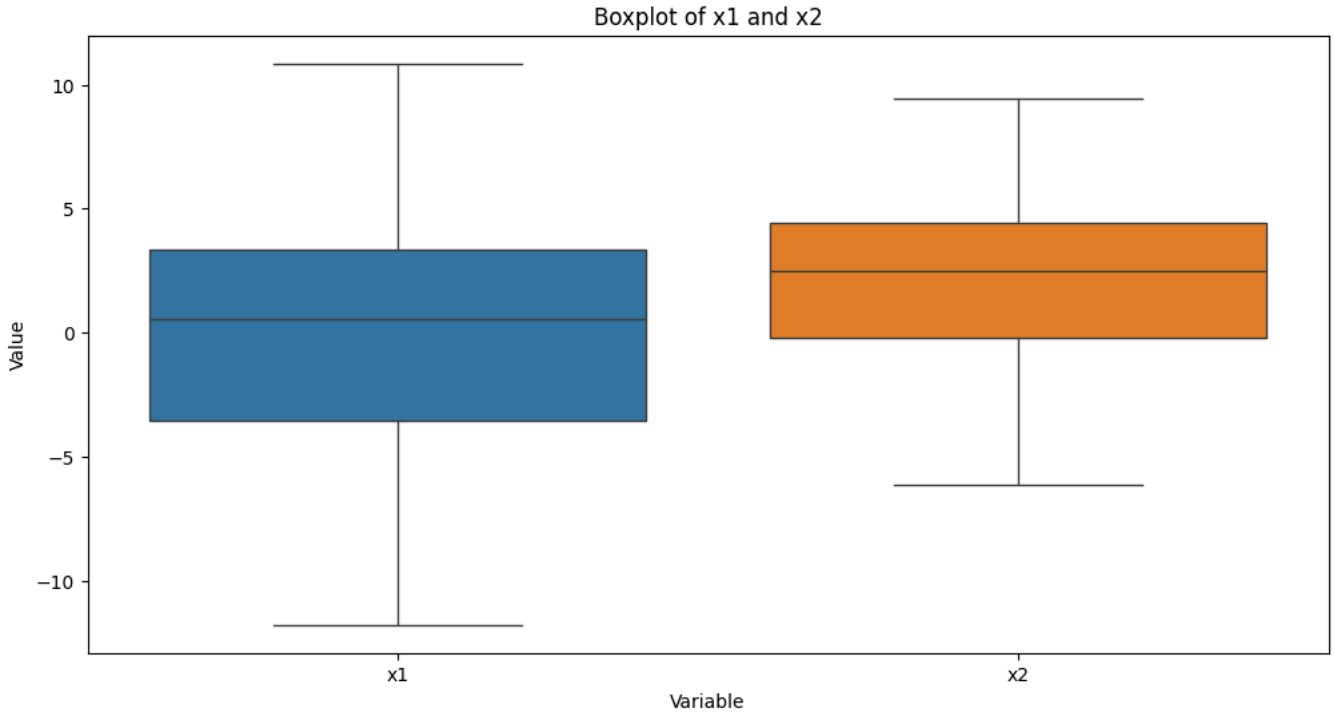


Based on these plots, provide a description of your data:

Your response here:

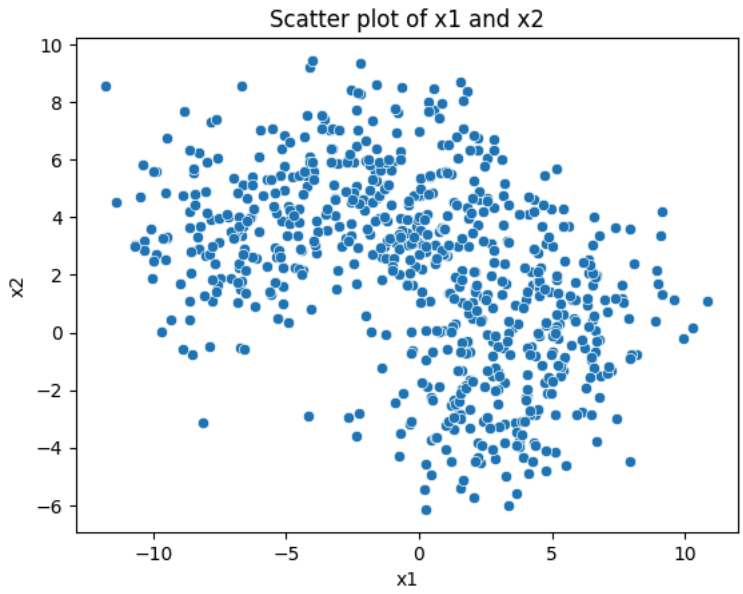
Plot in the same figure the boxplot of two variables

```
plt.figure(figsize=(12, 6))
sns.boxplot(data=df[['x1', 'x2']])
plt.xlabel('Variable')
plt.ylabel('Value')
plt.title('Boxplot of x1 and x2')
plt.show()
```



Plot the scatter plot of two variables

```
sns.scatterplot(data=df, x='x1', y='x2')
plt.xlabel('x1')
plt.ylabel('x2')
plt.title('Scatter plot of x1 and x2')
plt.show()
```



Questions

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

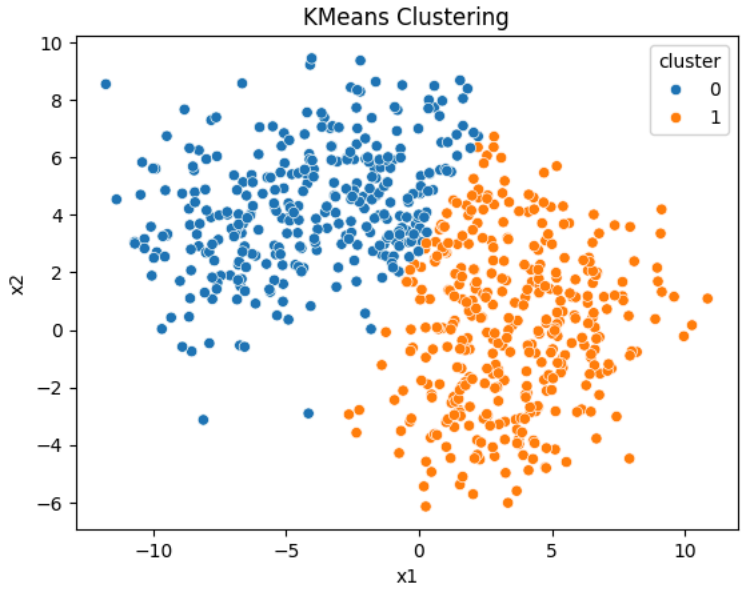
Your response:

A4 Kmeans

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

```
# prompt: Do Kmeans clustering assuming a number of clusters accorging to the scatter plot

import matplotlib.pyplot as plt
# Assuming you want to cluster based on 'x1' and 'x2'
X = df[['x1', 'x2']]

# Determine the number of clusters from your scatter plot (replace 'n_clusters' with your chosen value)
kmeans = KMeans(n_clusters=2, random_state=0)

# Fit the model to your data
kmeans.fit(X)

# Get the cluster labels for each data point
df['cluster'] = kmeans.labels_

# Visualize the clusters
sns.scatterplot(data=df, x='x1', y='x2', hue='cluster')
plt.title('KMeans Clustering')
plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:1416: FutureWarning: The default value of `n_init` will change from 1
  super()._check_params_vs_input(X, default_n_init=10)
```



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

```
df['cluster'] = kmeans.fit_predict(df[['x1', 'x2']])
df
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:1416: FutureWarning: The default value of `n_init` will change from 1
  super()._check_params_vs_input(X, default_n_init=10)
```

	unnamed: 0	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	cluster
0	0	2.785038	-0.320253	-0.366829	5.489520	0.589037	-11.627570	-5.194364	10.221068	-10.330072	6.425405	1
1	1	1.512058	-2.787632	-4.509219	3.012480	2.089651	-10.785743	-3.284605	5.555869	-5.119256	6.116187	1
2	2	-6.791266	2.265681	0.173605	3.318990	-4.902140	1.059345	6.573512	8.931859	-0.911567	7.811470	0
3	3	1.473462	-1.301713	-3.486627	7.179560	-0.288922	-10.038305	-7.998483	4.292517	-9.015017	8.299924	1
4	4	0.897142	0.066026	-2.561047	7.156621	2.912814	-12.696372	-8.889818	9.609494	-15.232169	5.411228	1
...	...	...	...	...	...	...	...	...	...	...	...	...
683	683	-10.408806	5.830878	-6.951139	-0.778323	-6.302301	4.111784	4.652592	6.520621	-2.838583	8.315989	0
684	684	4.485890	-0.039411	-1.934012	6.487421	-0.906070	-14.807169	-7.917795	9.482359	-6.547273	5.686055	1
685	685	-3.195834	5.120192	4.269957	11.082383	0.331762	7.270322	3.399509	-7.838998	2.456319	-5.032645	0
686	686	-4.962794	3.358656	-8.345166	-0.635303	-7.994467	2.674455	4.409376	8.770110	0.063100	6.748839	0
687	687	4.042040	-1.441539	-4.966627	9.078894	6.333406	-9.660980	-6.995774	7.279895	-13.650498	5.505477	1

688 rows × 12 columns

Pasos siguientes: Generar código con df | Ver gráficos recomendados | New interactive sheet

Print the number associated to each cluster

```
df['cluster'].value_counts()
```

cluster	count
1	361
0	327

dtype: int64

Print the centroids

```
kmeans.cluster_centers_
```

```
array([[-4.04141752,  4.29780876],
       [ 3.48085001,  0.0687545 ]])
```

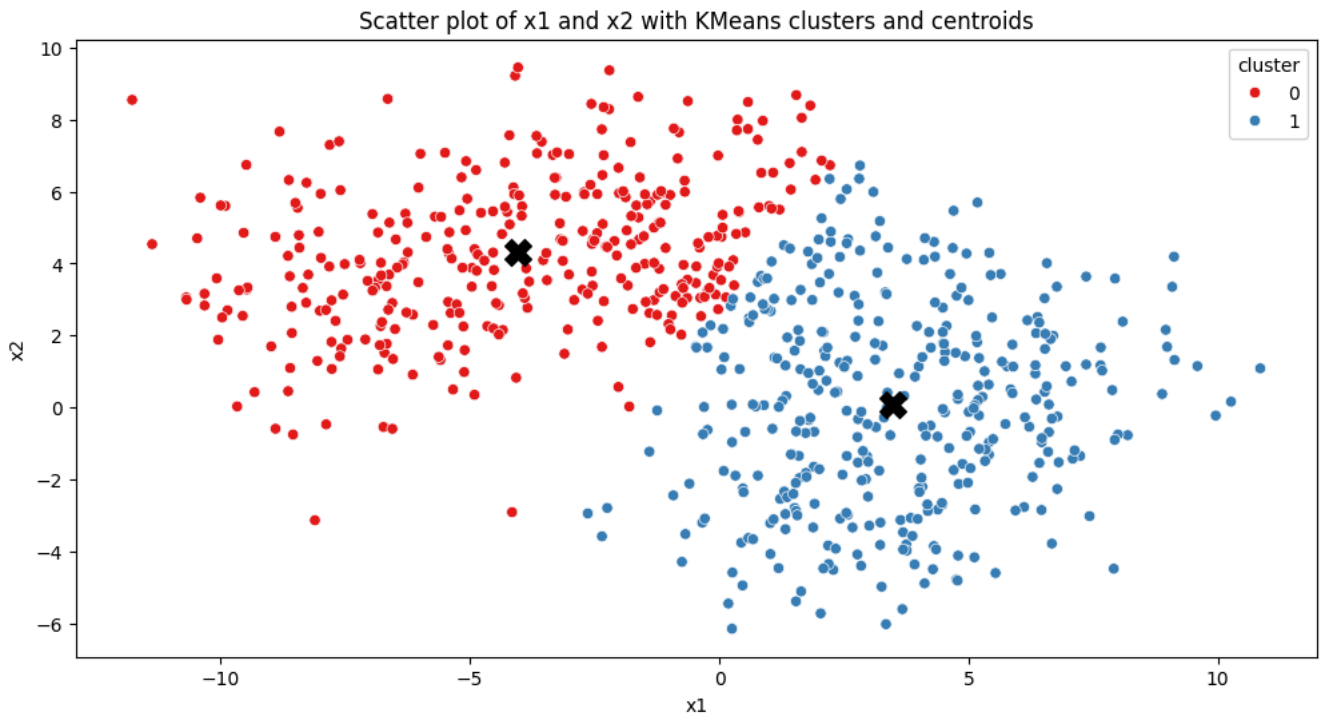
Print the intertia metric

```
kmeans.inertia_
```

```
9804.165695586235
```

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

```
plt.figure(figsize=(12, 6))
sns.scatterplot(data=df, x='x1', y='x2', hue='cluster', palette='Set1')
plt.scatter(kmeans.cluster_centers_[:, 0], kmeans.cluster_centers_[:, 1], marker='X', color='black', s=200)
plt.xlabel('x1')
plt.ylabel('x2')
plt.title('Scatter plot of x1 and x2 with KMeans clusters and centroids')
plt.show()
```



Questions

Provides a detailed description of your results

Your response:

A5 Elbow plot

Compute the Elbow plot

```
inertia = []
for i in range(1, 11):
    kmeans = KMeans(n_clusters=i, random_state=42)
    kmeans.fit(df[['x1', 'x2']])
    inertia.append(kmeans.inertia_)

plt.plot(range(1, 11), inertia, marker='o')
plt.title('Elbow Method')
plt.xlabel('Number of Clusters')
plt.ylabel('Inertia')
plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:1416: FutureWarning: The default value of `n_init` will change from 1
  super()._check_params_vs_input(X, default_n_init=10)
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:1416: FutureWarning: The default value of `n_init` will change from 1
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  super()._check_params_vs_input(X, default_n_init=10)
```

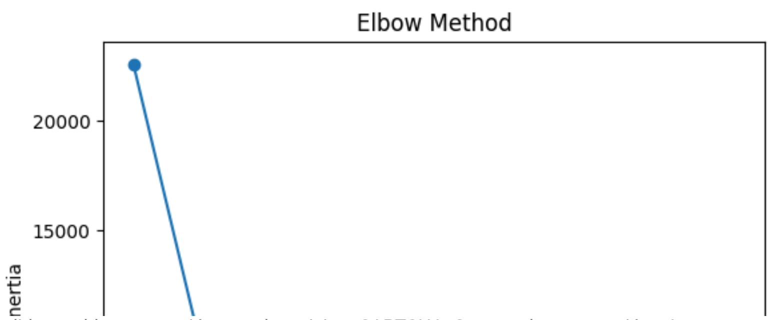

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