Maestría en Inteligencia Artificial Aplicada

Curso: Ciencia y Analitica de Datos

Tecnológico de Monterrey

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Reto - Entrega 1 - Limpieza, Analisis, Visualizaicon, Kmeans

Fecha: 13 de Noviembre del 2022

```
# Incluye aquí todos módulos, librerías y paquetes que requieras.

# Descargar Data Set
# ==============================
import requests, zipfile
from io import BytesIO

# Tratamiento de datos
# ==============================
import numpy as np
import pandas as pd

# Graficos
# ==============================
import seaborn as sns
import matplotlib.pyplot as plt

# Preprocesado y modelado
# ==============================
from sklearn.model_selection import train_test_split
from sklearn.pipeline import Pipeline
from sklearn.compose import ColumnTransformer
from sklearn.impute import SimpleImputer
```

```
from sklearn.preprocessing import MinMaxScaler, OneHotEncoder, StandardScaler
from sklearn.dummy import DummyRegressor
from sklearn.model_selection import RepeatedKFold
from sklearn.linear_model import LinearRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.neural_network import MLPRegressor
from sklearn.model_selection import cross_validate
from sklearn.metrics import make_scorer
from tabulate import tabulate
from sklearn.model_selection import GridSearchCV
from sklearn.inspection import permutation_importance
from sklearn.preprocessing import LabelEncoder

# Geopandas
# ==============================
! pip install qeds fiona geopandas xgboost gensim folium pyLDAvis descartes

import geopandas as gpd
from shapely.geometry import Point


# Kmeans
# ==============================
from sklearn.cluster import KMeans


# Mapa
# ==============================
import folium
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/p
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```

Eleccion de una base de datos

```
# Extraccion de la carpeta comprimida
url = "http://201.116.60.46/Datos_de_calidad_del_agua_de_5000_sitios_de_monitoreo.zip"
req = requests.get(url)
zipfile.ZipFile(BytesIO(req.content)).extractall()

# Lectura del csv como dataframe
path = "Datos_de_calidad_del_agua_2020/Datos_de_calidad_del_agua_de_sitios_de_monitoreo_de_ag
df=pd.read_csv(path, encoding="latin1")

# Datos de la calidad de aguas superficiales
df.head()
```

	CLAVE	SITIO	ORGANISMO_DE_CUENCA	ESTADO	MUNICIPIO	
0	DLAGU6	POZO SAN GIL	LERMA SANTIAGO PACIFICO	AGUASCALIENTES	ASIENTOS	
1	DLAGU6516	POZO R013 CAÑADA HONDA	LERMA SANTIAGO PACIFICO	AGUASCALIENTES	AGUASCALIENTES	
2	DLAGU7	POZO COSIO	LERMA SANTIAGO PACIFICO	AGUASCALIENTES	COSIO	A(
3	DLAGU9	POZO EL SALITRILLO	LERMA SANTIAGO PACIFICO	AGUASCALIENTES	RINCON DE ROMOS	A(
4	DLBAJ107	RANCHO EL TECOLOTE	PENINSULA DE BAJA CALIFORNIA	BAJA CALIFORNIA SUR	LA PAZ	

5 rows × 57 columns

Limpieza de los datos

```
# Se verifica la cantidad de datos nulos en cada columna
df.isna().sum()
```

```
CLAVE                    0
SITIO                    0
ORGANISMO_DE_CUENCA      0
ESTADO                   0
MUNICIPIO                0
ACUIFERO                 0
SUBTIPO                  0
LONGITUD                 0
LATITUD                  0
PERIODO                  0
ALC_mg/L                 4
CALIDAD_ALC              4
CONDUCT_mS/cm            6
CALIDAD_CONDUC           6
SDT_mg/L              1068
SDT_M_mg/L               2
CALIDAD_SDT_ra           2
CALIDAD_SDT_salin        2
FLUORUROS_mg/L           0
CALIDAD_FLUO             0
DUR_mg/L                 1
CALIDAD_DUR              1
COLI_FEC_NMP/100_mL      0
CALIDAD_COLI_FEC         0
```

```
N_NO3_mg/L                1
CALIDAD_N_NO3             1
AS_TOT_mg/L               0
CALIDAD_AS                0
CD_TOT_mg/L               0
CALIDAD_CD                0
CR_TOT_mg/L               0
CALIDAD_CR                0
HG_TOT_mg/L               0
CALIDAD_HG                0
PB_TOT_mg/L               0
CALIDAD_PB                0
MN_TOT_mg/L               0
CALIDAD_MN                0
FE_TOT_mg/L               0
CALIDAD_FE                0
SEMAFORO                  0
CONTAMINANTES           434
CUMPLE_CON_ALC            0
CUMPLE_CON_COND           0
CUMPLE_CON_SDT_ra         0
CUMPLE_CON_SDT_salin      0
CUMPLE_CON_FLUO           0
CUMPLE_CON_DUR            0
CUMPLE_CON_CF             0
CUMPLE_CON_NO3            0
CUMPLE_CON_AS             0
CUMPLE_CON_CD             0
CUMPLE_CON_CR             0
CUMPLE_CON_HG             0
CUMPLE_CON_PB             0
CUMPLE_CON_MN             0
CUMPLE_CON_FE             0
```

```
# Se descartan las columnas de CONTAMINANTES y SDT_mg/L ya que la mayor parte de sus datos so
df.drop(["CONTAMINANTES","SDT_mg/L"], inplace=True, axis=1)
```

Las demas columnas presentaban un 6 datos nulos como maximo, estos se pueden considerar despreciables, por lo que se procede a eliminarlos.

```
#Eliminamos los datos NaN
df.dropna(inplace = True)
```

```
#Se corrobora si quedo algún dato vacío, False = No hay datos nulos
df.isna().values.any()
```

```
False
```

Al analizar el set de datos, se puede inferir que los datos categoricos son dependientes de los datos numericos, es decir, hacen referencia a ellos, provocando asi una redundancia en los

mismos, por lo tanto se procede a eliminar estas columnas y utilizar solo las numericas.

```
col_num = ['LONGITUD','LATITUD','ALC_mg/L','CONDUCT_mS/cm','SDT_M_mg/L','FLUORUROS_mg/L','DUR
           'N_NO3_mg/L','AS_TOT_mg/L','CD_TOT_mg/L','CR_TOT_mg/L','HG_TOT_mg/L','PB_TOT_mg/L'
df_new = df[col_num]
df_new.head()
```

	LONGITUD	LATITUD	ALC_mg/L	CONDUCT_mS/cm	SDT_M_mg/L	FLUORUROS_mg/L	DUR_mg/L	C
0	-102.02210	22.20887	229.990	940.0	603.6	0.9766	213.732	
1	-102.20075	21.99958	231.990	608.0	445.4	0.9298	185.0514	
2	-102.28801	22.36685	204.920	532.0	342	1.8045	120.719	
3	-102.29449	22.18435	327.000	686.0	478.6	1.1229	199.879	
4	-110.24480	23.45138	309.885	1841.0	1179	0.2343	476.9872	

```
# Se comprueba la cantidad de datos nulos por columna y su tipo de dato
df_new.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1054 entries, 0 to 1067
Data columns (total 17 columns):
 #   Column               Non-Null Count  Dtype  
---  ------               --------------  -----  
 0   LONGITUD             1054 non-null   float64
 1   LATITUD              1054 non-null   float64
 2   ALC_mg/L             1054 non-null   float64
 3   CONDUCT_mS/cm        1054 non-null   float64
 4   SDT_M_mg/L           1054 non-null   object 
 5   FLUORUROS_mg/L       1054 non-null   object 
 6   DUR_mg/L             1054 non-null   object 
 7   COLI_FEC_NMP/100_mL  1054 non-null   object 
 8   N_NO3_mg/L           1054 non-null   object 
 9   AS_TOT_mg/L          1054 non-null   object 
 10  CD_TOT_mg/L          1054 non-null   object 
 11  CR_TOT_mg/L          1054 non-null   object 
 12  HG_TOT_mg/L          1054 non-null   object 
 13  PB_TOT_mg/L          1054 non-null   object 
 14  MN_TOT_mg/L          1054 non-null   object 
 15  FE_TOT_mg/L          1054 non-null   object 
 16  SEMAFORO             1054 non-null   object 
dtypes: float64(4), object(13)
memory usage: 148.2+ KB
```

Se aprecia como en la mayor parte de las columnas son de tipo string (object) aunque son numericas, y esto se debe a que incluyen el simbolo <.

```
# Conversion de tipo de dato de la columna y eliminacion del <
col = ['ALC_mg/L','CONDUCT_mS/cm','SDT_M_mg/L','FLUORUROS_mg/L','DUR_mg/L','COLI_FEC_NMP/100_
       'AS_TOT_mg/L','CD_TOT_mg/L','CR_TOT_mg/L','HG_TOT_mg/L','PB_TOT_mg/L','MN_TOT_mg/L','F
for name in col:
  df_new[name] = df_new[name].astype(str)
  df_new[name] = df_new[name].replace("<","", regex=True)
  df_new[name]= df_new[name].astype(float)

df_new.head()
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_
  """
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_
  import sys
```

	LONGITUD	LATITUD	ALC_mg/L	CONDUCT_mS/cm	SDT_M_mg/L	FLUORUROS_mg/L	DUR_mg/L	C
0	-102.02210	22.20887	229.990	940.0	603.6	0.9766	213.7320	
1	-102.20075	21.99958	231.990	608.0	445.4	0.9298	185.0514	
2	-102.28801	22.36685	204.920	532.0	342.0	1.8045	120.7190	
3	-102.29449	22.18435	327.000	686.0	478.6	1.1229	199.8790	
4	-110.24480	23.45138	309.885	1841.0	1179.0	0.2343	476.9872	

Se prosigue dividiendo este conjunto de datos en tres partes dependiendo de su categoria.

```
df_location = df_new[["LONGITUD","LATITUD"]] # Localizacion
```

```
df_sust = df_new.drop(["LONGITUD","LATITUD","SEMAFORO"], axis=1) # Sustancias contaminantes
y = pd.DataFrame(df_new["SEMAFORO"])# Semaforo
y
```

	SEMAFORO
0	Verde
1	Verde
2	Rojo
3	Verde
4	Rojo
...	...
1063	Rojo
1064	Rojo
1065	Rojo
1066	Verde
1067	Verde

1054 rows × 1 columns

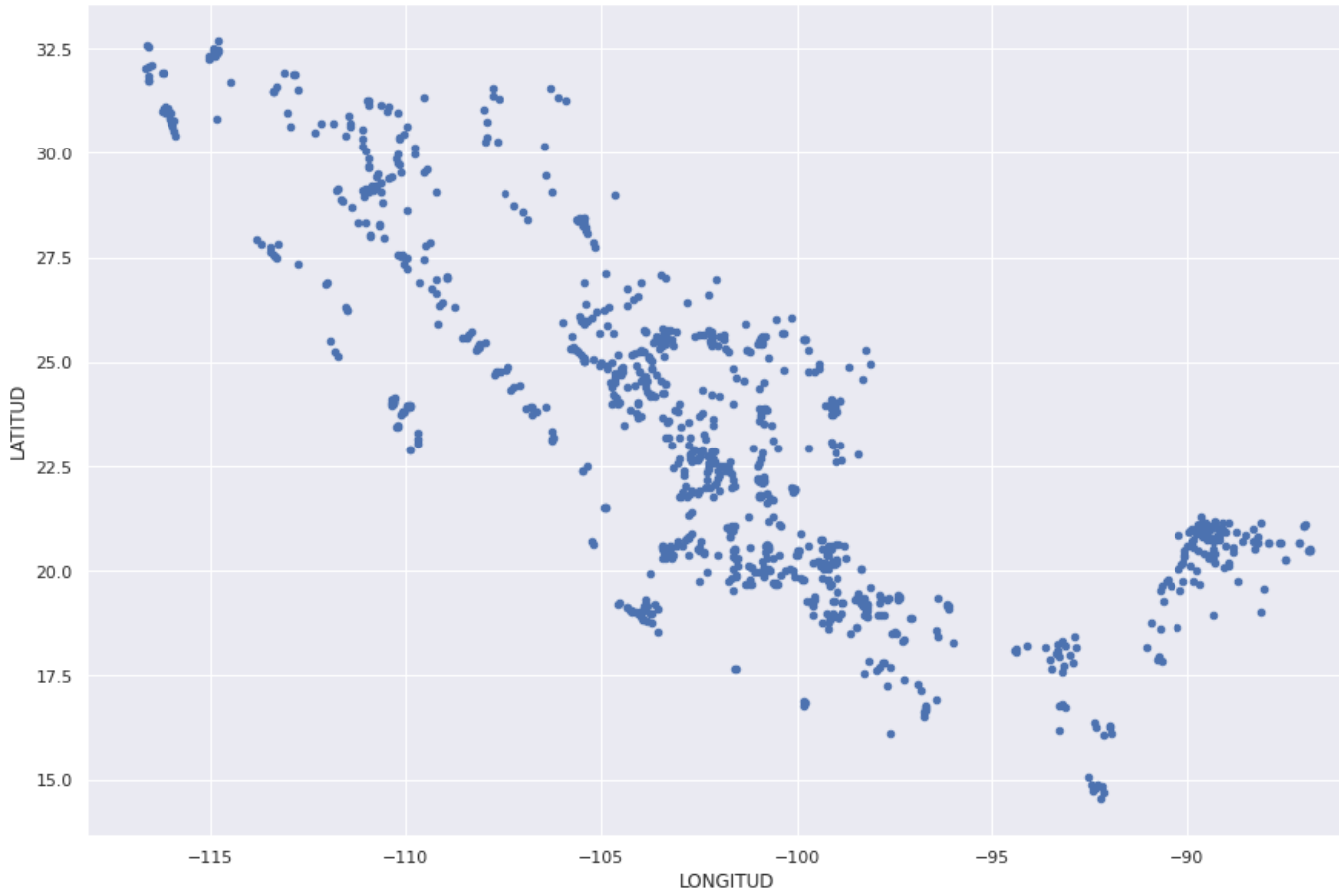
Exploracion de los datos

[ ] ↳ *9 cells hidden*

Relacion entre la calidad del agua y su ubicacion geografica utilizando Kmeans

```
# Graficamos los cuerpos de agua segun los puntos de sus coordenadas

df_location.plot.scatter('LONGITUD','LATITUD')
```

```
WARNING:matplotlib.axes._axes:*c* argument looks like a single numeric RGB or RGBA seque
<matplotlib.axes._subplots.AxesSubplot at 0x7fd5d6f97d90>
```




```
#Generamos dataframe con los datos de las coordendas
df_location
df_location["COORDENADAS"] = list(zip(df_location.LONGITUD, df_location.LATITUD))
df_location["COORDENADAS"] = df_location["COORDENADAS"].apply(Point)
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_
  This is separate from the ipykernel package so we can avoid doing imports until
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:4: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_
  after removing the cwd from sys.path.
```

```
df_location.head()
```

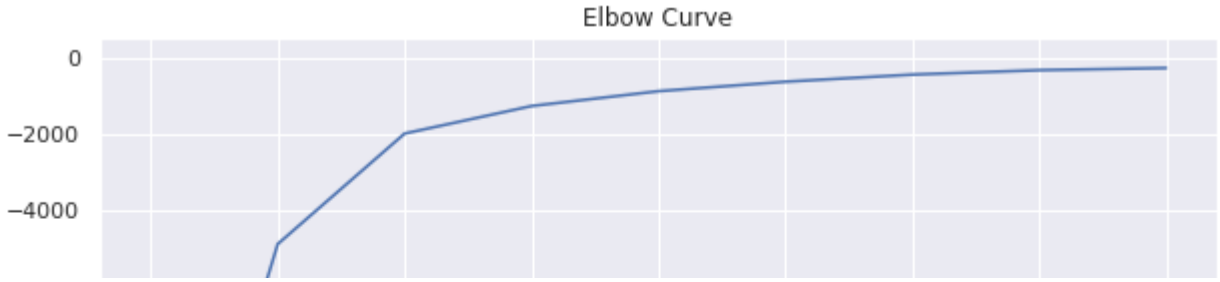
	LONGITUD	LATITUD	COORDENADAS
0	-102.02210	22.20887	POINT (-102.0221 22.20887)
1	-102.20075	21.99958	POINT (-102.20075 21.99958)
2	-102.28801	22.36685	POINT (-102.28801 22.36685)
3	-102.29449	22.18435	POINT (-102.29449 22.18435)

```
#Creamos Geodataframe

Mapa_Geo_Mex = gpd.GeoDataFrame(df_location, geometry="COORDENADAS")

world = gpd.read_file(gpd.datasets.get_path("naturalearth_lowres"))

world = world.set_index("iso_a3")
world.name.unique()
fig, gax = plt.subplots(figsize=(10,10))

world.query("name == 'Mexico'").plot(ax=gax, edgecolor='black',color='white')

gax.set_xlabel('LATITUD')
gax.set_ylabel('LONGITUD')

gax.spines['top'].set_visible(False)
gax.spines['right'].set_visible(False)

Mapa_Geo_Mex.plot(ax=gax, color='Blue', alpha = 0.5)
Mapa_Geo_Mex
```

	LONGITUD	LATITUD	COORDENADAS
0	-102.02210	22.20887	POINT (-102.02210 22.20887)
1	-102.20075	21.99958	POINT (-102.20075 21.99958)
2	-102.28801	22.36685	POINT (-102.28801 22.36685)
3	-102.29449	22.18435	POINT (-102.29449 22.18435)
4	-110.24480	23.45138	POINT (-110.24480 23.45138)
...	...	...	...
1063	-99.54191	24.76036	POINT (-99.54191 24.76036)
1064	-99.70099	24.78280	POINT (-99.70099 24.78280)
1065	-99.82249	25.55197	POINT (-99.82249 25.55197)
1066	-100.32683	24.80118	POINT (-100.32683 24.80118)
1067	-100.73302	25.09380	POINT (-100.73302 25.09380)

1054 rows × 3 columns

```
#Aplicamos Kmeans

Cluster_num = range(1,10)
mi_kmeans = [KMeans(n_clusters=i) for i in Cluster_num]
Y_axis = df_location[['LATITUD']]
X_axis = df_location[['LONGITUD']]
calulo_kmeans = [mi_kmeans[i].fit(Y_axis).score(Y_axis) for i in range(len(mi_kmeans))]

plt.figure(figsize=(10,6))
plt.plot(Cluster_num, calulo_kmeans)
plt.xlabel('Number of Clusters')
plt.ylabel('Score')
plt.title('Elbow Curve')

plt.show()
```




```
# De acuaerdo a la grafica de codo, el mayor cambio en el score se lo llevan los tres primero
# y a partir de estos se podria considerar que los demas son constantes.

X = df[['LONGITUD', 'LATITUD']]

kmeans = KMeans(n_clusters=3).fit(X)
centroids = kmeans.cluster_centers_ # Obtencion de centroides
labels = kmeans.predict(X) # prediccion de color de semaforo segun el centroide mas cercano
# Obtencion de los centroides
C = kmeans.cluster_centers_

df_centroids = pd.DataFrame(C) # Conversion a DataFrame
df_centroids["Coordinates"] = list(zip(df_centroids[0], df_centroids[1])) # Se convierte a li
df_centroids["Coordinates"] = df_centroids["Coordinates"].apply(Point) # Se convierte a punto

centroids_plot = gpd.GeoDataFrame(df_centroids, geometry="Coordinates")
centroids_plot
```

	0	1	Coordinates
0	-90.698434	19.475165	POINT (-90.69843 19.47516)
1	-110.740896	28.420375	POINT (-110.74090 28.42038)
2	-101.715581	22.271624	POINT (-101.71558 22.27162)

```
# Conteo de cuerpos de agua de acuerdo a su respectivo color de semaforo
df['SEMAFORO'].value_counts()
```

```
Verde       427
Rojo        382
Amarillo    245
Name: SEMAFORO, dtype: int64
```

```
y
```

	SEMAFORO
0	Verde
1	Verde
2	Rojo
3	Verde
4	Rojo
...	...
1063	Rojo
1064	Rojo
1065	Rojo

```
# Reemplazo del los nombres del color para que el codigo los respete
y['SEMAFORO_plot'] = y['SEMAFORO'].replace(to_replace = "Verde", value = "green")
y['SEMAFORO_plot'].replace(to_replace = "Rojo", value = "red", inplace=True)
y['SEMAFORO_plot'].replace(to_replace = "Amarillo", value = "yellow", inplace=True)
y
```

	SEMAFORO	SEMAFORO_plot
0	Verde	green
1	Verde	green
2	Rojo	red
3	Verde	green
4	Rojo	red
...	...	...
1063	Rojo	red
1064	Rojo	red
1065	Rojo	red
1066	Verde	green
1067	Verde	green

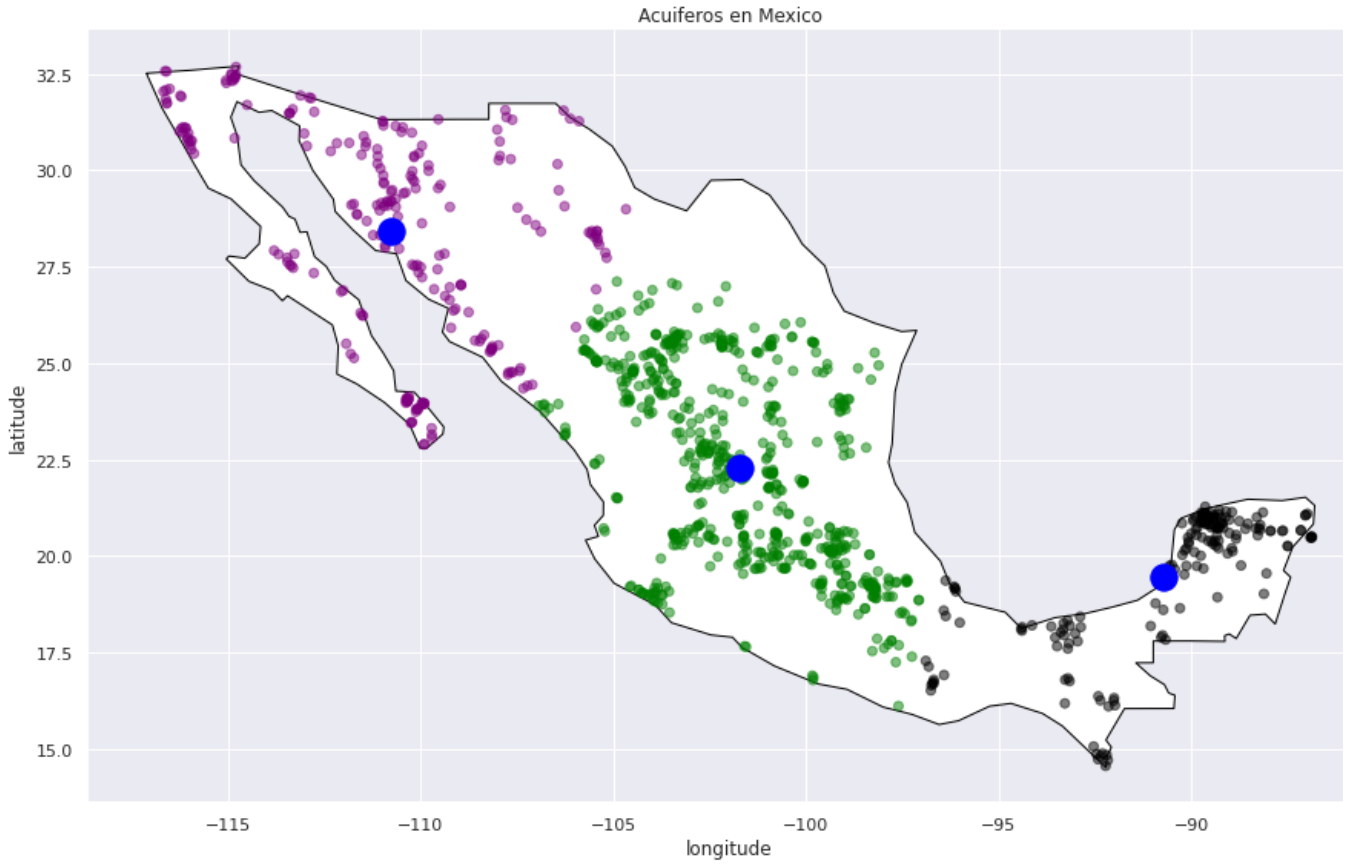
1054 rows × 2 columns

```
Mapa_Geo_Mex['Coordenada'] = Mapa_Geo_Mex['LATITUD'] + Mapa_Geo_Mex['LONGITUD']

semaforo_plot = dict(zip(Mapa_Geo_Mex.Coordenada, y['SEMAFORO_plot']))


# Para graficar el mapa
```

```
lat = Mapa_Geo_Mex.iloc[0]['LATITUD']
lng = Mapa_Geo_Mex.iloc[0]['LONGITUD']
map = folium.Map(location=[lng, lat], zoom_start=1)

for _, row in Mapa_Geo_Mex.iterrows():
    folium.CircleMarker(
        location=[row["LATITUD"], row["LONGITUD"]],
        radius=5,
        weight=1,
        fill=True,
        fill_color=semaforo_plot[row["Coordenada"]],
        color=semaforo_plot[row["Coordenada"]]
    ).add_to(map)
color='black'

for _, row in Mapa_Geo_Mex.iterrows():
    folium.CircleMarker(
        location=[row[1], row[0]],
        radius=5,
        weight=1,
        fill=True,
        fill_color=color,
        color=color
    ).add_to(map)
map
```

Make this Notebook Trusted to load map: File -> Trust Notebook


```
#Graficacion de los puntos respecto a su centroide mas cercano

fig, gax = plt.subplots(figsize=(15,10))
colores = ['black','purple','green']
color_asig = []

for row in labels:
  color_asig.append(colores[row])

world.query("name == 'Mexico'").plot(ax = gax, edgecolor='black', color='white') #filtramos p

Mapa_Geo_Mex.plot(ax=gax, color=color_asig, alpha = 0.5)
centroids_plot.plot(ax=gax, color='blue', alpha = 1, markersize = 300)

gax.set_xlabel('longitude')
gax.set_ylabel('latitude')
gax.set_title('Acuiferos en Mexico')

gax.spines['top'].set_visible(False)
gax.spines['right'].set_visible(False)

plt.show()
```




```
Mapa_Geo_Mex['COLOR']= y['SEMAFORO']
Mapa_Geo_Mex['CLUSTER'] = labels
Mapa_Geo_Mex
```

	LONGITUD	LATITUD	COORDENADAS	Coordenada	COLOR	CLUSTER
0	-102.02210	22.20887	POINT (-102.02210 22.20887)	-79.81323	Verde	2

```
mode_list=[]

for i in range(0,3):
  df_cluster = pd.DataFrame()
  df_cluster = Mapa_Geo_Mex[Mapa_Geo_Mex.CLUSTER == i].copy()
  moda = df_cluster['COLOR'].mode()[0]
  mode_list.append(moda)

len(mode_list)


centroids_plot['MODA'] = mode_list
centroids_plot

#Representacion de cada centroide respecto a la moda de los datos en su cluster
```

	0	1	Coordinates	MODA
0	-90.698434	19.475165	POINT (-90.69843 19.47516)	Amarillo
1	-110.740896	28.420375	POINT (-110.74090 28.42038)	Verde
2	-101.715581	22.271624	POINT (-101.71558 22.27162)	Rojo

```
List_plot_cluster = []

for i in range(0,3):
  if mode_list[i] == 'Verde':
    List_plot.append('green')
  if mode_list[i] == 'Rojo':
    List_plot.append('red')
  if mode_list[i] == 'Amarillo':
    List_plot.append('yellow')


Mapa_Geo_Mex['COLOR']= y['SEMAFORO']

List_plot_dot = []

for i in range(0,1054):
  if List_plot_dot.COLOR[i] == 'Verde':
    List_plot_dot.append('green')
  if List_plot_dot.COLOR[i] == 'Rojo':
    List_plot_dot.append('red')
  if List_plot_dot.COLOR[i] == 'Amarillo':
    List_plot_dot.append('yellow')
```

```
len(List_plot_dot)
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
<ipython-input-199-a2289acad8fa> in <module>
     15
     16 for i in range(0,1054):
---> 17   if List_plot_dot.COLOR[i] == 'Verde':
     18     List_plot_dot.append('green')
     19   if List_plot_dot.COLOR[i] == 'Rojo':

AttributeError: 'list' object has no attribute 'COLOR'
```

SEARCH STACK OVERFLOW

Resultados de agrupamiento de latitudes y longitudes con Kmeans en el mapa de Mexico

```
fig, gax = plt.subplots(figsize=(15,10))

color_asig = []
color_individual = Mapa_Geo_Mex['COLOR']

for row in range(0,len(List_plot_cluster)):
  color_asig.append(List_plot_cluster[row])

world.query("name == 'Mexico'").plot(ax = gax, edgecolor='black', color='white') #filtramos p

#Mapa_Geo_Mex.plot(ax=gax, color=semaforo_plot[row["Coordenada"]], alpha = 0.5)
Mapa_Geo_Mex.plot(ax=gax, color=color_asig, alpha = 1, markersize = 300)

gax.set_xlabel('longitude')
gax.set_ylabel('latitude')
gax.set_title('Acuiferos en Mexico')

gax.spines['top'].set_visible(False)
gax.spines['right'].set_visible(False)

plt.show()
```

```
---------------------------------------------------------------------------
IndexError                                Traceback (most recent call last)
<ipython-input-202-50818c387a08> in <module>
     10
     11 #Mapa_Geo_Mex.plot(ax=gax, color=semaforo_plot[row["Coordenada"]], alpha = 0.5)
---> 12 Mapa_Geo_Mex.plot(ax=gax, color=color_asig, alpha = 1, markersize = 300)
     13
     14 gax.set_xlabel('longitude')

                                 7 frames
<__array_function__ internals> in take(*args, **kwargs)

/usr/local/lib/python3.7/dist-packages/numpy/core/fromnumeric.py in _wrapit(obj,
method, *args, **kwds)
     41     except AttributeError:
     42         wrap = None
---> 43     result = getattr(asarray(obj), method)(*args, **kwds)
     44     if wrap:
     45         if not isinstance(result, mu.ndarray):

IndexError: cannot do a non-empty take from an empty axes.
```

SEARCH STACK OVERFLOW