belhadj-olfa-1-notebook-112023

April 2, 2024

[238]:
```
import pandas as pd
import numpy as np
import matplotlib as plt
import seaborn as sns
import plotly_express as px
import plotly.graph_objs as go
```

[471]:
```
import statsmodels.api as sm
```

[33]:
```
from datetime import datetime
```

[949]:
```
from statsmodels.tsa.seasonal import seasonal_decompose
```

[999]:
```
from statsmodels.graphics.gofplots import qqplot
```

[1032]:
```
from scipy import stats
```

[1704]:
```
from scipy.stats import chi2_contingency as chi2_contingency
```

[10]:
```
#Importation des fichiers csv enregistré sous excel:
##Importation du fichier
df_customers = pd.read_excel("/Users/helmisaddem/Documents/customers.xlsx")
```

[17]:
```
df_products = pd.read_excel("/Users/helmisaddem/Documents/products.xlsx")
```

[23]:
```
df_transactions = pd.read_excel("/Users/helmisaddem/Documents/Transactions.
↪xlsx")
```

[ ]:
```
df_transactions.info()
```

[29]:
```
len(df_transactions["date"].unique())
```

[29]:
```
687419
```

[12]:
```
df_customers.rename(columns = {'sex':'gender',
                               'birth':'year_of_birth'} , inplace = True)
```

[16]:
```
df_customers.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8621 entries, 0 to 8620
Data columns (total 3 columns):
 #   Column         Non-Null Count  Dtype 
---  ------         --------------  ----- 
 0   client_id      8621 non-null   object
 1   gender         8621 non-null   object
 2   year_of_birth  8621 non-null   int64 
dtypes: int64(1), object(2)
memory usage: 202.2+ KB
```

[39]:
```
len(df_customers["client_id"].unique())
```

[39]: 8621

[1420]:
```
len(df_customers.loc[df_customers["gender"] == 'm'])
```

[1420]: 4131

[1425]:
```
round((len(df_customers.loc[df_customers["gender"] == 'm']) * 100/
 ↪len(df_customers)),2)
```

[1425]: 47.92

[1426]:
```
fig11 = go.Figure(data= go.Pie(labels=["F", "H"],
        values=[4490, 4131]),
layout_title_text="distribution des clients en fonction du genre")
fig11.update_traces(marker=dict(colors=['tomato', 'slategray']))
fig11.update_layout(
        title_font_size=12,
        width=400,
        height=400)
```

[34]:
```
df_transactions.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 687534 entries, 0 to 687533
Data columns (total 4 columns):
 #   Column      Non-Null Count   Dtype 
---  ------      --------------   ----- 
 0   product_id  687534 non-null  object
 1   date        687534 non-null  object
 2   session_id  687534 non-null  object
 3   client_id   687534 non-null  object
dtypes: object(4)
memory usage: 21.0+ MB
```

[38]:
```
len(df_transactions["client_id"].unique())
```

[38]: 8600

[73]:
```
df_transactions["date"] = df_transactions["date"].astype('string')
```

[31]:
```
df_products.rename(columns = {'id_prod':'product_id'} , inplace = True)
```

[32]:
```
df_transactions.rename(columns = {'id_prod':'product_id'} , inplace = True)
```

[112]:
```
df_transactions.rename(columns = {'date_duree_transaction':
 ↪'date_heure_transaction'} , inplace = True)
```

[83]:
```
df_transactions["date_transaction"] = ""
```

[85]:
```
for i in range(len(df_transactions)):
    df_transactions.iloc[i,5] = df_transactions.iloc[i,1].split(' ')[0]
```

[89]:
```
df_transactions["date_transaction"] = df_transactions["date_transaction"].
 ↪astype('datetime64[ns]')
```

[253]:
```
df_transactions.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 687534 entries, 0 to 687533
Data columns (total 6 columns):
 #   Column                  Non-Null Count   Dtype
---  ------                  --------------   -----
 0   product_id              687534 non-null  object
 1   date_heure_transaction  687534 non-null  string
 2   session_id              687534 non-null  object
 3   client_id               687534 non-null  object
 4   transaction_id          687534 non-null  int64
 5   date_transaction        687534 non-null  datetime64[ns]
dtypes: datetime64[ns](1), int64(1), object(3), string(1)
memory usage: 31.5+ MB
```

[254]:
```
df_merge = pd.merge(df_products, df_transactions, on= 'product_id', how='right')
```

[660]:
```
df_final = pd.merge(df_merge, df_customers, on= 'client_id', how='left')
```

[315]:
```
df_merge.head()
```

[315]:

	product_id	price	categ	date_heure_transaction	session_id	client_id
0	0_1259	11.99	0	2021-03-01 00:01:07.843138	s_1	c_329
1	0_1390	19.37	0	2021-03-01 00:02:26.047414	s_2	c_664
2	0_1352	4.50	0	2021-03-01 00:02:38.311413	s_3	c_580

```
3     0_1458   6.55      0  2021-03-01 00:04:54.559692        s_4    c_7912
4     0_1358  16.49      0  2021-03-01 00:05:18.801198        s_5    c_2033

   transaction_id date_transaction
0               1       2021-03-01
1               2       2021-03-01
2               3       2021-03-01
3               4       2021-03-01
4               5       2021-03-01
```

[1065]:
```
df_final.head()
```

[1065]:
```
  product_id  price  categ      date_heure_transaction session_id client_id  \
0     0_1259  11.99      0  2021-03-01 00:01:07.843138        s_1     c_329
1     0_1390  19.37      0  2021-03-01 00:02:26.047414        s_2     c_664
2     0_1352   4.50      0  2021-03-01 00:02:38.311413        s_3     c_580
3     0_1458   6.55      0  2021-03-01 00:04:54.559692        s_4    c_7912
4     0_1358  16.49      0  2021-03-01 00:05:18.801198        s_5    c_2033

   transaction_id date_transaction gender  year_of_birth
0               1       2021-03-01      f           1967
1               2       2021-03-01      m           1960
2               3       2021-03-01      m           1988
3               4       2021-03-01      f           1989
4               5       2021-03-01      f           1956
```

[714]:
```
identifiant_client = df_final["client_id"].unique().tolist()
```

[730]:
```
import calendar
```

[771]:
```
list_month = pd.date_range('2021-03-01','2023-02-28',
              freq='MS').strftime("%Y-%m-%d")
```

[1429]:
```
moy_panier_client = pd.DataFrame({'client_id': identifiant_client,
                                  'moy_panier_mars_2021': 0.0,
                                  'moy_panier_avril_2021': 0.0,
                                  'moy_panier_mai_2021': 0.0,
                                  'moy_panier_juin_2021': 0.0,
                                  'moy_panier_juillet_2021': 0.0,
                                  'moy_panier_aout_2021': 0.0,
                                  'moy_panier_septembre_2021': 0.0,
                                  'moy_panier_octobre_2021': 0.0,
                                  'moy_panier_novembre_2021': 0.0,
                                  'moy_panier_decembre_2021': 0.0,
                                  'moy_panier_janvier_2022': 0.0,
                                  'moy_panier_fevrier_2022': 0.0,
                                  'moy_panier_mars_2022': 0.0,
```

```
                                'moy_panier_avril_2022': 0.0,
                                'moy_panier_mai_2022': 0.0,
                                'moy_panier_juin_2022': 0.0,
                                'moy_panier_juillet_2022': 0.0,
                                'moy_panier_aout_2022': 0.0,
                                'moy_panier_septembre_2022': 0.0,
                                'moy_panier_octobre_2022': 0.0,
                                'moy_panier_novembre_2022': 0.0,
                                'moy_panier_decembre_2022': 0.0,
                                'moy_panier_janvier_2023': 0.0,
                                'moy_panier_fevrier_2023': 0.0})
```

[1430]:
```
#Table avec la moyenne du panier par client :
for j in range(len(list_month)):

    datee = datetime.strptime(list_month[j], "%Y-%m-%d")
    month = datee.month
    year = datee.year
    first, last = calendar.monthrange(year, month)
    if month < 10:
            df_month = df_final.loc[(df_final['date_transaction'] >= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-0'+str(first+1))[:10],'%Y-%m-%d'))
                    & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
    else:
            df_month = df_final.loc[(df_final['date_transaction'] >= datetime.
 ↪strptime((str(year)+'-'+str(month)+'-0'+str(first+1))[:10],'%Y-%m-%d'))
                    & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
    for i in range(len(moy_panier_client)):
                    moy_panier_client.iloc[i,j+1] = round((df_month.
 ↪loc[df_month.iloc[:,5] == moy_panier_client.iloc[i,0]]["price"].mean()),2)
```

[1432]:
```
moy_panier_client.fillna(0, inplace=True)
```

[1434]:
```
moy_panier_client = pd.merge(moy_panier_client, df_customers, on="client_id",␣
 ↪how="left")
```

[1435]:
```
moy_panier_client["age"] = 2023 - moy_panier_client["year_of_birth"]
```

[1436]:
```
moy_panier_client.head()
```

[1436]:

	client_id	moy_panier_mars_2021	moy_panier_avril_2021	moy_panier_mai_2021	\
0	c_329	15.02	15.99	0.00	
1	c_664	27.96	12.64	13.99	
2	c_580	12.13	14.17	11.58	
3	c_7912	14.60	10.30	13.55	

```
4    c_2033                 22.01                  17.09                  7.05

   moy_panier_juin_2021  moy_panier_juillet_2021  moy_panier_aout_2021  \
0                 26.10                    22.42                  0.00
1                 21.55                    22.39                 17.24
2                  8.35                    13.31                 12.81
3                 12.05                    21.72                  9.80
4                 17.67                    20.99                  9.99

   moy_panier_septembre_2021  moy_panier_octobre_2021  \
0                      19.23                     3.99
1                      19.49                    15.21
2                      14.47                    14.40
3                      10.07                    12.79
4                       8.99                    27.99

   moy_panier_novembre_2021  …  moy_panier_aout_2022  \
0                     20.99  …                  0.00
1                     23.12  …                 15.03
2                     13.50  …                 11.80
3                     13.01  …                 13.78
4                     20.03  …                 17.97

   moy_panier_septembre_2022  moy_panier_octobre_2022  \
0                      15.99                    19.80
1                      13.23                     8.50
2                      12.90                    17.24
3                      19.29                    12.36
4                      11.12                    13.43

   moy_panier_novembre_2022  moy_panier_decembre_2022  \
0                      3.73                    21.32
1                     22.39                    16.17
2                     13.16                    12.66
3                     11.74                    14.19
4                      0.00                    18.38

   moy_panier_janvier_2023  moy_panier_fevrier_2023  gender  year_of_birth  \
0                    18.68                    16.33       f           1967
1                    26.08                    24.21       m           1960
2                    12.97                    12.26       m           1988
3                    15.03                     8.84       f           1989
4                    12.19                    17.38       f           1956

   age
0   56
1   63
```

```
2   35
3   34
4   67

[5 rows x 28 columns]
```

[1437]:
```
moy_panier_client["moy_panier_total"] = 0
```

[1438]:
```
for i in range(len(moy_panier_client)):
    for j in range(1,25):
        moy_panier_client.iloc[i,28] = moy_panier_client.iloc[i,28] +␣
 ↪moy_panier_client.iloc[i,j]
```

```
/var/folders/r_/fd0gwkxn6n995_hk_5lc9f540000gn/T/ipykernel_79914/2732073182.py:3
: FutureWarning:

Setting an item of incompatible dtype is deprecated and will raise in a future
error of pandas. Value '15.02' has dtype incompatible with int64, please
explicitly cast to a compatible dtype first.
```

[1440]:
```
moy_panier_client["moy_panier_total"] =␣
 ↪round((moy_panier_client["moy_panier_total"] / 24),2)
```

[1441]:
```
moy_panier_client.head()
```

[1441]:

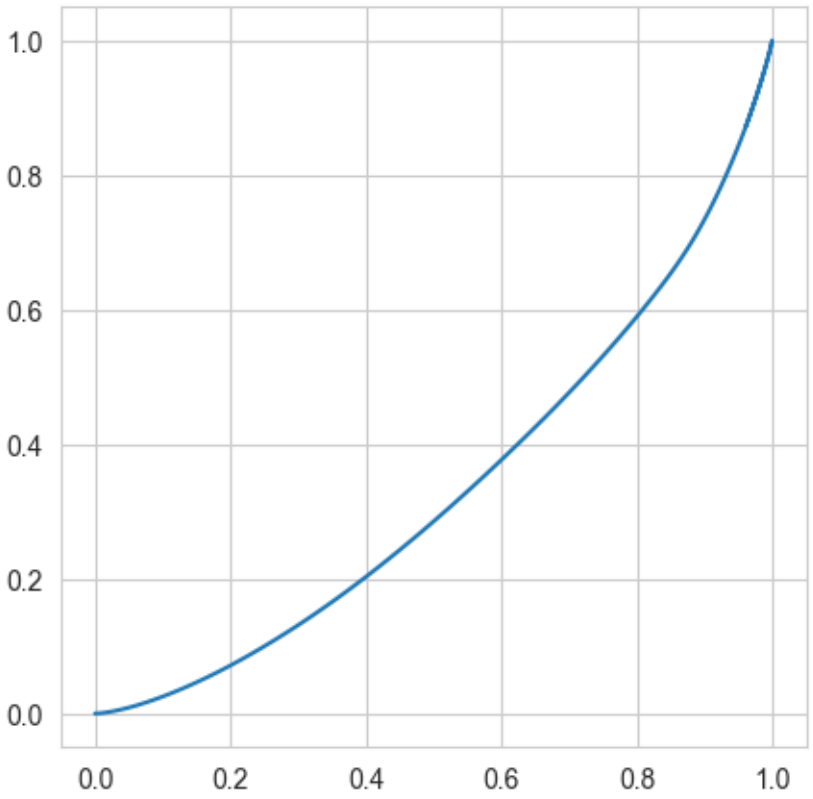
	client_id	moy_panier_mars_2021	moy_panier_avril_2021	moy_panier_mai_2021	\
0	c_329	15.02	15.99	0.00	
1	c_664	27.96	12.64	13.99	
2	c_580	12.13	14.17	11.58	
3	c_7912	14.60	10.30	13.55	
4	c_2033	22.01	17.09	7.05	

	moy_panier_juin_2021	moy_panier_juillet_2021	moy_panier_aout_2021	\
0	26.10	22.42	0.00	
1	21.55	22.39	17.24	
2	8.35	13.31	12.81	
3	12.05	21.72	9.80	
4	17.67	20.99	9.99	

	moy_panier_septembre_2021	moy_panier_octobre_2021	\
0	19.23	3.99	
1	19.49	15.21	
2	14.47	14.40	
3	10.07	12.79	
4	8.99	27.99	

```
   moy_panier_novembre_2021  …  moy_panier_septembre_2022  \
0                     20.99  …                      15.99
1                     23.12  …                      13.23
2                     13.50  …                      12.90
3                     13.01  …                      19.29
4                     20.03  …                      11.12

   moy_panier_octobre_2022  moy_panier_novembre_2022  \
0                    19.80                      3.73
1                     8.50                     22.39
2                    17.24                     13.16
3                    12.36                     11.74
4                    13.43                      0.00

   moy_panier_decembre_2022  moy_panier_janvier_2023  moy_panier_fevrier_2023  \
0                     21.32                    18.68                    16.33
1                     16.17                    26.08                    24.21
2                     12.66                    12.97                    12.26
3                     14.19                    15.03                     8.84
4                     18.38                    12.19                    17.38

   gender  year_of_birth  age  moy_panier_total
0       f           1967   56             14.20
1       m           1960   63             19.92
2       m           1988   35             12.89
3       f           1989   34             12.45
4       f           1956   67             15.05

[5 rows x 29 columns]
```

[1442]:
```
plt.pyplot.figure(figsize=(5,5))
lorenz = np.cumsum(np.sort(moy_panier_client["moy_panier_total"]))/
 ↪moy_panier_client["moy_panier_total"].sum()
lorenz = np.append([0],lorenz)
n = len(moy_panier_client)
xaxis = np.linspace(0-1/n,1+1/n,n+1)
plt.pyplot.plot(xaxis,lorenz,drawstyle='steps-post')
plt.pyplot.show()
```

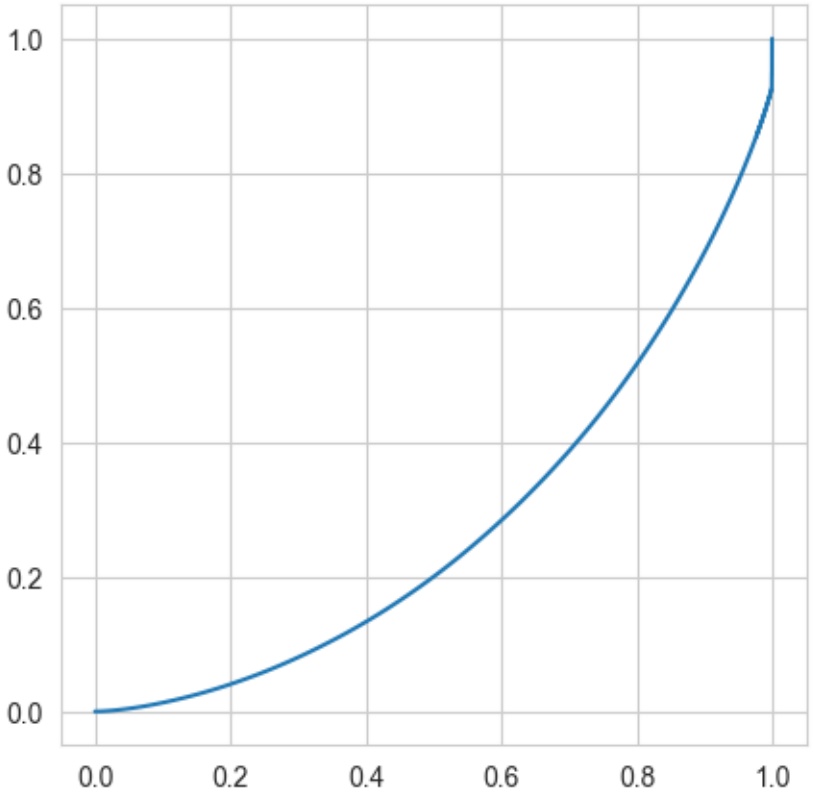


[1443]:
```
#Calcul de l'indice de Gini :
AUC = (lorenz.sum() -lorenz[-1]/2 -lorenz[0]/2)/n # Surface sous la courbe de␣
 ↪Lorenz. Le premier segment (lorenz[0]) est à moitié en dessous de 0, on le␣
 ↪coupe donc en 2, on fait de même pour le dernier segment lorenz[-1] qui est␣
 ↪à moitié au dessus de 1.
S = 0.5 - AUC # surface entre la première bissectrice et le courbe de Lorenz
gini = 2*S
print(gini)

#l'inégalité est d'autant plus forte que l'indice de Gini est élevé.
# Il est égal à 0 dans une situation d'égalité parfaite où la variable prend␣
 ↪une valeur identique sur
# l'ensemble de la population
```

```
0.3277086428499363
```

[2030]:
```
plt.pyplot.figure(figsize=(5,5))
lorenz = np.cumsum(np.sort(CA_par_client["CA_total"]))/
 ↪CA_par_client["CA_total"].sum()
lorenz = np.append([0],lorenz)
n = len(CA_par_client)
```

```
xaxis = np.linspace(0-1/n,1+1/n,n+1)
plt.pyplot.plot(xaxis,lorenz,drawstyle='steps-post')
plt.pyplot.show()
```

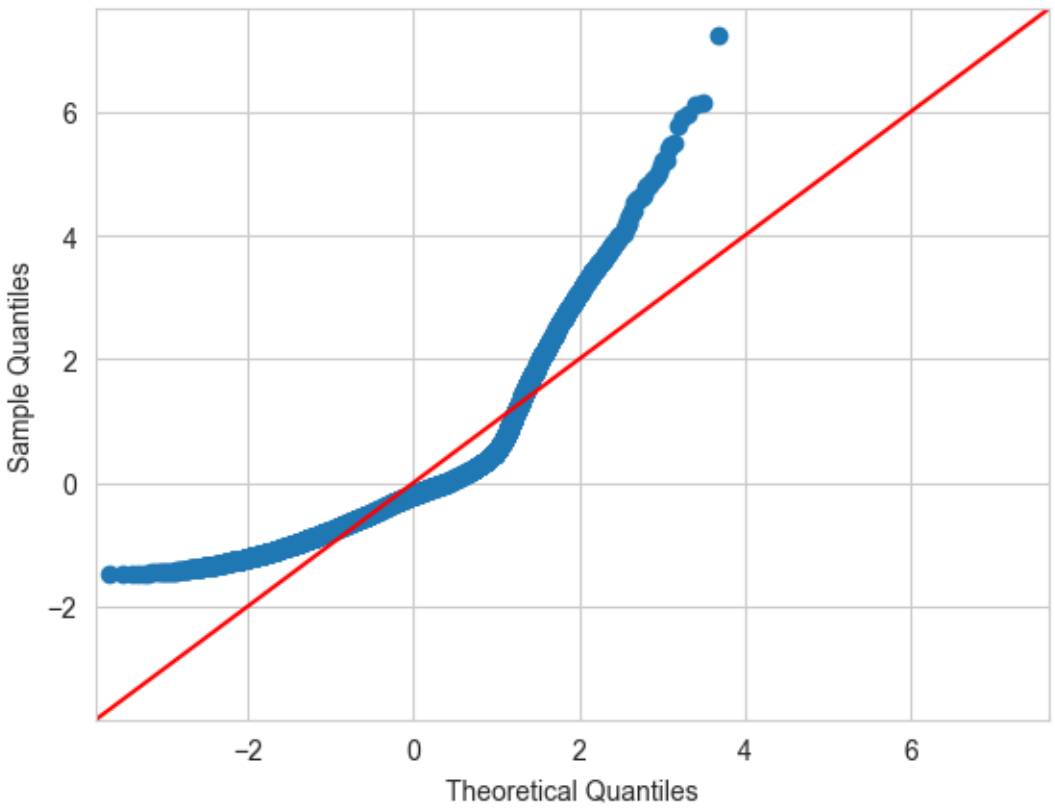


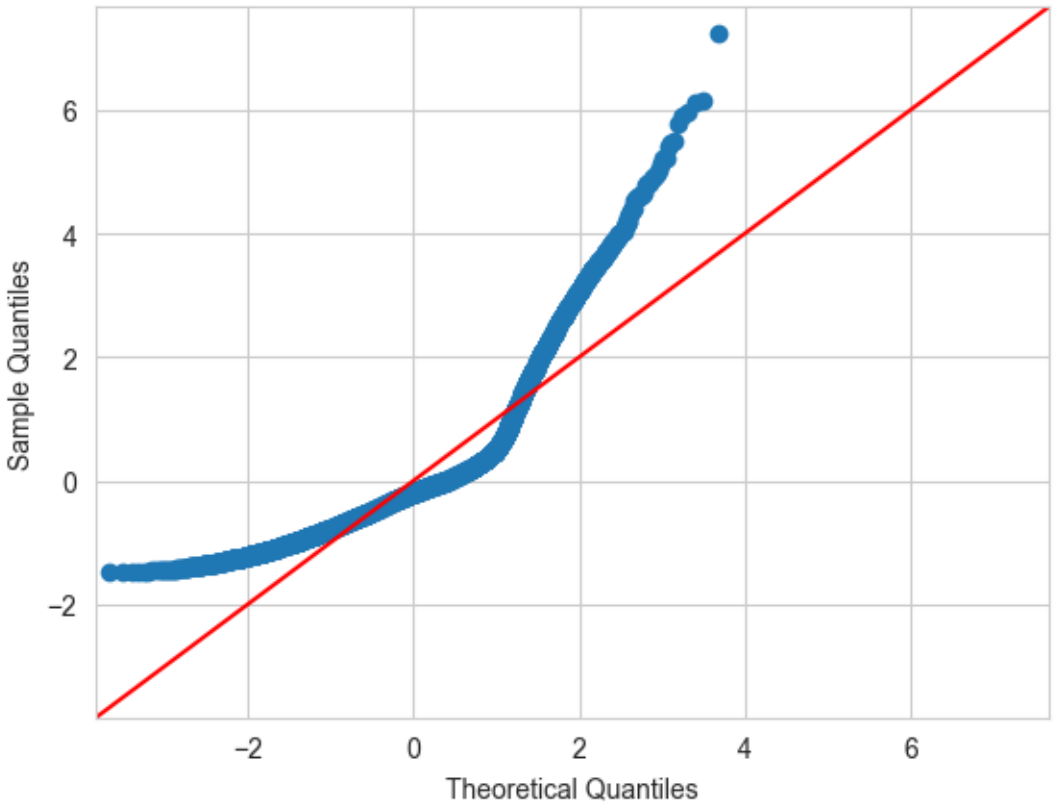
[2031]:
```
AUC = (lorenz.sum() -lorenz[-1]/2 -lorenz[0]/2)/n # Surface sous la courbe de␣
↪Lorenz. Le premier segment (lorenz[0]) est à moitié en dessous de 0, on le␣
↪coupe donc en 2, on fait de même pour le dernier segment lorenz[-1] qui est␣
↪à moitié au dessus de 1.
S = 0.5 - AUC # surface entre la première bissectrice et le courbe de Lorenz
gini = 2*S
print(gini)
```

```
0.4454126346005266
```

[1793]:
```
sm.qqplot(moy_panier_client["moy_panier_total"], line='45', fit=True)
```

[1793]:


Sample Quantiles
6
4
2
0
−2
−2
0
2
4
6
Theoretical Quantiles



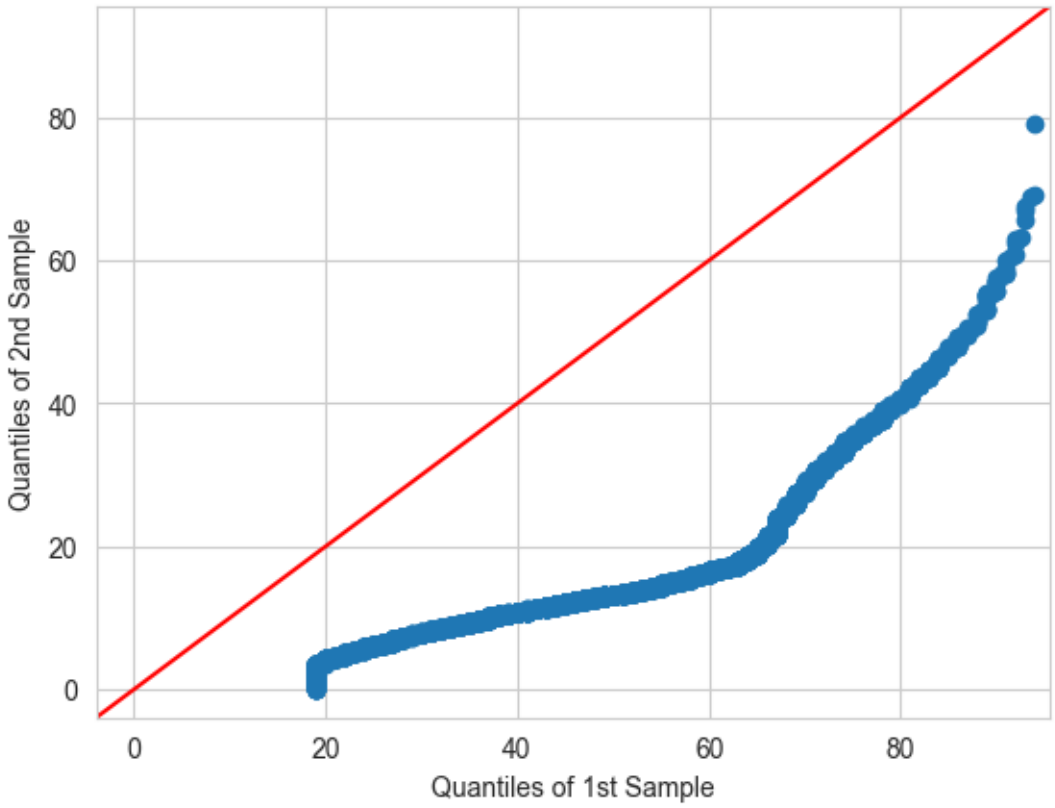
[2029]:
```
CA_par_client["CA_total"].sum()
```

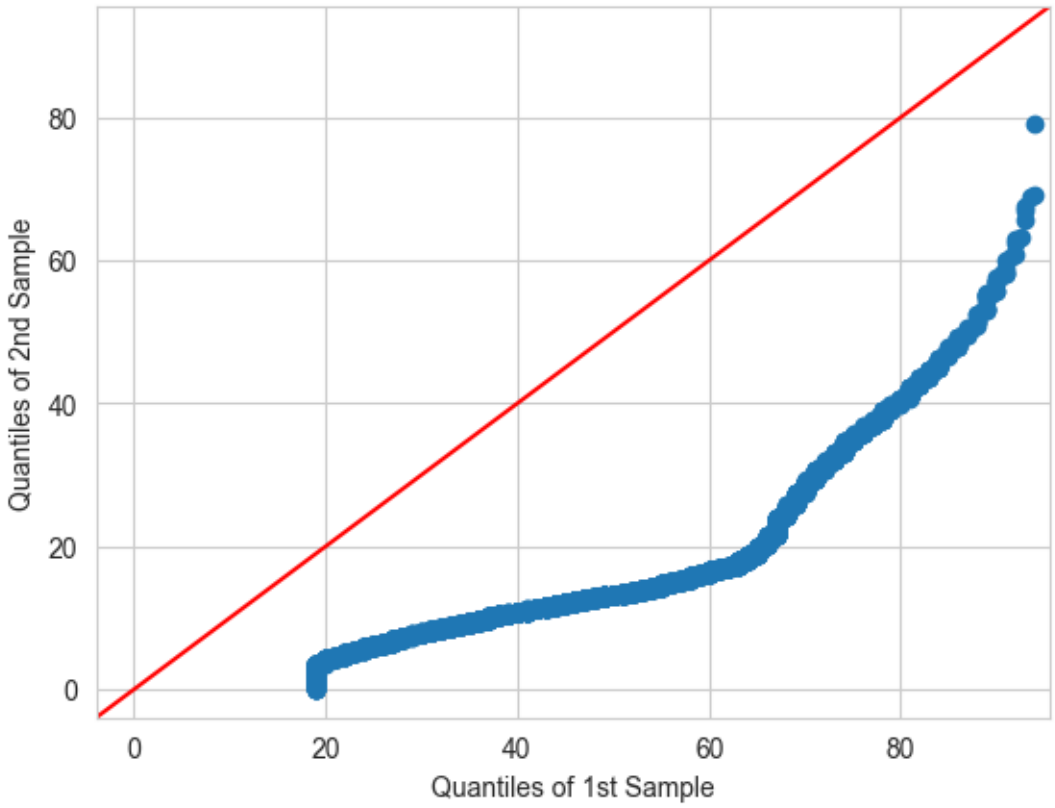
[2029]: 10886783.59

[1794]:
```
from statsmodels.graphics.gofplots import qqplot_2samples
```

[1796]:
```
pp_x = sm.ProbPlot(2023 - df_customers["year_of_birth"])
pp_y = sm.ProbPlot(moy_panier_client["moy_panier_total"])
qqplot_2samples(pp_x, pp_y, line='45')
```

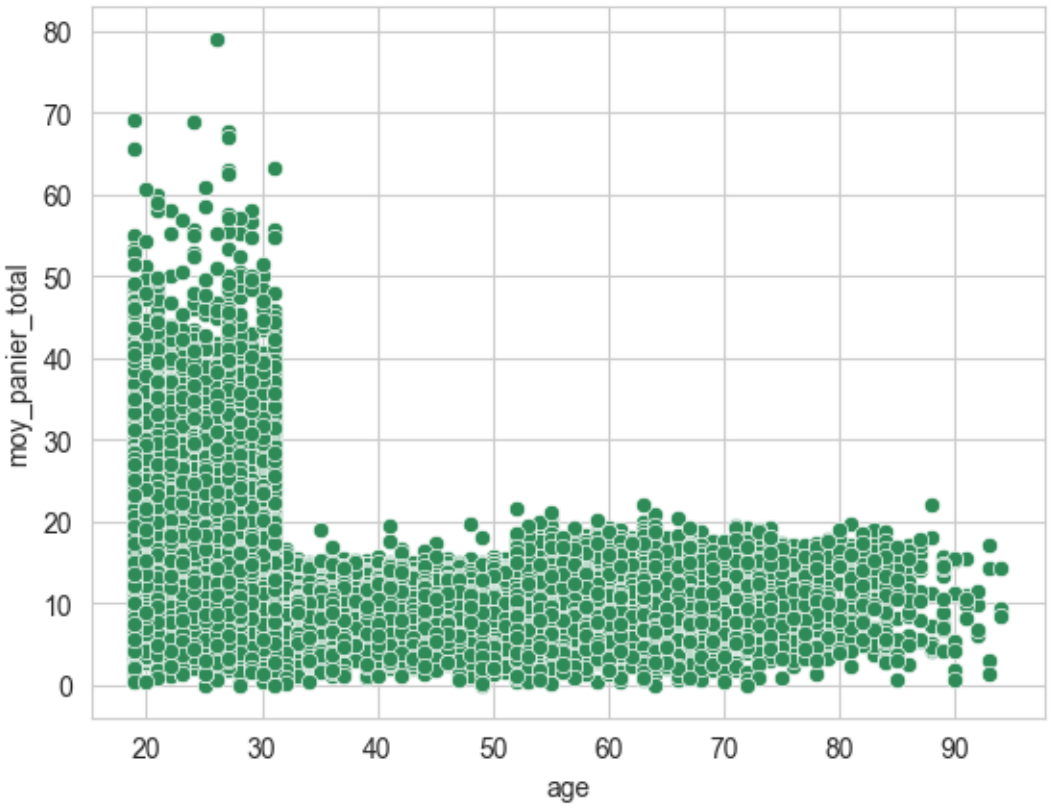
[1796]:


Quantiles of 2nd Sample
Quantiles of 1st Sample
0
20
40
60
80



[1751]:
```
sns.set_style='whitegrid'
sns.scatterplot(data=moy_panier_client,
    x="age",
    y="moy_panier_total",
    color='seagreen')
```

[1751]: <Axes: xlabel='age', ylabel='moy_panier_total'>



[1445]:
```
stats.spearmanr(moy_panier_client["age"], moy_panier_client["moy_panier_total"])
```

[1445]:
```
SignificanceResult(statistic=-0.2914441932878984, pvalue=5.519687008628242e-168)
```

[1448]:
```
CA_par_client = pd.DataFrame({'client_id': identifiant_client,
                              'CA_client_mars_2021': 0.0,
                              'CA_client_avril_2021': 0.0,
                              'CA_client_mai_2021': 0.0,
                              'CA_client_juin_2021': 0.0,
                              'CA_client_juillet_2021': 0.0,
                              'CA_client_aout_2021': 0.0,
                              'CA_client_septembre_2021': 0.0,
                              'CA_client_octobre_2021': 0.0,
                              'CA_client_novembre_2021': 0.0,
                              'CA_client_decembre_2021': 0.0,
                              'CA_client_janvier_2022': 0.0,
                              'CA_client_fevrier_2022': 0.0,
                              'CA_client_mars_2022': 0.0,
                              'CA_client_avril_2022': 0.0,
                              'CA_client_mai_2022': 0.0,
                              'CA_client_juin_2022': 0.0,
```

```
                                'CA_client_juillet_2022': 0.0,
                                'CA_client_aout_2022': 0.0,
                                'CA_client_septembre_2022': 0.0,
                                'CA_client_octobre_2022': 0.0,
                                'CA_client_novembre_2022': 0.0,
                                'CA_client_decembre_2022': 0.0,
                                'CA_client_mars_2021': 0.0,
                                'CA_client_janvier_2023': 0.0,
                                'CA_client_fevrier_2023': 0.0})
```

[1449]:
```
# pour construire la table CA par produit et par client :
for j in range(len(list_month)):

    datee = datetime.strptime(list_month[j], "%Y-%m-%d")
    month = datee.month
    year = datee.year
    first, last = calendar.monthrange(year, month)
    if month < 10:
            df_month = df_final.loc[(df_final['date_transaction'] >= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-0'+str(first+1))[:10],'%Y-%m-%d'))
                    & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
    else:
            df_month = df_final.loc[(df_final['date_transaction'] >= datetime.
 ↪strptime((str(year)+'-'+str(month)+'-0'+str(first+1))[:10],'%Y-%m-%d'))
                    & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
    for i in range(len(CA_par_client)):
                    CA_par_client.iloc[i,j+1] = round((df_month.loc[df_month.
 ↪iloc[:,5] == CA_par_client.iloc[i,0]]["price"].sum()),2)
```

[1450]:
```
CA_par_client = pd.merge(CA_par_client, df_customers, on="client_id",␣
 ↪how="left")
```

[1451]:
```
CA_par_client["age"] = 2023 - CA_par_client["year_of_birth"]
```

[1452]:
```
CA_par_client["CA_total"] = 0
```

[1453]:
```
for i in range (len(CA_par_client)):
    for j in range(1,25):
        CA_par_client.iloc[i,28] = CA_par_client.iloc[i,28] + CA_par_client.
 ↪iloc[i,j]
```

```
/var/folders/r_/fd0gwkxn6n995_hk_5lc9f540000gn/T/ipykernel_79914/989841997.py:3:
FutureWarning:

Setting an item of incompatible dtype is deprecated and will raise in a future
```

error of pandas. Value '60.08' has dtype incompatible with int64, please explicitly cast to a compatible dtype first.

[1807]:
```
CA_par_client.nlargest(4, "CA_total").iloc[0,1:25].sum()
```

[1807]:

	client_id	CA_client_mars_2021	CA_client_avril_2021	CA_client_mai_2021	\
6	c_1609	13740.67	11972.62	12037.61	
107	c_4958	12073.43	11293.84	11191.03	
135	c_6714	6194.25	5731.28	5460.85	
32	c_3454	4513.55	3966.85	4126.84	

	CA_client_juin_2021	CA_client_juillet_2021	CA_client_aout_2021	\
6	11807.05	9279.51	9377.54	
107	13634.47	13414.09	12737.74	
135	6470.91	4885.12	3662.38	
32	3694.11	3539.93	3215.14	

	CA_client_septembre_2021	CA_client_octobre_2021	\
6	16666.96	11139.92	
107	6413.62	6325.78	
135	6768.19	3690.51	
32	4504.26	1848.19	

	CA_client_novembre_2021	…	CA_client_septembre_2022	\
6	14198.61	…	12981.90	
107	11096.49	…	9972.90	
135	7471.30	…	4635.84	
32	5309.25	…	4196.64	

	CA_client_octobre_2022	CA_client_novembre_2022	CA_client_decembre_2022	\
6	11450.35	13212.44	13208.96	
107	11189.73	12519.86	11697.94	
135	5404.43	6650.56	6980.62	
32	4005.16	3992.75	4391.57	

	CA_client_janvier_2023	CA_client_fevrier_2023	gender	year_of_birth	\
6	10189.75	11145.73	m	1980	
107	8308.10	10975.64	m	1999	
135	5890.10	5729.56	f	1968	
32	4072.59	4384.54	m	1969	

	age	CA_total
6	43	298076.59
107	24	265154.04
135	55	138438.08
32	54	103071.24

```
[4 rows x 29 columns]
```

[1833]:
```
BtoB_CA = CA_par_client.nlargest(100, "CA_total").head(4).reset_index()
```

[1911]:
```
BtoB_CA["CA_total"].sum()
```

[1911]:
```
804739.95
```

[1912]:
```
CA_par_client["CA_total"].sum()
```

[1912]:
```
10886783.59
```

[2032]:
```
stats.spearmanr(CA_par_client["age"], CA_par_client["CA_total"])
```

[2032]:
```
SignificanceResult(statistic=-0.18101396337024364, pvalue=2.989403913881456e-64)
```

[ ]:
```
#color = ['violet']* 8600
#go.Figure(data=go.Scatter(
    #x = CA_par_client["age"],
    #y= CA_par_client["CA_total"],
    #mode = 'markers',
    #marker_color=color))
```

[ ]:
```
sns.set_style='whitegrid'
sns.scatterplot(data=CA_par_client,
    x="age",
    y="CA_total",
    color='violet')
```

[1834]:
```
BtoB_CA.head()
```

[1834]:

	index	client_id	CA_client_mars_2021	CA_client_avril_2021	CA_client_mai_2021	CA_client_juin_2021	CA_client_juillet_2021	CA_client_aout_2021	CA_client_septembre_2021	CA_client_octobre_2021	…
0	6	c_1609	13740.67	11972.62	12037.61	11807.05	9279.51	9377.54	16666.96	11139.92	…
1	107	c_4958	12073.43	11293.84	11191.03	13634.47	13414.09	12737.74	6413.62	6325.78	…
2	135	c_6714	6194.25	5731.28	5460.85	6470.91	4885.12				
3	32	c_3454	4513.55	3966.85	4126.84	3694.11	3539.93				

```
2              3662.38                  6768.19                  3690.51  …
3              3215.14                  4504.26                  1848.19  …

   CA_client_septembre_2022  CA_client_octobre_2022  CA_client_novembre_2022  \
0                  12981.90                11450.35                 13212.44
1                   9972.90                11189.73                 12519.86
2                   4635.84                 5404.43                  6650.56
3                   4196.64                 4005.16                  3992.75

   CA_client_decembre_2022  CA_client_janvier_2023  CA_client_fevrier_2023  \
0                 13208.96                10189.75                11145.73
1                 11697.94                 8308.10                10975.64
2                  6980.62                 5890.10                 5729.56
3                  4391.57                 4072.59                 4384.54

   gender  year_of_birth  age   CA_total
0       m           1980   43  298076.59
1       m           1999   24  265154.04
2       f           1968   55  138438.08
3       m           1969   54  103071.24

[4 rows x 30 columns]
```

[1832]:
```
go.Figure(data=go.Pie(labels= ['c_1609', 'c_4958', 'c_6714', 'c_3454', 'autres␣
↪clients'],
       values= [2.73, 2.43, 1.27, 0.94, 92.63]),
layout_title_text="Part des CA des clients BtoB du CA total").update_layout(
       title_font_size=12,
       width=500,
       height=400).update_traces(
              marker=dict(colors=['darkorchid', 'palevioletred', 'plum',␣
↪'skyblue', 'lightsteelblue']))
```

[1928]:
```
df = pd.DataFrame({
                   'c_1609': BtoB_CA.iloc[0,1:26],
                   'c_4958': BtoB_CA.iloc[1,1:26],
                   'c_6714': BtoB_CA.iloc[2,1:26],
                   'c_3454': BtoB_CA.iloc[3,1:26]
                   })
```

[1929]:
```
df = df.reset_index()
```

[1930]:
```
df = df.drop(columns=["index"])
```

[1931]:
```
df = df.drop(0)
```

[1932]:
```
df = df.reset_index()
```

[1934]:
```
df = df.drop(columns=["index"])
```

[1935]:
```
df["period"] = period
```

[1938]:
```
df.head()
```

[1938]:

	c_1609	c_4958	c_6714	c_3454	period	CA_total_btob
0	13740.67	12073.43	6194.25	4513.55	Mar-21	0
1	11972.62	11293.84	5731.28	3966.85	Apr-21	0
2	12037.61	11191.03	5460.85	4126.84	May-21	0
3	11807.05	13634.47	6470.91	3694.11	Jun-21	0
4	9279.51	13414.09	4885.12	3539.93	Jul-21	0

[1937]:
```
df["CA_total_btob"] = 0
```

[ ]:
```
for i in range(len(df)):
    df.iloc[i,5] =  df.iloc[i,0:4].sum()
```

[1947]:
```
df["CA_total"] = evolut_catego["CA_total"]
```

[1948]:
```
df.head()
```

[1948]:

	c_1609	c_4958	c_6714	c_3454	period	CA_total_btob	CA_total
0	13740.67	12073.43	6194.25	4513.55	Mar-21	36521.90	482440.61
1	11972.62	11293.84	5731.28	3966.85	Apr-21	32964.59	429113.16
2	12037.61	11191.03	5460.85	4126.84	May-21	32816.33	413862.24
3	11807.05	13634.47	6470.91	3694.11	Jun-21	35606.54	467689.41
4	9279.51	13414.09	4885.12	3539.93	Jul-21	31118.65	433173.21

[1973]:
```
px.bar(df, x="period",
               y=["CA_total_btob", "CA_total"], color_discrete_sequence= px.
 ↪colors.qualitative.Vivid, width= 800, barmode="stack",
            title="CA BtoB par rapport au CA total")
```

[1968]:
```
df_1 = pd.DataFrame({"x_axis":"periode totale",
                     "CA_total_btob": [df["CA_total_btob"].sum()],
                     "CA_total": [df["CA_total"].sum()]})
```

[1972]:
```
print(df["CA_total_btob"].sum(),
df["CA_total"].sum())
```

```
804739.95 10886783.59
```

[1970]:
```
px.bar(df_1, x="x_axis",
               y=["CA_total_btob", "CA_total"], color_discrete_sequence= px.
 ↪colors.qualitative.Vivid, width= 350, barmode="stack",
            title="CA BtoB par rapport au CA total")
```

[ ]:
```
sns.set_style='whitegrid'
sns.scatterplot(data=df,
    x="age",
    y="CA_total",
    color='violet')
```

[1456]:
```
stats.anderson(CA_par_client["CA_total"], dist='norm')
```

[1456]:
```
AndersonResult(statistic=2138.5248786011507, critical_values=array([0.576,
0.656, 0.787, 0.918, 1.091]), significance_level=array([15. , 10. ,  5. ,  2.5,
1. ]), fit_result=  params: FitParams(loc=1265.9050686046512,
scale=4744.906161558257)
 success: True
 message: '`anderson` successfully fit the distribution to the data.')
```

[1415]:
```
df_final.loc[(df_final['date_transaction'] >= '2021-03-01')
                    & (df_final['date_transaction'] <= '2021-03-31')].
 ↪loc[df_final["client_id"] == 'c_1609']
```

[1415]:

	product_id	price	categ	date_heure_transaction	session_id	\
6	0_1304	5.86	0	2021-03-01 00:07:04.371179	s_7	
13	0_1159	7.99	0	2021-03-01 00:11:57.832228	s_7	
78	0_1425	12.99	0	2021-03-01 01:56:41.944044	s_46	
88	0_1469	14.99	0	2021-03-01 02:12:21.294004	s_53	
101	1_406	24.81	1	2021-03-01 02:41:13.649521	s_63	
…	…	…	…	…	…	
28581	0_1042	18.53	0	2021-03-31 23:28:50.975115	s_14195	
28585	1_660	22.23	1	2021-03-31 23:36:39.178171	s_14199	
28589	0_1525	6.99	0	2021-03-31 23:44:24.515328	s_14195	
28592	0_1428	3.55	0	2021-03-31 23:47:32.661703	s_14199	
28595	0_1317	4.99	0	2021-03-31 23:52:31.939708	s_14195	

	client_id	transaction_id	date_transaction	gender	year_of_birth
6	c_1609	7	2021-03-01	m	1980
13	c_1609	14	2021-03-01	m	1980
78	c_1609	79	2021-03-01	m	1980
88	c_1609	89	2021-03-01	m	1980
101	c_1609	102	2021-03-01	m	1980
…	…	…	…	…	…
28581	c_1609	28582	2021-03-31	m	1980
28585	c_1609	28586	2021-03-31	m	1980
28589	c_1609	28590	2021-03-31	m	1980
28592	c_1609	28593	2021-03-31	m	1980
28595	c_1609	28596	2021-03-31	m	1980

[1083 rows x 10 columns]

[481]:
```
period = pd.date_range('2021-03-01','2023-02-28',
              freq='M').strftime("%b-%y").tolist()
#
```

[1459]:
```
#nombre de client par mois:
nombre_client = pd.DataFrame({'periode': period,
                              'nbre_client':0})
```

[1460]:
```
for j in range(len(list_month)):

    datee = datetime.strptime(list_month[j], "%Y-%m-%d")
    month = datee.month
    year = datee.year
    first, last = calendar.monthrange(year, month)
    if month < 10:
            df_month = df_final.loc[(df_final['date_transaction'] >= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-0'+str(first+1))[:10],'%Y-%m-%d'))
                    & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
    else:
            df_month = df_final.loc[(df_final['date_transaction'] >= datetime.
 ↪strptime((str(year)+'-'+str(month)+'-0'+str(first+1))[:10],'%Y-%m-%d'))
                    & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
    nombre_client.iloc[j,1] = len(df_month.groupby("client_id").
 ↪agg({'product_id':'count'}).reset_index())
```

[1478]:
```
nombre_client["nbre_reference"]=0
```

[1482]:
```
nombre_client["nbre_produit"]=0
```

[ ]:
```
#scatter et moyenne mobile du nombre de clients par mois
px.line(nombre_client,
              x="periode",
              y="nbre_client",
              markers=True,
              title='evolution du nombre de clients', color_discrete_sequence=␣
 ↪px.colors.qualitative.G10)
```

[1484]:
```
#nombre de références vendues :
for j in range(len(list_month)):

    datee = datetime.strptime(list_month[j], "%Y-%m-%d")
    month = datee.month
    year = datee.year
    first, last = calendar.monthrange(year, month)
    if month < 10:
```

```
            df_month = df_final.loc[(df_final['date_transaction'] >= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-0'+str(first+1))[:10],'%Y-%m-%d'))
                    & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
   else:
            df_month = df_final.loc[(df_final['date_transaction'] >= datetime.
 ↪strptime((str(year)+'-'+str(month)+'-0'+str(first+1))[:10],'%Y-%m-%d'))
                    & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
   df_month = df_month.groupby("product_id").agg({"product_id":"count"}).
 ↪reset_index(names="count")
   nombre_client.iloc[j,2] = len(df_month)
   nombre_client.iloc[j,3] = df_month["product_id"].sum()
```

[1485]:
```
nombre_client.head()
```

[1485]:

	periode	nbre_client	nbre_reference	nbre_produit
0	Mar-21	5676	2482	28601
1	Apr-21	5411	2439	25620
2	May-21	5186	2381	23715
3	Jun-21	5579	2391	25929
4	Jul-21	5418	2308	22179

[1987]:
```
px.bar(nombre_client, x="periode",
            y="nbre_client", color_discrete_sequence= px.colors.qualitative.
 ↪Safe, width= 800,
            title="Evolution du nombre de clients")
```

[ ]:
```
#px.line(nombre_client,
             #x="periode",
             #y="nbre_reference",
             #markers=True,
             #title='evolution du nombre de references',␣
 ↪color_discrete_sequence= px.colors.qualitative.G10)
```

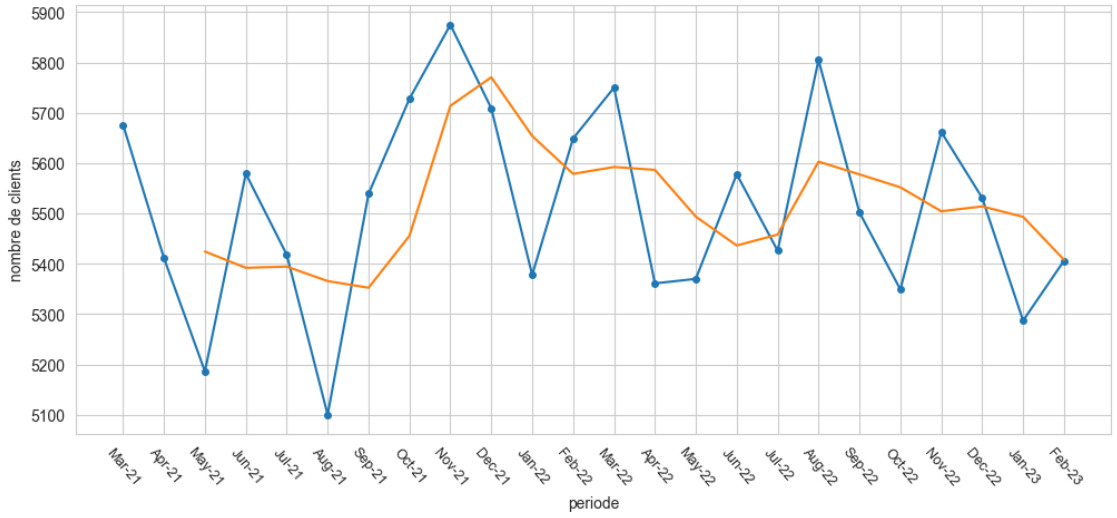
[1984]:
```
px.bar(nombre_client, x="periode",
            y="nbre_produit", color_discrete_sequence= px.colors.qualitative.
 ↪Vivid, width= 800,
            title="Evolution du nombre de produits vendus")
```

[1498]:
```
window_size = 3
nombre_client["moving_average_client"] = nombre_client["nbre_client"].
 ↪rolling(window=window_size).mean()
nombre_client["moving_average_reference"] = nombre_client["nbre_reference"].
 ↪rolling(window=window_size).mean()
```

```
nombre_client["moving_average_produit"] = nombre_client["nbre_produit"].
 ↪rolling(window=window_size).mean()
```

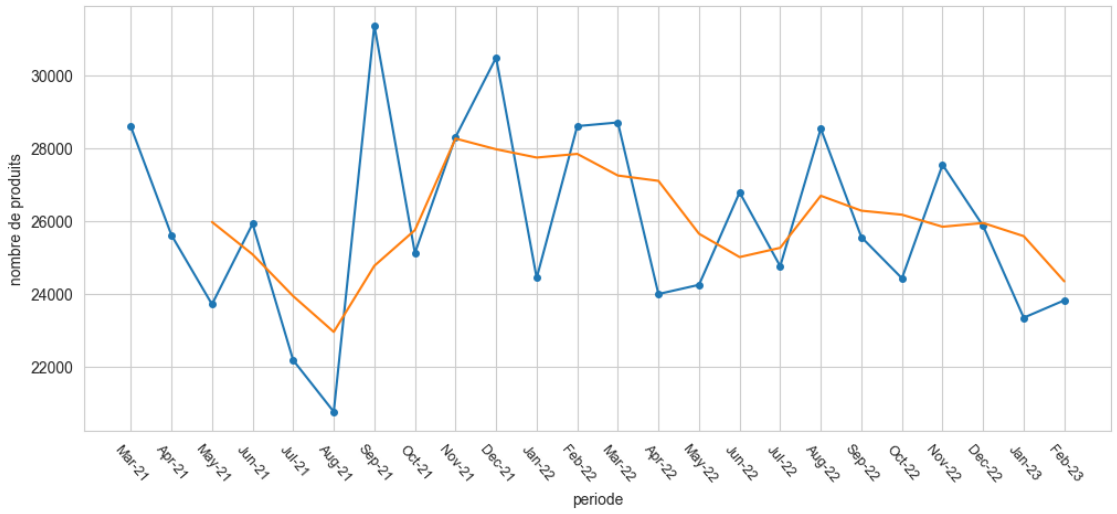
[1988]:
```
# Plot the data and moving average of nombre de clients
plt.pyplot.figure(figsize=(12, 5))
plt.pyplot.plot(nombre_client["periode"], nombre_client["nbre_client"],␣
 ↪marker='o', markersize=4)
plt.pyplot.plot(nombre_client["periode"],␣
 ↪nombre_client["moving_average_client"])
plt.pyplot.xlabel('periode')
plt.pyplot.xticks(rotation = -50, fontsize=9)
plt.pyplot.ylabel("nombre de clients")
```

[1988]:
```
Text(0, 0.5, 'nombre de clients')
```



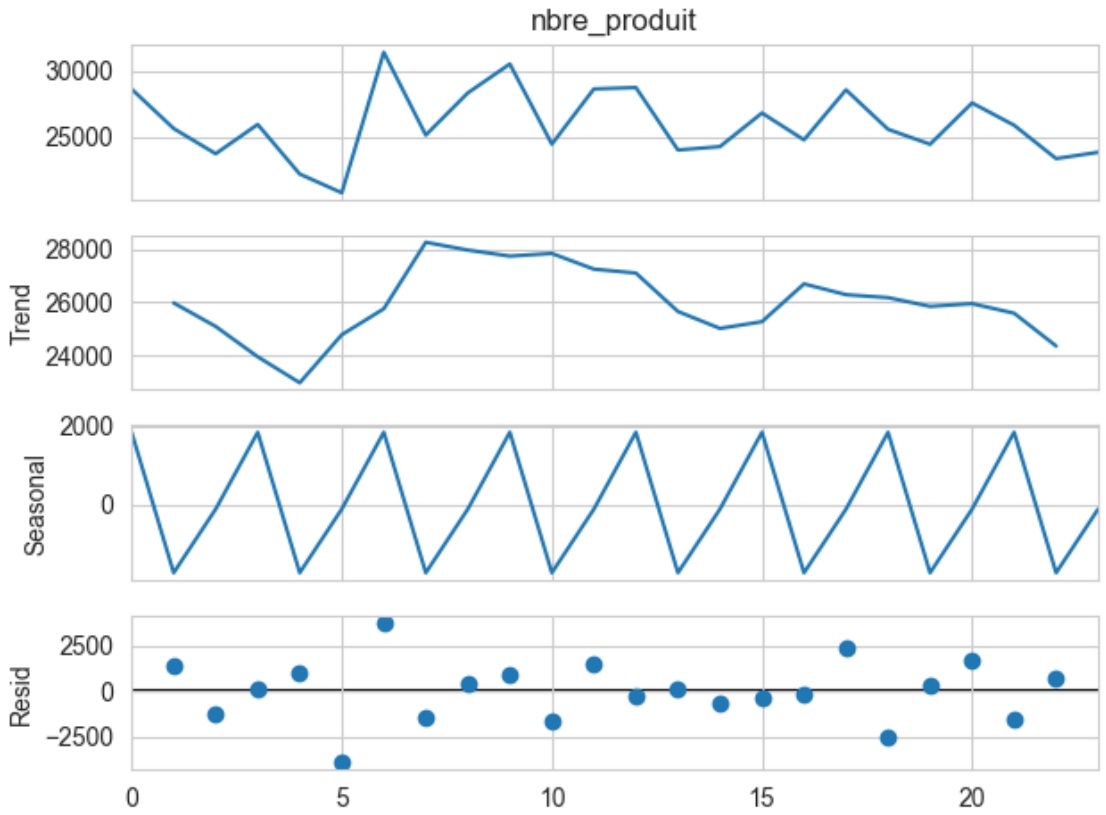
[1789]:
```
#moving average de nombre de produits
plt.pyplot.figure(figsize=(12, 5))
plt.pyplot.plot(nombre_client["periode"], nombre_client["nbre_produit"],␣
 ↪marker='o', markersize=4)
plt.pyplot.plot(nombre_client["periode"],␣
 ↪nombre_client["moving_average_produit"])
plt.pyplot.xlabel('periode')
plt.pyplot.xticks(rotation = -50, fontsize=9)
plt.pyplot.ylabel("nombre de produits")
```

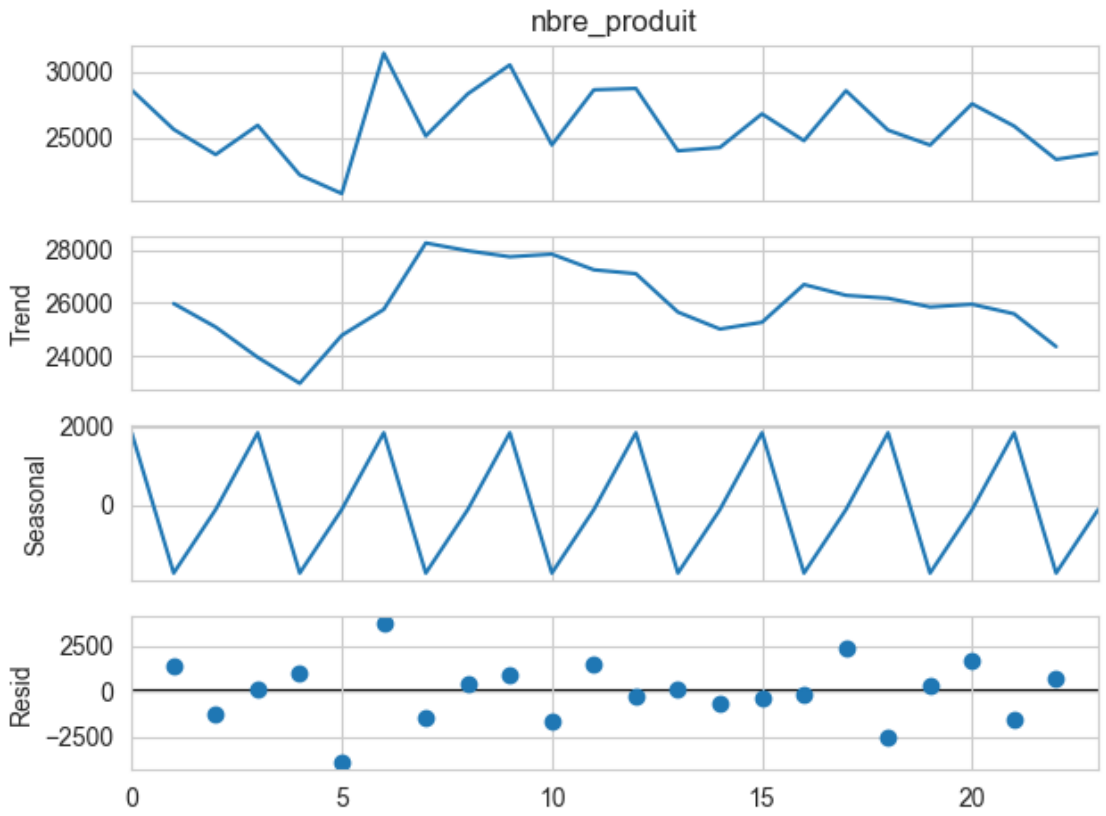
[1789]:
```
Text(0, 0.5, 'nombre de produits')
```



[2058]:
```
result_2 = seasonal_decompose(nombre_client["nbre_produit"], model='additive',␣
↪period=3)
result_2.plot()
```

[2058]:





[1520]:
```
products = df_products["product_id"].to_list()
```

[ ]:
```
#nombre de produits vendus par mois :
datee = datetime.strptime(list_month[1], "%Y-%m-%d")
month = datee.month
year = datee.year
first, last = calendar.monthrange(year, month)
df_month = df_final.loc[(df_final['date_transaction'] >= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-0'+str(first+1))[:10],'%Y-%m-%d'))
                    & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
df_month.loc[df_month["product_id"] == products[0]]
```

[1529]:
```
df_produits = pd.DataFrame({"product_id" : products,
                                    "nbre_exemplaire_mars_21": 0,
                                    "nbre_exemplaire_avril_21": 0,
                                    "nbre_exemplaire_mai_21": 0,
                                    "nbre_exemplaire_juin_21": 0,
                                    "nbre_exemplaire_juillet_21": 0,
                                    "nbre_exemplaire_aout_21": 0,
                                    "nbre_exemplaire_septembre_21": 0,
```

```
                                    "nbre_exemplaire_octobre_21": 0,
                                    "nbre_exemplaire_novembre_21": 0,
                                    "nbre_exemplaire_decembre_21": 0,
                                    "nbre_exemplaire_janvier_22": 0,
                                    "nbre_exemplaire_fevrier_22": 0,
                                    "nbre_exemplaire_mars_22": 0,
                                    "nbre_exemplaire_avril_22": 0,
                                    "nbre_exemplaire_mai_22": 0,
                                    "nbre_exemplaire_juin_22": 0,
                                    "nbre_exemplaire_juillet_22": 0,
                                    "nbre_exemplaire_aout_22": 0,
                                    "nbre_exemplaire_septembre_22": 0,
                                    "nbre_exemplaire_octobre_22": 0,
                                    "nbre_exemplaire_novembre_22": 0,
                                    "nbre_exemplaire_decembre_22": 0,
                                    "nbre_exemplaire_janvier_23": 0,
                                    "nbre_exemplaire_fevrier_23": 0})
```

[1531]:
```
for i in range (len(products)):
    for j in range(len(list_month)):
        datee = datetime.strptime(list_month[j], "%Y-%m-%d")
        month = datee.month
        year = datee.year
        first, last = calendar.monthrange(year, month)
        if month < 10:
            df_month = df_final.loc[(df_final['date_transaction'] >= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-0'+str(first+1))[:10],'%Y-%m-%d'))
                    & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
        else:
            df_month = df_final.loc[(df_final['date_transaction'] >= datetime.
 ↪strptime((str(year)+'-'+str(month)+'-0'+str(first+1))[:10],'%Y-%m-%d'))
                    & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]

        df_produits.iloc[i,j+1] = len(df_month.loc[df_month["product_id"] ==␣
 ↪products[i]])
```

[1537]:
```
#merge avec df product pour avoir le prix de chaque produit
df_produits = pd.merge(df_produits, df_products, on="product_id", how="inner")
```

[1538]:
```
df_produits.head(10)
```

[1538]:

	product_id	nbre_exemplaire_mars_21	nbre_exemplaire_avril_21	\
0	0_1421	57	38	
1	0_1368	46	45	
2	0_731	1	2	

```
3      1_587                        4                          1
4     0_1507                       25                         27
5     0_1163                       27                         14
6      1_463                        0                          0
7     0_2157                        0                          0
8     0_1915                        3                          6
9      0_389                        0                          0

   nbre_exemplaire_mai_21  nbre_exemplaire_juin_21  \
0                      34                       48
1                      24                       32
2                       1                        0
3                       2                        4
4                      26                       24
5                      16                       24
6                       1                        1
7                       0                        1
8                       2                        3
9                       1                        4

   nbre_exemplaire_juillet_21  nbre_exemplaire_aout_21  \
0                          27                       36
1                          25                       31
2                           1                        0
3                           4                        4
4                          22                       23
5                          14                       18
6                           0                        1
7                           1                        1
8                           2                        1
9                           1                        2

   nbre_exemplaire_septembre_21  nbre_exemplaire_octobre_21  \
0                            65                          51
1                            56                          33
2                             1                           1
3                             6                           3
4                            36                          18
5                            22                          21
6                             0                           2
7                             1                           0
8                             6                           2
9                             2                           1

   nbre_exemplaire_novembre_21  …  nbre_exemplaire_juillet_22  \
0                           50  …                          34
1                           27  …                          28
```

```
2                            0  …                            0
3                            5  …                            1
4                           24  …                           34
5                           14  …                           17
6                            2  …                            1
7                            2  …                            0
8                            4  …                            2
9                            1  …                            0

   nbre_exemplaire_aout_22  nbre_exemplaire_septembre_22  \
0                       47                           32
1                       40                           25
2                        2                            0
3                        7                           10
4                       26                           28
5                       18                            8
6                        1                            1
7                        1                            0
8                        0                            2
9                        1                            1

   nbre_exemplaire_octobre_22  nbre_exemplaire_novembre_22  \
0                          35                           58
1                          31                           36
2                           0                            1
3                           4                            8
4                          20                           31
5                          10                           19
6                           0                            1
7                           1                            0
8                           4                            1
9                           2                            1

   nbre_exemplaire_decembre_22  nbre_exemplaire_janvier_23  \
0                           31                          46
1                           37                          37
2                            0                           0
3                            5                           3
4                           25                          18
5                           24                          17
6                            3                           1
7                            0                           0
8                            2                           0
9                            1                           0

   nbre_exemplaire_fevrier_23  price  categ
0                          43  19.99      0
```

```
1                          20   5.13      0
2                           0  17.99      0
3                           3   4.99      1
4                          27   3.99      0
5                          15   9.99      0
6                           1  36.99      1
7                           0  34.99      0
8                           2  16.99      0
9                           1  18.99      0

[10 rows x 27 columns]
```

[1541]:
```
df_produits["CA_total_produit"] = 0
```

[1546]:
```
for j in range(len(df_produits)):
    for i in range(1, 25):
        df_produits.iloc[j,27] = round((df_produits.iloc[j,27] + (df_produits.
 ↪iloc[j,i]*df_produits.iloc[j,25])),2)
```

[1547]:
```
df_produits.head(10)
```

[1547]:
```
  product_id  nbre_exemplaire_mars_21  nbre_exemplaire_avril_21  \
0     0_1421                       57                        38
1     0_1368                       46                        45
2      0_731                        1                         2
3      1_587                        4                         1
4     0_1507                       25                        27
5     0_1163                       27                        14
6      1_463                        0                         0
7     0_2157                        0                         0
8     0_1915                        3                         6
9      0_389                        0                         0

   nbre_exemplaire_mai_21  nbre_exemplaire_juin_21  \
0                      34                       48
1                      24                       32
2                       1                        0
3                       2                        4
4                      26                       24
5                      16                       24
6                       1                        1
7                       0                        1
8                       2                        3
9                       1                        4

   nbre_exemplaire_juillet_21  nbre_exemplaire_aout_21  \
0                          27                       36
```

```
1                          25                          31
2                           1                           0
3                           4                           4
4                          22                          23
5                          14                          18
6                           0                           1
7                           1                           1
8                           2                           1
9                           1                           2

   nbre_exemplaire_septembre_21  nbre_exemplaire_octobre_21  \
0                            65                          51
1                            56                          33
2                             1                           1
3                             6                           3
4                            36                          18
5                            22                          21
6                             0                           2
7                             1                           0
8                             6                           2
9                             2                           1

   nbre_exemplaire_novembre_21  …  nbre_exemplaire_aout_22  \
0                           50  …                       47
1                           27  …                       40
2                            0  …                        2
3                            5  …                        7
4                           24  …                       26
5                           14  …                       18
6                            2  …                        1
7                            2  …                        1
8                            4  …                        0
9                            1  …                        1

   nbre_exemplaire_septembre_22  nbre_exemplaire_octobre_22  \
0                            32                          35
1                            25                          31
2                             0                           0
3                            10                           4
4                            28                          20
5                             8                          10
6                             1                           0
7                             0                           1
8                             2                           4
9                             1                           2

   nbre_exemplaire_novembre_22  nbre_exemplaire_decembre_22  \
```

```
0                           58                           31
1                           36                           37
2                            1                            0
3                            8                            5
4                           31                           25
5                           19                           24
6                            1                            3
7                            0                            0
8                            1                            2
9                            1                            1

   nbre_exemplaire_janvier_23  nbre_exemplaire_fevrier_23  price  categ  \
0                          46                          43  19.99      0
1                          37                          20   5.13      0
2                           0                           0  17.99      0
3                           3                           3   4.99      1
4                          18                          27   3.99      0
5                          17                          15   9.99      0
6                           1                           1  36.99      1
7                           0                           0  34.99      0
8                           0                           2  16.99      0
9                           0                           1  18.99      0

   CA_total_produit
0          41499.24
1           8382.42
2            503.72
3           1057.88
4           5051.34
5           7972.02
6           1553.58
7            629.82
8           2344.62
9           1063.44

[10 rows x 28 columns]
```

[1548]:
```
df_produits.nlargest(100, "CA_total_produit").head(10)
```

[1548]:
```
     product_id  nbre_exemplaire_mars_21  nbre_exemplaire_avril_21  \
1314      2_159                       28                        20
2670      2_135                       44                        30
465       2_112                       27                        39
2345      2_102                       33                        29
492       2_209                       29                        33
1746      1_395                       58                        50
2646      1_369                       88                        68
```

```
3235     1_383                      64                       51
2217     1_414                      86                       64
2486     2_166                       6                       11

      nbre_exemplaire_mai_21  nbre_exemplaire_juin_21  \
1314                      23                       22
2670                      42                       49
465                       51                       43
2345                      34                       42
492                       34                       39
1746                      48                       70
2646                      61                       92
3235                      56                       80
2217                      67                       90
2486                       5                        9

      nbre_exemplaire_juillet_21  nbre_exemplaire_aout_21  \
1314                          23                       28
2670                          54                       44
465                           45                       46
2345                          47                       46
492                           44                       34
1746                          75                       55
2646                          81                       60
3235                          64                       53
2217                          89                       74
2486                          14                       12

      nbre_exemplaire_septembre_21  nbre_exemplaire_octobre_21  \
1314                            36                          13
2670                            21                          25
465                             22                          33
2345                            31                          23
492                             17                          18
1746                            73                          74
2646                            92                          83
3235                            66                          80
2217                            79                          62
2486                             5                           6

      nbre_exemplaire_novembre_21  …  nbre_exemplaire_aout_22  \
1314                           27  …                       27
2670                           32  …                       49
465                            26  …                       31
2345                           41  …                       40
492                            25  …                       39
1746                          124  …                       98
```

```
2646                          116  …                        104
3235                          108  …                         91
2217                          107  …                        104
2486                            8  …                          5

      nbre_exemplaire_septembre_22  nbre_exemplaire_octobre_22  \
1314                            35                          20
2670                            29                          36
465                             34                          38
2345                            42                          39
492                             29                          39
1746                            73                          83
2646                            90                          72
3235                            76                          51
2217                            68                          83
2486                             6                          11

      nbre_exemplaire_novembre_22  nbre_exemplaire_decembre_22  \
1314                           23                          30
2670                           42                          53
465                            34                          50
2345                           36                          35
492                            34                          27
1746                           75                          72
2646                           85                          86
3235                           73                          73
2217                           96                         100
2486                           14                          10

      nbre_exemplaire_janvier_23  nbre_exemplaire_fevrier_23   price  categ  \
1314                          21                          22  145.99      2
2670                          30                          35   68.99      2
465                           38                          45   67.57      2
2345                          43                          46   59.14      2
492                           25                          33   69.99      2
1746                          75                          55   28.99      1
2646                          94                          83   23.99      1
3235                          65                          58   28.99      1
2217                          92                          91   23.83      1
2486                          12                           7  230.04      2

      CA_total_produit
1314         170516.32
2670         125147.86
465          117436.66
2345         109763.84
492          101765.46
```

```
1746         101696.92
2646         100518.10
3235          98508.02
2217          97178.74
2486          97076.88

[10 rows x 28 columns]
```

[1549]:
```
df_produits.sort_values(by="CA_total_produit", ascending=False).head(10)
```

[1549]:
```
     product_id  nbre_exemplaire_mars_21  nbre_exemplaire_avril_21  \
1314      2_159                       28                        20
2670      2_135                       44                        30
465       2_112                       27                        39
2345      2_102                       33                        29
492       2_209                       29                        33
1746      1_395                       58                        50
2646      1_369                       88                        68
3235      1_383                       64                        51
2217      1_414                       86                        64
2486      2_166                        6                        11

      nbre_exemplaire_mai_21  nbre_exemplaire_juin_21  \
1314                      23                       22
2670                      42                       49
465                       51                       43
2345                      34                       42
492                       34                       39
1746                      48                       70
2646                      61                       92
3235                      56                       80
2217                      67                       90
2486                       5                        9

      nbre_exemplaire_juillet_21  nbre_exemplaire_aout_21  \
1314                          23                       28
2670                          54                       44
465                           45                       46
2345                          47                       46
492                           44                       34
1746                          75                       55
2646                          81                       60
3235                          64                       53
2217                          89                       74
2486                          14                       12

      nbre_exemplaire_septembre_21  nbre_exemplaire_octobre_21  \
```

```
1314                            36                            13
2670                            21                            25
465                             22                            33
2345                            31                            23
492                             17                            18
1746                            73                            74
2646                            92                            83
3235                            66                            80
2217                            79                            62
2486                             5                             6

      nbre_exemplaire_novembre_21  …  nbre_exemplaire_aout_22  \
1314                           27  …                        27
2670                           32  …                        49
465                            26  …                        31
2345                           41  …                        40
492                            25  …                        39
1746                          124  …                        98
2646                          116  …                       104
3235                          108  …                        91
2217                          107  …                       104
2486                            8  …                         5

      nbre_exemplaire_septembre_22  nbre_exemplaire_octobre_22  \
1314                           35                           20
2670                           29                           36
465                            34                           38
2345                           42                           39
492                            29                           39
1746                           73                           83
2646                           90                           72
3235                           76                           51
2217                           68                           83
2486                            6                           11

      nbre_exemplaire_novembre_22  nbre_exemplaire_decembre_22  \
1314                           23                           30
2670                           42                           53
465                            34                           50
2345                           36                           35
492                            34                           27
1746                           75                           72
2646                           85                           86
3235                           73                           73
2217                           96                          100
2486                           14                           10
```

```
      nbre_exemplaire_janvier_23  nbre_exemplaire_fevrier_23   price  categ  \
1314                          21                          22  145.99      2
2670                          30                          35   68.99      2
465                           38                          45   67.57      2
2345                          43                          46   59.14      2
492                           25                          33   69.99      2
1746                          75                          55   28.99      1
2646                          94                          83   23.99      1
3235                          65                          58   28.99      1
2217                          92                          91   23.83      1
2486                          12                           7  230.04      2

      CA_total_produit
1314         170516.32
2670         125147.86
465          117436.66
2345         109763.84
492          101765.46
1746         101696.92
2646         100518.10
3235          98508.02
2217          97178.74
2486          97076.88

[10 rows x 28 columns]
```

[1550]:
```
df_produits["nbre_total_exemplaire"] = 0
```

[1552]:
```
for j in range(len(df_produits)):
    for i in range(1, 25):
        df_produits.iloc[j,28] = df_produits.iloc[j,28] + df_produits.iloc[j,i]
```

[1556]:
```
df_produits.sort_values(by="nbre_total_exemplaire", ascending=False).head(10)
```

[1556]:
```
     product_id  nbre_exemplaire_mars_21  nbre_exemplaire_avril_21  \
2646      1_369                       88                        68
2199      1_417                       95                        66
2217      1_414                       86                        64
2886      1_498                       97                        70
1040      1_425                       79                        62
740       1_403                       85                        49
3240      1_413                       90                        52
1325      1_407                       78                        69
641       1_396                       85                        49
2587      1_412                       81                        37

      nbre_exemplaire_mai_21  nbre_exemplaire_juin_21  \
```

```
2646                      61                      92
2199                      67                      94
2217                      67                      90
2886                      61                      86
1040                      44                      87
740                       50                      83
3240                      58                      63
1325                      50                      76
641                       61                      79
2587                      53                      94

      nbre_exemplaire_juillet_21  nbre_exemplaire_aout_21  \
2646                          81                      60
2199                          71                      48
2217                          89                      74
2886                          71                      43
1040                          87                      58
740                           65                      49
3240                          63                      49
1325                          68                      56
641                           53                      47
2587                          60                      55

      nbre_exemplaire_septembre_21  nbre_exemplaire_octobre_21  \
2646                            92                          83
2199                            87                          80
2217                            79                          62
2886                            72                          67
1040                            71                          61
740                             84                          73
3240                            80                          77
1325                            69                          58
641                             81                          85
2587                            61                          60

      nbre_exemplaire_novembre_21  …  nbre_exemplaire_septembre_22  \
2646                          116  …                            90
2199                          113  …                            70
2217                          107  …                            68
2886                          123  …                            78
1040                          118  …                            85
740                           104  …                            72
3240                          111  …                            74
1325                          113  …                            73
641                           115  …                            72
2587                          131  …                            74
```

```
      nbre_exemplaire_octobre_22  nbre_exemplaire_novembre_22  \
2646                          72                           85
2199                          77                           88
2217                          83                           96
2886                          72                           73
1040                          67                           86
740                           68                           59
3240                          69                           77
1325                          59                           90
641                           71                           80
2587                          71                           77

      nbre_exemplaire_decembre_22  nbre_exemplaire_janvier_23  \
2646                           86                          94
2199                           86                          59
2217                          100                          92
2886                          105                          65
1040                           82                          88
740                            67                          71
3240                           69                          69
1325                           92                          74
641                            79                          59
2587                           76                          64

      nbre_exemplaire_fevrier_23  price  categ  CA_total_produit  \
2646                          83  23.99      1         100518.10
2199                          79  20.99      1          85849.10
2217                          91  23.83      1          97178.74
2886                          75  23.37      1          93620.22
1040                          63  16.99      1          65887.22
740                           69  17.99      1          65879.38
3240                          64  17.99      1          65699.48
1325                          71  15.99      1          57979.74
641                           73  18.60      1          67369.20
2587                          73  16.65      1          59773.50

      nbre_total_exemplaire
2646                   2095
2199                   2045
2217                   2039
2886                   2003
1040                   1939
740                    1831
3240                   1826
1325                   1813
641                    1811
2587                   1795
```

```
[10 rows x 29 columns]
```

[1892]:
```
df_produits["CA_total_produit"] = round((df_produits["nbre_total_exemplaire"] *␣
↪df_produits["price"]),2)
```

[1893]:
```
df_produits.head()
```

[1893]:

	product_id	nbre_exemplaire_mars_21	nbre_exemplaire_avril_21	\
0	0_1421	57	38	
1	0_1368	46	45	
2	0_731	1	2	
3	1_587	4	1	
4	0_1507	25	27	

	nbre_exemplaire_mai_21	nbre_exemplaire_juin_21	\
0	34	48	
1	24	32	
2	1	0	
3	2	4	
4	26	24	

	nbre_exemplaire_juillet_21	nbre_exemplaire_aout_21	\
0	27	36	
1	25	31	
2	1	0	
3	4	4	
4	22	23	

	nbre_exemplaire_septembre_21	nbre_exemplaire_octobre_21	\
0	65	51	
1	56	33	
2	1	1	
3	6	3	
4	36	18	

	nbre_exemplaire_novembre_21	…	nbre_exemplaire_septembre_22	\
0	50	…	32	
1	27	…	25	
2	0	…	0	
3	5	…	10	
4	24	…	28	

	nbre_exemplaire_octobre_22	nbre_exemplaire_novembre_22	\
0	35	58	
1	31	36	
2	0	1	

```
3                           4                           8
4                          20                          31

   nbre_exemplaire_decembre_22  nbre_exemplaire_janvier_23  \
0                           31                          46
1                           37                          37
2                            0                           0
3                            5                           3
4                           25                          18

   nbre_exemplaire_fevrier_23  price  categ  CA_total_produit  \
0                          43  19.99      0          20749.62
1                          20   5.13      0           4191.21
2                           0  17.99      0            251.86
3                           3   4.99      1            528.94
4                          27   3.99      0           2525.67

   nbre_total_exemplaire
0                   1038
1                    817
2                     14
3                    106
4                    633

[5 rows x 29 columns]
```

[1983]:
```
#meilleurs références en chiffre d'affaire :
colors = ['seagreen'] * 10
fig6 = go.Figure(data=go.Bar(
    x=df_produits.sort_values(by="CA_total_produit", ascending=False).
 ↪head(10)['product_id'],
    y=df_produits.sort_values(by="CA_total_produit", ascending=False).
 ↪head(10)['CA_total_produit'],
    orientation='v',
    marker_color=colors
    ),
                layout_title_text="Top 10 des références qui réalisent les␣
 ↪meilleurs CA")

fig6.update_layout(
        width=500,
        height=400)
fig6.update_layout(
xaxis = dict(
tickfont = dict(size=10)))
fig6.update_yaxes(title_text="Chiffre d'affaire par référence")
fig6.show()
```

[1982]:
```
#meilleurs références vendues en terme de nombre d'exemplaires :

colors = ['seagreen'] * 10
fig12 = go.Figure(data=go.Bar(
    x=df_produits.sort_values(by="nbre_total_exemplaire", ascending=False).
 ↪head(10)['product_id'],
    y=df_produits.sort_values(by="nbre_total_exemplaire", ascending=False).
 ↪head(10)['nbre_total_exemplaire'],
    orientation='v',
    marker_color=colors
    ),
                 layout_title_text="Top 10 des références les plus vendues")

fig12.update_layout(
        width=500,
        height=400)
fig12.update_layout(
xaxis = dict(
tickfont = dict(size=10)))
fig12.update_yaxes(title_text="Nbre d'exemplaires vendus par référence")
fig12.show()
```

[1363]:
```
round((df_products.loc[df_products["categ"] == 1]["price"].mean()),2)
```

[1363]:
```
25.53
```

[1377]:
```
distrib_categ = df_products.groupby("categ").agg({"product_id":"count"}).
 ↪reset_index()
```

[1378]:
```
distrib_categ.rename(columns={"product_id":"product_count"}, inplace=True)
```

[1379]:
```
distrib_categ.head()
```

[1379]:

	categ	product_count
0	0	2308
1	1	739
2	2	239

[ ]:
```
fig10 = go.Figure(data=go.Pie(labels=["11.73 €", "25.53 €", "108.35␣
 ↪€"],#distrib_categ["categ"]
        values=distrib_categ["product_count"],
        hole=.5,
    insidetextorientation='radial'),
layout_title_text="distribution des livres par catégorie et prix moyen de␣
 ↪chaque catégorie")
fig10.update_traces(marker=dict(colors=['steelblue', 'darkorange', 'green']))
fig10.update_layout(
```

```
        title_font_size=12,
        width=500,
        height=400)
```

[1576]:
```
len(df_produits.loc[df_produits["nbre_total_exemplaire"] == 1].
 ↪loc[df_produits["categ"] == 0])
```

[1576]:
```
21
```

[ ]:
```
#nombre de références dont aucun exemplaire n'a été vendu au cours de la␣
 ↪période d'étude : 23 dont 18
#sont de la categorie 0 : 78,26%.
#24 produits sont vendus 1e seule fois sur toute la période : parmi eux 21 sont␣
 ↪de catégorie 0
```

[1896]:
```
df_produits.groupby("categ").agg({"CA_total_produit":"sum"}).reset_index()
```

[1896]:
```
   categ  CA_total_produit
0      0        4019011.38
1      1        4349444.39
2      2        2518327.82
```

[1897]:
```
#pie chart : contribution de chaque categorie dans le CA total:
fig13 = go.Figure(data=go.Pie(labels=df_produits.groupby("categ").
 ↪agg({"CA_total_produit":"sum"}).reset_index()["categ"],
        values=df_produits.groupby("categ").agg({"CA_total_produit":"sum"}).
 ↪reset_index()["CA_total_produit"]),
        #insidetextorientation='radial'
        layout_title_text="contribution de chaque catégorie dans le chiffre␣
 ↪d'affaire total")
fig13.update_traces(marker=dict(colors=['steelblue', 'darkorange', 'green']))
fig13.update_layout(
        title_font_size=12,
        width=500,
        height=400)
```

[1648]:
```
#pie chart qui montre aussi la part de chaque catégorie en nombre d'exemplaires:
 ↪ modifier le code

fig14 = go.Figure(data=go.Pie(labels=df_produits.groupby("categ").
 ↪agg({"nbre_total_exemplaire":"sum"}).reset_index()["categ"],
        values=df_produits.groupby("categ").agg({"nbre_total_exemplaire":
 ↪"sum"}).reset_index()["nbre_total_exemplaire"]),
        #insidetextorientation='radial'
        layout_title_text="répartition du nombre d'exemplaires vendus en␣
 ↪fonction de la categorie")
```

```
fig14.update_traces(marker=dict(colors=['steelblue', 'darkorange', 'green']))
fig14.update_layout(
        title_font_size=12,
        width=500,
        height=400)
```

[1630]:
```
evolution_par_categ = pd.DataFrame({"categ":[0,1,2],
                                    "1eme mois":0, "2eme mois":0,"3eme mois":0,
                                    "4eme mois":0,"5eme mois":0,"6eme mois":0,
                                    "7eme mois":0,"8eme mois":0,"9eme mois":0,
                                    "10eme mois":0,"11eme mois":0,"12eme mois":0,
                                    "13eme mois":0,"14eme mois":0,"15eme mois":0,
                                    "16eme mois":0,"17eme mois":0,"18eme mois":0,
                                    "19eme mois":0,"20eme mois":0,"21eme mois":0,
                                    "22eme mois":0,"23eme mois":0,"24eme mois":0
                                    })
```

[ ]:
```
#Evolution dans le temps du chiffre d'affaire par catégorie:
for k in range (3):
    temporary_df = df_produits.loc[df_produits["categ"] == k]
    for i in range(1,25):
        for j in range(len(temporary_df)):
            evolution_par_categ.iloc[k,i] = round((evolution_par_categ.
 ↪iloc[k,i] + (temporary_df.iloc[j,i]*temporary_df.iloc[j,25])),2)
```

[1632]:
```
evolution_par_categ.head()
```

[1632]:

	categ	1eme mois	2eme mois	3eme mois	4eme mois	5eme mois	6eme mois	\
0	0	193629.17	185775.05	163706.06	161660.08	130055.59	137417.91	
1	1	186974.17	139065.96	141060.93	183599.71	168343.56	129934.13	
2	2	101837.27	104272.15	109095.25	122429.62	134774.06	122262.48	

	7eme mois	8eme mois	9eme mois	…	15eme mois	16eme mois	17eme mois	\
0	233170.99	171839.15	155909.56	…	158009.96	173492.50	163792.91	
1	177797.27	163031.48	252910.39	…	166676.62	189579.70	163048.91	
2	64711.18	77687.86	107347.78	…	94273.41	102890.02	113596.35	

	18eme mois	19eme mois	20eme mois	21eme mois	22eme mois	23eme mois	\
0	177372.76	166688.84	158832.28	178576.71	163789.77	147761.56	
1	211360.09	174213.46	167288.95	191343.58	184452.92	167765.32	
2	117734.42	103779.54	103070.34	109638.04	113694.91	101779.99	

	24eme mois
0	152607.05
1	166824.95
2	103106.14

```
[3 rows x 25 columns]
```

[1634]:
```
evolut_catego = pd.DataFrame(
    {'period': period,
     'Categorie_0': evolution_par_categ.iloc[0,1:],
     'Categorie_1': evolution_par_categ.iloc[1,1:],
     'Categorie_2': evolution_par_categ.iloc[2,1:],
     'vol_categ_0':0,
     'vol_categ_1':0,
     'vol_categ_2':0
    })
```

[1635]:
```
evolut_catego = evolut_catego.reset_index()
```

[1636]:
```
evolut_catego = evolut_catego.drop(columns=["index"])
```

[1640]:
```
for k in range (3):
    temporary_df = df_produits.loc[df_produits["categ"] == k]
    for i in range(1,25):
        for j in range(len(temporary_df)):
            evolut_catego.iloc[i-1,k+4] = evolut_catego.iloc[i-1,k+4] +␣
 ↪temporary_df.iloc[j,i]
```

[1641]:
```
evolut_catego.head()
```

[1641]:

	period	Categorie_0	Categorie_1	Categorie_2	vol_categ_0	vol_categ_1	vol_categ_2
0	Mar-21	193629.17	186974.17	101837.27	18131	9134	1336
1	Apr-21	185775.05	139065.96	104272.15	17483	6755	1382
2	May-21	163706.06	141060.93	109095.25	15446	6872	1397
3	Jun-21	161660.08	183599.71	122429.62	15312	8989	1628
4	Jul-21	130055.59	168343.56	134774.06	12163	8214	1803

[ ]:
```
evolut_catego["CA_total"] = 0
for i in range (len(evolut_catego)):
    evolut_catego.iloc[i,7] = round((evolut_catego.iloc[i,1:4].sum()),2)
```

[1904]:
```
evolut_catego.head()
```

[1904]:

	period	Categorie_0	Categorie_1	Categorie_2	vol_categ_0	vol_categ_1	vol_categ_2
0	Mar-21	193629.17	186974.17	101837.27	18131	9134	1336

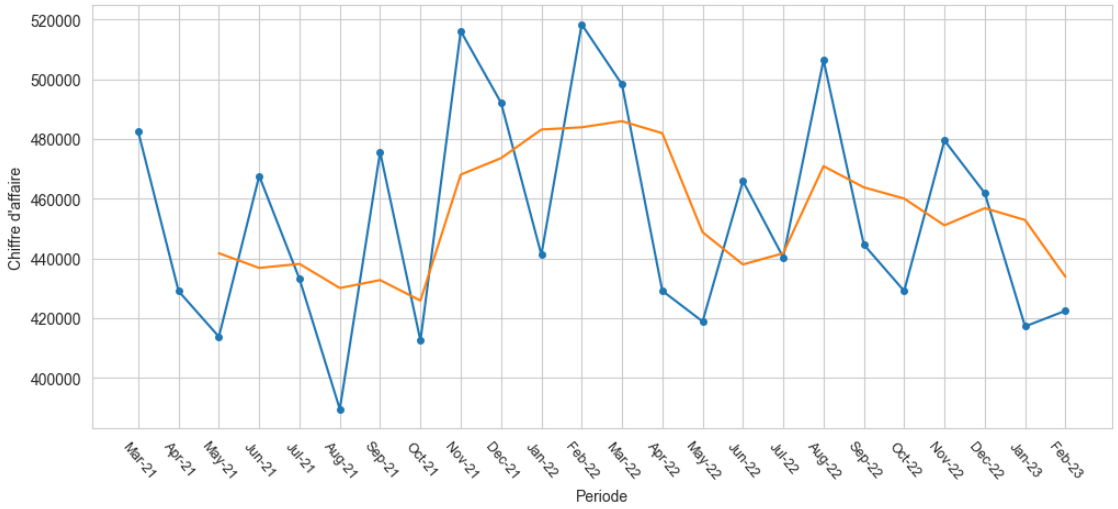
```
1  Apr-21    185775.05    139065.96    104272.15        17483         6755
2  May-21    163706.06    141060.93    109095.25        15446         6872
3  Jun-21    161660.08    183599.71    122429.62        15312         8989
4  Jul-21    130055.59    168343.56    134774.06        12163         8214

   vol_categ_2   CA_total  moving_average
0         1336  482440.61             NaN
1         1382  429113.16             NaN
2         1397  413862.24       441805.34
3         1628  467689.41       436888.27
4         1803  433173.21       438241.62
```

[ ]:
```
colors = ["darkblue"] * 24
go.Figure(data=go.Bar(
    x=evolut_catego['period'],
    y=evolut_catego['CA_total'],
   marker=dict(
        color=colors,
   )), layout_title_text="Evolution du CA par mois"
               )
```

[1981]:
```
px.bar(evolut_catego, x="period",
             y=["CA_total"], color_discrete_sequence= px.colors.qualitative.
 ↪Set2, width= 800,
            title="Evolution du CA total")
```

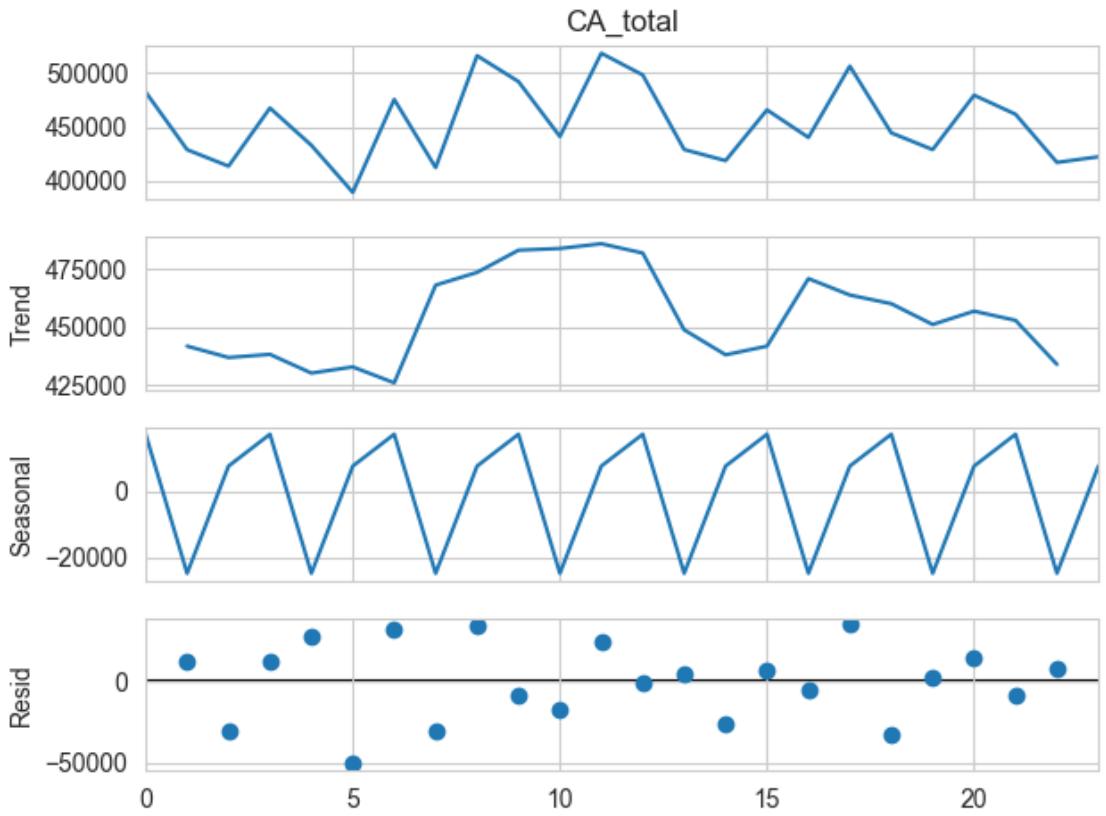
[1734]:
```
#Moving average avec plt rolling:
window_size = 3
evolut_catego["moving_average"] = round((evolut_catego["CA_total"].
 ↪rolling(window=window_size).mean()),2)
# Plot the data and moving average
plt.pyplot.figure(figsize=(12, 5))
plt.pyplot.plot(evolut_catego['period'], evolut_catego['CA_total'], label='CA␣
 ↪total', marker='o', markersize=4)
plt.pyplot.plot(evolut_catego['period'], evolut_catego['moving_average'],␣
 ↪label=f'Moving Average ({window_size} periods)')
plt.pyplot.xlabel('Periode')
plt.pyplot.xticks(rotation = -50, fontsize=9)
plt.pyplot.ylabel("Chiffre d'affaire")
```

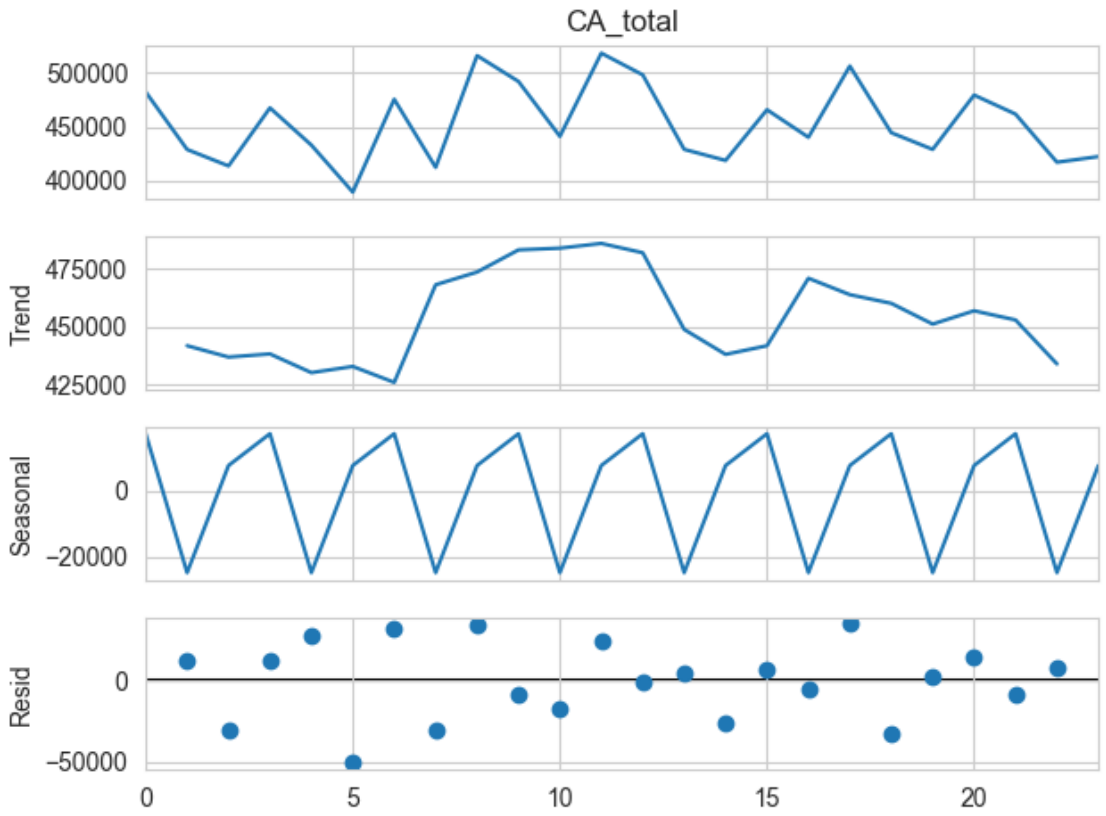
[1734]:
```
Text(0, 0.5, "Chiffre d'affaire")
```



[1700]:
```
result = seasonal_decompose(evolut_catego['CA_total'], model='additive',␣
↪period=3)
result.plot()
```

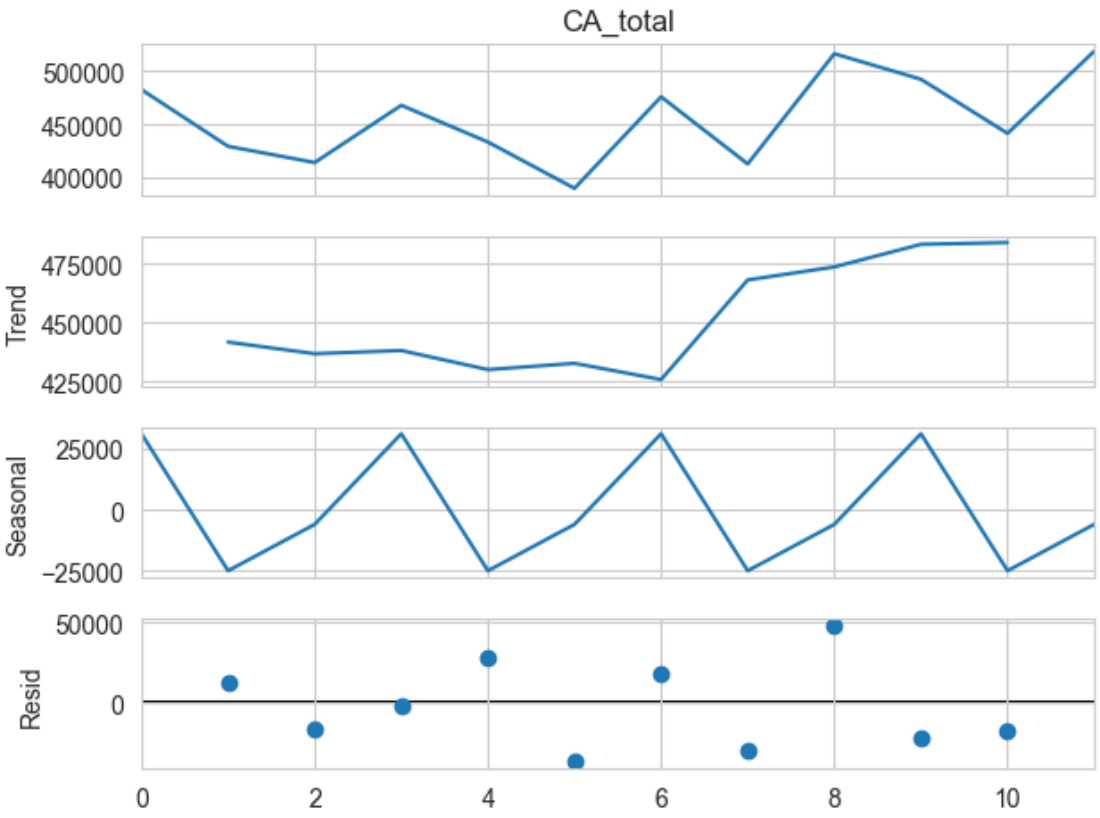
[1700]:

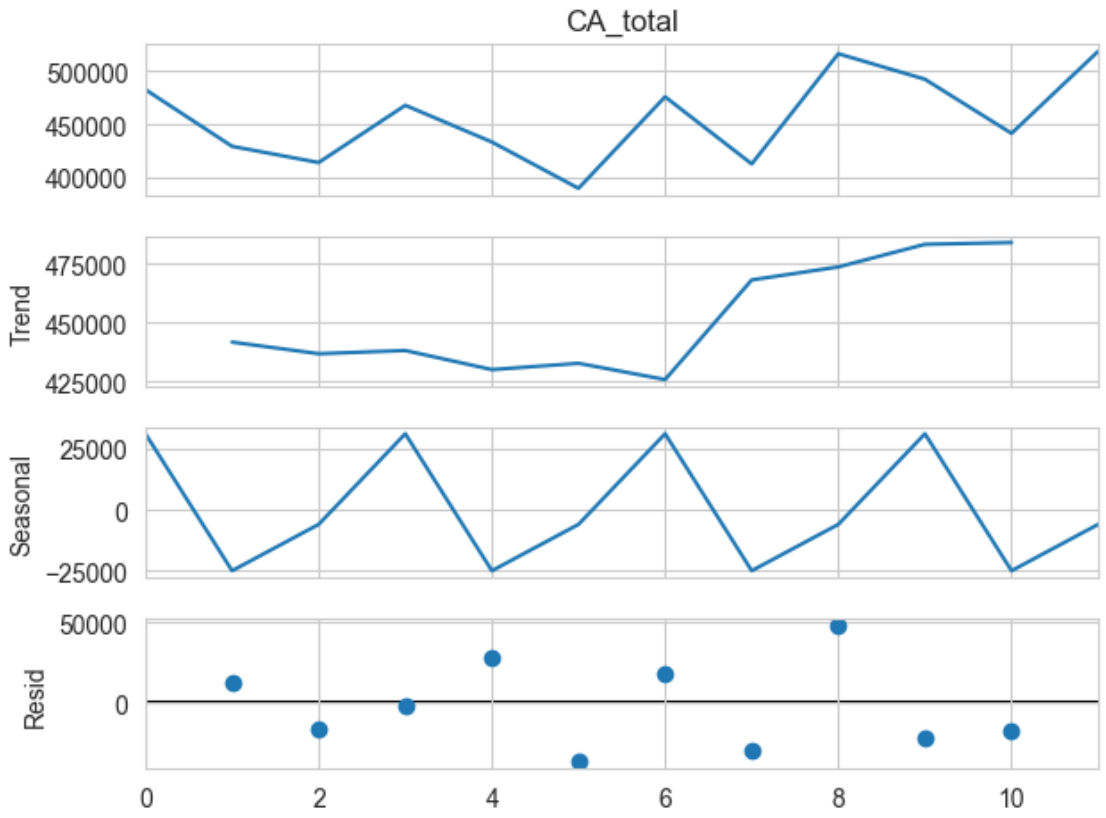




[2010]:
```
result = seasonal_decompose(evolut_catego.iloc[0:12,7], model='additive',␣
↪period=3)
result.plot()
```

[2010]:


CA_total
500000
450000
400000
Trend
475000
450000
425000
Seasonal
25000
0
−25000
Resid
50000
0
0
2
4
6
8
10

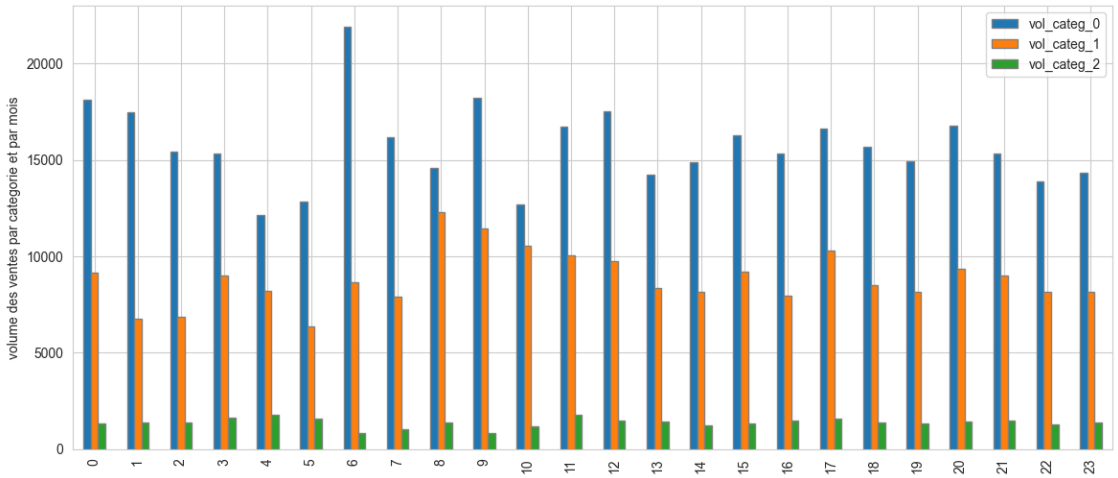


[ ]:
```
plt.pyplot.figure(figsize=(10, 5))
sns.barplot(x = evolut_catego['period'], y = evolut_catego["vol_categ_0"],␣
 ↪color='steelblue').text(s='Categ_0', x='Nov-22', y=22000.0,␣
 ↪color='steelblue', fontsize=9)
sns.barplot(x = evolut_catego['period'], y = evolut_catego["vol_categ_1"],␣
 ↪color='darkorange').text(s='Categ_1', x='Nov-22', y=21000.0,␣
 ↪color='darkorange', fontsize=9)
sns.barplot(x = evolut_catego['period'], y = evolut_catego["vol_categ_2"],␣
 ↪color='green').text(s='Categ_2', x='Nov-22', y=20000.0, color='green',␣
 ↪fontsize=9)
plt.pyplot.xticks(rotation = -50, fontsize=9)
plt.pyplot.ylabel('Evolution des ventes en quantité par categorie')
plt.pyplot.xlabel('Mois')

#x='Nov-22', y=260000.0, x='Nov-22', y=250000.0, x='Nov-22', y=240000.0,
```

[1644]:
```
evolut_catego[["vol_categ_0","vol_categ_1","vol_categ_2"]].plot.
 ↪bar(figsize=(14,6),edgecolor = "grey")
plt.pyplot.ylabel('volume des ventes par categorie et par mois')
plt.pyplot.xlabel("")
```

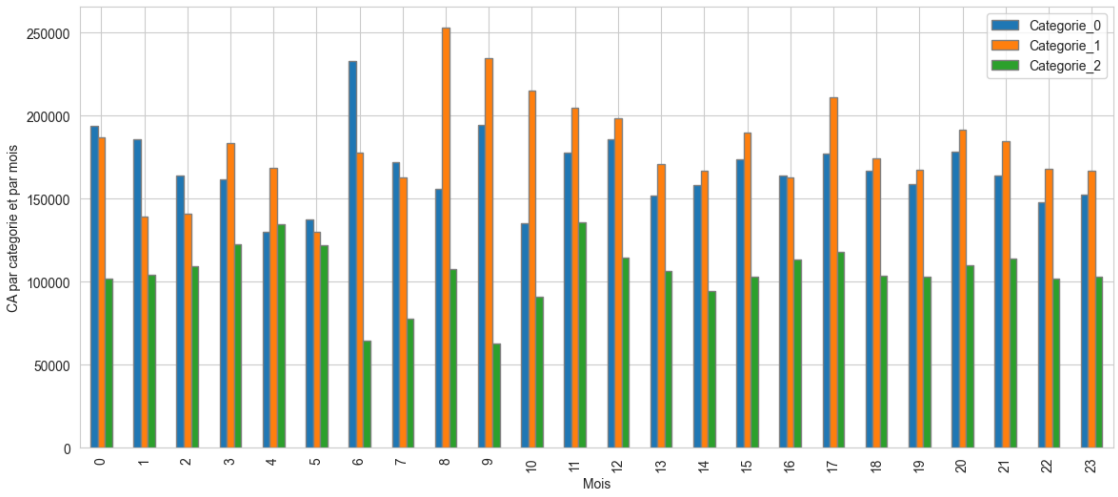
```
#Il faut determiner les volumes des ventes par categorie et par mois c'est a␣
↪dire nombre de product id vendu par mois
```

[1644]: Text(0.5, 0, '')



[1645]:
```
evolut_catego[["Categorie_0","Categorie_1","Categorie_2"]].plot.
↪bar(figsize=(14,6),edgecolor = "grey")
plt.pyplot.ylabel('CA par categorie et par mois')
plt.pyplot.xlabel('Mois')
```

[1645]: Text(0.5, 0, 'Mois')



[1998]:
```
evolut_catego.head(24)
```

[1998]:

	period	Categorie_0	Categorie_1	Categorie_2	vol_categ_0	vol_categ_1	vol_categ_2	CA_total	moving_average
0	Mar-21	193629.17	186974.17	101837.27	18131	9134	1336	482440.61	NaN
1	Apr-21	185775.05	139065.96	104272.15	17483	6755	1382	429113.16	NaN
2	May-21	163706.06	141060.93	109095.25	15446	6872	1397	413862.24	441805.34
3	Jun-21	161660.08	183599.71	122429.62	15312	8989	1628	467689.41	436888.27
4	Jul-21	130055.59	168343.56	134774.06	12163	8214	1803	433173.21	438241.62
5	Aug-21	137417.91	129934.13	122262.48	12837	6345	1580	389614.52	430159.05
6	Sep-21	233170.99	177797.27	64711.18	21916	8642	823	475679.44	432822.39
7	Oct-21	171839.15	163031.48	77687.86	16190	7900	1036	412558.49	425950.82
8	Nov-21	155909.56	252910.39	107347.78	14600	12316	1395	516167.73	468135.22
9	Dec-21	194574.70	234722.99	62885.78	18216	11464	821	492183.47	473636.56
10	Jan-22	135339.57	215223.80	90736.58	12688	10553	1199	441299.95	483217.05
11	Feb-22	177550.67	204871.13	135997.38	16748	10061	1805	518419.18	483967.53
12	Mar-22	185818.28	198235.75	114250.18	17512	9727	1476	498304.21	486007.78
13	Apr-22	151640.26	171118.62	106477.09	14238	8343	1418	429235.97	481986.45
14	May-22	158009.96	166676.62	94273.41	14878	8143	1230	418959.99	448833.39
15	Jun-22	173492.50	189579.70	102890.02	16260	9192	1343	465962.22	438052.73
16	Jul-22	163792.91	163048.91	113596.35	15321	7951	1490	440438.17	441786.79
17	Aug-22	177372.76	211360.09	117734.42	16650	10306	1589	506467.27	470955.89
18	Sep-22	166688.84	174213.46	103779.54	15667	8527			
19	Oct-22	158832.28	167288.95	103070.34	14946	8147			
20	Nov-22	178576.71	191343.58	109638.04	16763	9363			
21	Dec-22	163789.77	184452.92	113694.91	15355	9026			
22	Jan-23	147761.56	167765.32	101779.99	13864	8178			
23	Feb-23	152607.05	166824.95	103106.14	14314	8149			

```
18          1367  444681.84       463862.43
19          1338  429191.57       460113.56
20          1427  479558.33       451143.91
21          1491  461937.60       456895.83
22          1305  417306.87       452934.27
23          1362  422538.14       433927.54
```

[2004]:
```
evolut_catego.iloc[0:12,7].sum() - evolut_catego.iloc[12:24,7].sum()
```

[2004]:
```
57619.23000000045
```

[2018]:
```
print(len(df_customers.loc[2023-df_customers["year_of_birth"] <= 30]),
len(df_customers.loc[(2023-df_customers["year_of_birth"] > 30) &␣
 ↪(2023-df_customers["year_of_birth"] <= 60)]),
#len(df_customers.loc[(2023-df_customers["year_of_birth"] > 40) &␣
 ↪(2023-df_customers["year_of_birth"] <= 60)]),
len(df_customers.loc[2023-df_customers["year_of_birth"] > 60]))
# repartition de la clientèle en tranches d'age
```

```
2092 4866 1663
```

[2026]:
```
go.Figure(data=go.Pie(labels= ['age <= 30', 'age > 30 et <=60', 'age > 60'],
        values= [len(df_customers.loc[2023-df_customers["year_of_birth"] <=␣
 ↪30]),
                 len(df_customers.loc[(2023-df_customers["year_of_birth"] > 30)␣
 ↪& (2023-df_customers["year_of_birth"] <= 60)]),
                 len(df_customers.loc[2023-df_customers["year_of_birth"] >␣
 ↪60])]),
layout_title_text="Distribution des clients en fonction des âges").
 ↪update_layout(
        title_font_size=12,
        width=500,
        height=400).update_traces(marker=dict(colors=['lightskyblue',␣
 ↪'royalblue', 'navy']))
```

[1649]:
```
categ_et_genre = pd.DataFrame(
    {'period': period,
     'f_categ_0': 0,
     'f_categ_1': 0,
     'f_categ_2': 0,
     'm_categ_0': 0,
     'm_categ_1': 0,
     'm_categ_2': 0
     })
```

[1650]:
```
gender_list = ["f", "m"]
```

[1651]:
```
l = 1
for k in range(len(gender_list)):

    for n in range(3):

            for j in range(len(list_month)):
                datee = datetime.strptime(list_month[j], "%Y-%m-%d")
                month = datee.month
                year = datee.year
                first, last = calendar.monthrange(year, month)
                if month < 10:
                    df_month = df_final.loc[(df_final['date_transaction'] >=␣
 ↪datetime.strptime((str(year)+'-0'+str(month)+'-0'+str(first+1))[:
 ↪10],'%Y-%m-%d'))
                     & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
                else:
                    df_month = df_final.loc[(df_final['date_transaction'] >=␣
 ↪datetime.strptime((str(year)+'-'+str(month)+'-0'+str(first+1))[:
 ↪10],'%Y-%m-%d'))
                     & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]

                df_month = df_month.loc[df_month["categ"] == n].
 ↪groupby("client_id").agg(
                    {"transaction_id":"count"}).reset_index().
 ↪merge(df_customers, on="client_id", how="left")

                categ_et_genre.iloc[j,l] = len(df_month.loc[df_month["gender"]␣
 ↪== gender_list[k]])
            l = l+1
```

[1652]:
```
categ_et_genre.head(30)
```

[1652]:

	period	f_categ_0	f_categ_1	f_categ_2	m_categ_0	m_categ_1	m_categ_2
0	Mar-21	2255	2148	431	2031	1967	412
1	Apr-21	2176	1817	436	1981	1660	407
2	May-21	2037	1811	441	1827	1621	392
3	Jun-21	2105	2151	457	1933	1955	448
4	Jul-21	1962	2048	502	1770	1821	510
5	Aug-21	1913	1706	448	1764	1638	442
6	Sep-21	2269	2069	305	2133	1925	287
7	Oct-21	2126	1807	357	1916	1604	326
8	Nov-21	2086	2471	445	1949	2286	418
9	Dec-21	2216	2385	304	2032	2166	290
10	Jan-22	1915	2214	374	1790	2083	369

11	Feb-22	2144	2253	491	1930	2004	478
12	Mar-22	2250	2248	472	2000	2013	412
13	Apr-22	1973	2023	468	1844	1873	396
14	May-22	2032	1994	415	1886	1812	389
15	Jun-22	2138	2161	417	1948	1947	375
16	Jul-22	2078	1967	456	1875	1863	421
17	Aug-22	2196	2293	462	2008	2076	460
18	Sep-22	2062	2051	428	1918	1921	403
19	Oct-22	2044	1993	415	1836	1824	389
20	Nov-22	2174	2148	426	1959	2009	414
21	Dec-22	2047	2167	434	1930	1893	445
22	Jan-23	1958	2006	412	1834	1832	375
23	Feb-23	2053	2027	429	1861	1825	394

[1707]:
```
data = pd.DataFrame({'categ':␣
 ↪['categ_0','categ_0','categ_1','categ_1','categ_2','categ_2'],
       'gender': ['m', 'f', 'm', 'f', 'm', 'f']})


tableau = pd.crosstab(data['categ'], data['gender'])
print(tableau)
```

```
gender   f  m
categ
categ_0  1  1
categ_1  1  1
categ_2  1  1
```

[1729]:
```
tableau.iloc[0,0] = 2092
tableau.iloc[0,1]= 1915
tableau.iloc[1,0] = 2082
tableau.iloc[1,1] = 1901
tableau.iloc[2,0] = 426
tableau.iloc[2,1] = 402
```

[1730]:
```
print(tableau)
```

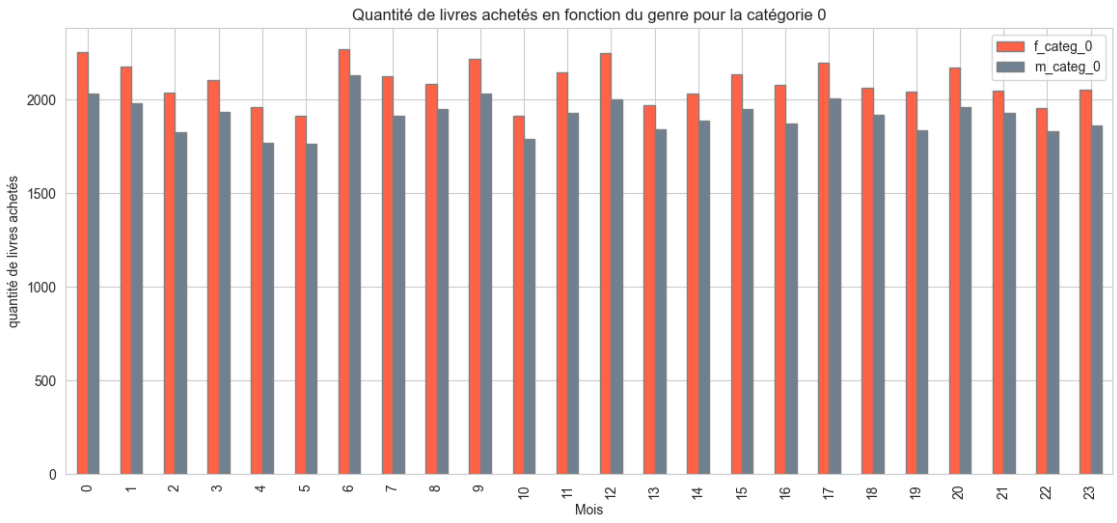
```
gender      f     m
categ
categ_0  2092  1915
categ_1  2082  1901
categ_2   426   402
```

[1731]:
```
chi2_contingency(tableau)

#les 2 variables sont indépendantes
```

[1731]:
```
Chi2ContingencyResult(statistic=0.19136225490726191, pvalue=0.9087537464938789,
dof=2, expected_freq=array([[2090.29258335, 1916.70741665],
       [2077.77273758, 1905.22726242],
       [ 431.93467907,  396.06532093]]))
```

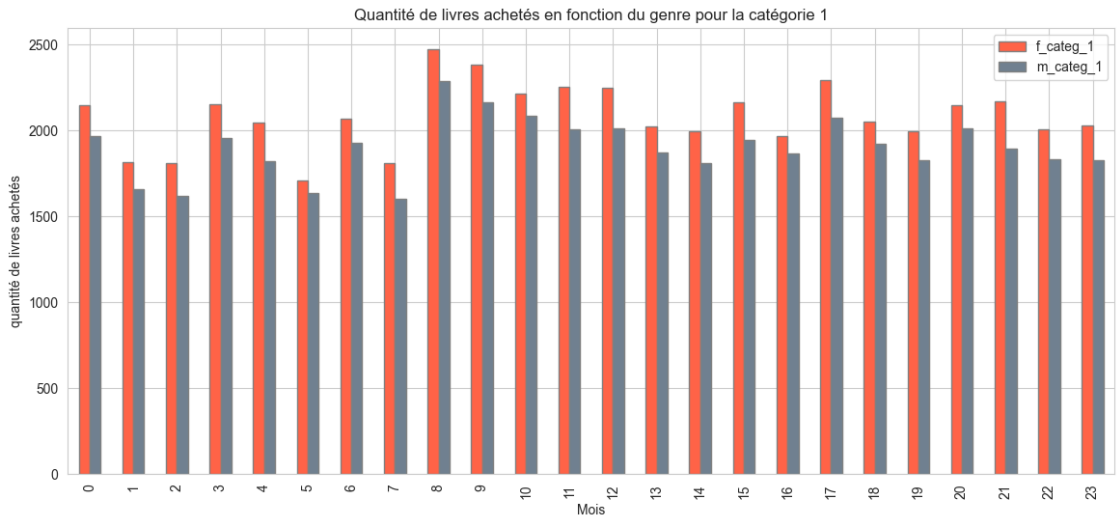
[1653]:
```
#genre prédominant au cours des mois pour la catégorie 0 : nombre de product id␣
 ↪
categ_et_genre[["f_categ_0","m_categ_0"]].plot.bar(figsize=(14,6),edgecolor =␣
 ↪"grey", color=["tomato","slategray"])
plt.pyplot.ylabel('quantité de livres achetés')
plt.pyplot.xlabel('Mois')
plt.pyplot.title('Quantité de livres achetés en fonction du genre pour la␣
 ↪catégorie 0')

#,"f_categ_1", "m_categ_1", "f_categ_2", "m_categ_2"
```

[1653]:
```
Text(0.5, 1.0, 'Quantité de livres achetés en fonction du genre pour la
catégorie 0')
```



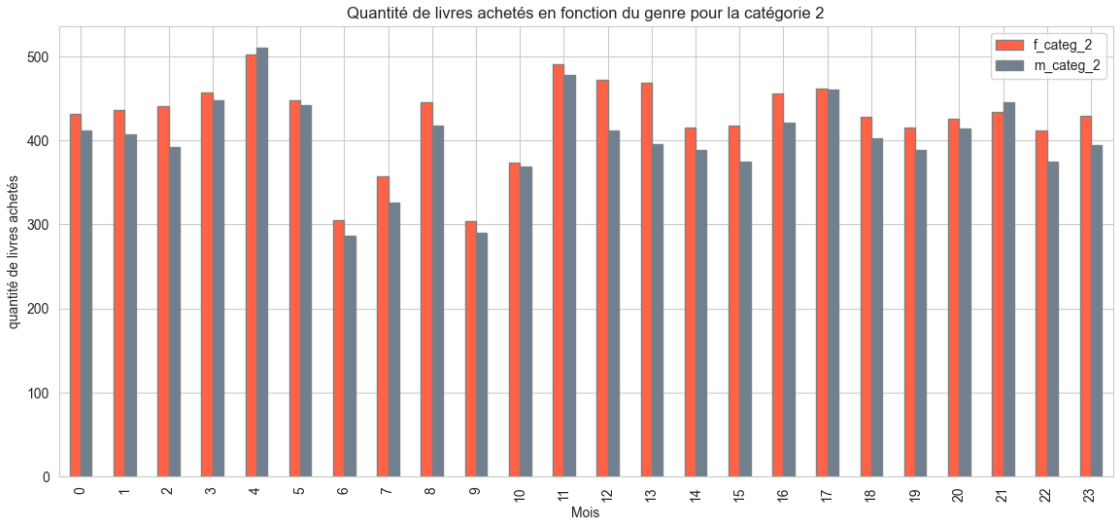
[1654]:
```
#genre prédominant au cours des mois pour la catégorie 1
categ_et_genre[["f_categ_1","m_categ_1"]].plot.bar(figsize=(14,6),edgecolor =␣
 ↪"grey", color=["tomato","slategray"])
plt.pyplot.ylabel('quantité de livres achetés')
plt.pyplot.xlabel('Mois')
plt.pyplot.title('Quantité de livres achetés en fonction du genre pour la␣
 ↪catégorie 1')
#,"f_categ_1", "m_categ_1", "f_categ_2", "m_categ_2"
```

[1654]: Text(0.5, 1.0, 'Quantité de livres achetés en fonction du genre pour la catégorie 1')



[1655]:
```
#genre prédominant au cours des mois pour la catégorie 2

categ_et_genre[["f_categ_2","m_categ_2"]].plot.bar(figsize=(14,6),edgecolor =␣
 ↪"grey", color=["tomato","slategray"])
plt.pyplot.ylabel('quantité de livres achetés')
plt.pyplot.xlabel('Mois')
plt.pyplot.title('Quantité de livres achetés en fonction du genre pour la␣
 ↪catégorie 2')
#,"f_categ_1", "m_categ_1", "f_categ_2", "m_categ_2"
```

[1655]: Text(0.5, 1.0, 'Quantité de livres achetés en fonction du genre pour la catégorie 2')



[1201]:
```
#Distribution des ages des clients :
distrib_age = df_customers.groupby("year_of_birth").agg({"client_id" :␣
↪"count"}).reset_index()
```

[1203]:
```
distrib_age["age"] = 2023 - distrib_age["year_of_birth"]
```

[1206]:
```
distrib_age.rename(columns={"client_id" : "client_count"}, inplace=True)
```

[1215]:
```
go.Figure(data=go.Bar(
    x=distrib_age["age"],
    y=distrib_age["client_count"]),
          layout_title_text="répartition des clients en fonction de leurs␣
↪âges").update_yaxes(title_text="nombre de clients")
```

[ ]:
```
#fréquence des achats :

datee = datetime.strptime(list_month[4], "%Y-%m-%d")
month = datee.month
year = datee.year
first, last = calendar.monthrange(year, month)
df_month = df_final.loc[(df_final['date_transaction'] > datetime.
↪strptime((str(year)+'-0'+str(month)+'-0'+str(first+1))[:10],'%Y-%m-%d'))
                    & (df_final['date_transaction'] < datetime.
↪strptime((str(year)+'-0'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
#df_month = df_month.loc[df_month["categ"] == 0].groupby("client_id").agg(
                    #{"product_id":"count"}).reset_index().merge(df_customers,␣
↪on="client_id", how="left")
```

[1656]:
```
frequence_achat = pd.DataFrame({'client_id': identifiant_client,
                                'nbre_session_mars_2021': 0.0,
                                'nbre_session_avril_2021': 0.0,
                                'nbre_session_mai_2021': 0.0,
                                'nbre_session_juin_2021': 0.0,
                                'nbre_session_juillet_2021': 0.0,
                                'nbre_session_aout_2021': 0.0,
                                'nbre_session_septembre_2021': 0.0,
                                'nbre_session_octobre_2021': 0.0,
                                'nbre_session_novembre_2021': 0.0,
                                'nbre_session_decembre_2021': 0.0,
                                'nbre_session_janvier_2022': 0.0,
                                'nbre_session_fevrier_2022': 0.0,
                                'nbre_session_mars_2022': 0.0,
                                'nbre_session_avril_2022': 0.0,
                                'nbre_session_mai_2022': 0.0,
                                'nbre_session_juin_2022': 0.0,
                                'nbre_session_juillet_2022': 0.0,
                                'nbre_session_aout_2022': 0.0,
                                'nbre_session_septembre_2022': 0.0,
                                'nbre_session_octobre_2022': 0.0,
                                'nbre_session_novembre_2022': 0.0,
                                'nbre_session_decembre_2022': 0.0,
                                'nbre_session_janvier_2023': 0.0,
                                'nbre_session_fevrier_2023': 0.0})
```

[1657]:
```
for j in range(len(list_month)):
                datee = datetime.strptime(list_month[j], "%Y-%m-%d")
                month = datee.month
                year = datee.year
                first, last = calendar.monthrange(year, month)
                if month < 10:
                    df_month = df_final.loc[(df_final['date_transaction'] >=␣
 ↪datetime.strptime((str(year)+'-0'+str(month)+'-0'+str(first+1))[:
 ↪10],'%Y-%m-%d'))
                     & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-0'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]
                else:
                    df_month = df_final.loc[(df_final['date_transaction'] >=␣
 ↪datetime.strptime((str(year)+'-'+str(month)+'-0'+str(first+1))[:
 ↪10],'%Y-%m-%d'))
                     & (df_final['date_transaction'] <= datetime.
 ↪strptime((str(year)+'-'+str(month)+'-'+str(last))[:10],'%Y-%m-%d'))]

                for i in range(len(frequence_achat)):
```

```
                    frequence_achat.iloc[i,j+1] = len(df_month.
↪loc[df_month["client_id"] == frequence_achat.iloc[i,0]]["session_id"].
↪unique())
```

[1658]:
```
frequence_achat = pd.merge(frequence_achat, df_customers, on="client_id",␣
↪how="left")
```

[1659]:
```
frequence_achat.head()
```

[1659]:

	client_id	nbre_session_mars_2021	nbre_session_avril_2021	\
0	c_329	4.0	1.0	
1	c_664	5.0	4.0	
2	c_580	8.0	5.0	
3	c_7912	9.0	8.0	
4	c_2033	5.0	3.0	

	nbre_session_mai_2021	nbre_session_juin_2021	nbre_session_juillet_2021	\
0	0.0	1.0	2.0	
1	1.0	4.0	3.0	
2	6.0	4.0	5.0	
3	5.0	4.0	4.0	
4	2.0	3.0	1.0	

	nbre_session_aout_2021	nbre_session_septembre_2021	\
0	0.0	1.0	
1	2.0	2.0	
2	3.0	6.0	
3	4.0	1.0	
4	1.0	5.0	

	nbre_session_octobre_2021	nbre_session_novembre_2021	…	\
0	1.0	2.0	…	
1	2.0	4.0	…	
2	4.0	5.0	…	
3	2.0	6.0	…	
4	1.0	3.0	…	

	nbre_session_juillet_2022	nbre_session_aout_2022	\
0	3.0	0.0	
1	5.0	5.0	
2	5.0	5.0	
3	2.0	5.0	
4	1.0	5.0	

	nbre_session_septembre_2022	nbre_session_octobre_2022	\
0	1.0	2.0	
1	5.0	3.0	

```
2                          6.0                          3.0
3                          3.0                          2.0
4                          2.0                          2.0

   nbre_session_novembre_2022  nbre_session_decembre_2022  \
0                         1.0                         2.0
1                         3.0                         6.0
2                        10.0                         3.0
3                         4.0                         5.0
4                         0.0                         3.0

   nbre_session_janvier_2023  nbre_session_fevrier_2023  gender  year_of_birth
0                        1.0                        1.0       f           1967
1                        5.0                        4.0       m           1960
2                        8.0                        6.0       m           1988
3                        3.0                        3.0       f           1989
4                        1.0                        6.0       f           1956

[5 rows x 27 columns]
```

[1666]:
```
frequence_achat["freq_moy"] = 0
```

[1736]:
```
for i in range(len(frequence_achat)):
    frequence_achat.iloc[i,27]= round(frequence_achat.iloc[i,1:25].mean())
```

[1737]:
```
frequence_achat.head()
```

[1737]:
```
  client_id  nbre_session_mars_2021  nbre_session_avril_2021  \
0     c_329                     4.0                      1.0
1     c_664                     5.0                      4.0
2     c_580                     8.0                      5.0
3    c_7912                     9.0                      8.0
4    c_2033                     5.0                      3.0

   nbre_session_mai_2021  nbre_session_juin_2021  nbre_session_juillet_2021  \
0                    0.0                     1.0                        2.0
1                    1.0                     4.0                        3.0
2                    6.0                     4.0                        5.0
3                    5.0                     4.0                        4.0
4                    2.0                     3.0                        1.0

   nbre_session_aout_2021  nbre_session_septembre_2021  \
0                     0.0                          1.0
1                     2.0                          2.0
2                     3.0                          6.0
3                     4.0                          1.0
4                     1.0                          5.0
```

```
   nbre_session_octobre_2021  nbre_session_novembre_2021  …  \
0                        1.0                         2.0  …
1                        2.0                         4.0  …
2                        4.0                         5.0  …
3                        2.0                         6.0  …
4                        1.0                         3.0  …

   nbre_session_septembre_2022  nbre_session_octobre_2022  \
0                          1.0                        2.0
1                          5.0                        3.0
2                          6.0                        3.0
3                          3.0                        2.0
4                          2.0                        2.0

   nbre_session_novembre_2022  nbre_session_decembre_2022  \
0                         1.0                         2.0
1                         3.0                         6.0
2                        10.0                         3.0
3                         4.0                         5.0
4                         0.0                         3.0

   nbre_session_janvier_2023  nbre_session_fevrier_2023  gender  \
0                        1.0                        1.0       f
1                        5.0                        4.0       m
2                        8.0                        6.0       m
3                        3.0                        3.0       f
4                        1.0                        6.0       f

   year_of_birth  freq_moy  age
0           1967         1   56
1           1960         4   63
2           1988         5   35
3           1989         4   34
4           1956         2   67

[5 rows x 29 columns]
```

[1738]:
```
frequence_achat.nlargest(20, "nbre_session_mars_2021").head()
```

[1738]:
```
     client_id  nbre_session_mars_2021  nbre_session_avril_2021  \
6       c_1609                   436.0                    407.0
32      c_3454                   218.0                    209.0
107     c_4958                   158.0                    139.0
135     c_6714                   104.0                     95.0
5       c_4908                    11.0                      4.0
```

```
     nbre_session_mai_2021  nbre_session_juin_2021  nbre_session_juillet_2021  \
6                    420.0                   404.0                      361.0
32                   206.0                   198.0                      182.0
107                  137.0                   164.0                      165.0
135                  107.0                   107.0                       81.0
5                      3.0                     4.0                        1.0

     nbre_session_aout_2021  nbre_session_septembre_2021  \
6                     335.0                        487.0
32                    164.0                        223.0
107                   149.0                        115.0
135                    65.0                        115.0
5                       5.0                          5.0

     nbre_session_octobre_2021  nbre_session_novembre_2021  …  \
6                        388.0                       487.0  …
32                       107.0                       231.0  …
107                       75.0                       165.0  …
135                       97.0                       110.0  …
5                          2.0                         3.0  …

     nbre_session_septembre_2022  nbre_session_octobre_2022  \
6                          424.0                      391.0
32                         201.0                      197.0
107                        135.0                      150.0
135                         80.0                       94.0
5                            8.0                        3.0

     nbre_session_novembre_2022  nbre_session_decembre_2022  \
6                         433.0                       444.0
32                        203.0                       217.0
107                       163.0                       168.0
135                       102.0                       124.0
5                           4.0                         4.0

     nbre_session_janvier_2023  nbre_session_fevrier_2023  gender  \
6                        368.0                      399.0       m
32                       197.0                      201.0       m
107                      118.0                      132.0       m
135                       94.0                       93.0       f
5                          4.0                        5.0       f

     year_of_birth  freq_moy  age
6             1980       418   43
32            1969       210   54
107           1999       146   24
135           1968        98   55
```

```
5             1981         5   42

[5 rows x 29 columns]
```

[1670]:
```
frequence_achat["age"] = 2023 - frequence_achat["year_of_birth"]
```

[1671]:
```
frequence_achat.head()
```

[1671]:
```
  client_id  nbre_session_mars_2021  nbre_session_avril_2021  \
0     c_329                     4.0                      1.0
1     c_664                     5.0                      4.0
2     c_580                     8.0                      5.0
3    c_7912                     9.0                      8.0
4    c_2033                     5.0                      3.0

   nbre_session_mai_2021  nbre_session_juin_2021  nbre_session_juillet_2021  \
0                    0.0                     1.0                        2.0
1                    1.0                     4.0                        3.0
2                    6.0                     4.0                        5.0
3                    5.0                     4.0                        4.0
4                    2.0                     3.0                        1.0

   nbre_session_aout_2021  nbre_session_septembre_2021  \
0                     0.0                          1.0
1                     2.0                          2.0
2                     3.0                          6.0
3                     4.0                          1.0
4                     1.0                          5.0

   nbre_session_octobre_2021  nbre_session_novembre_2021  …  \
0                        1.0                         2.0  …
1                        2.0                         4.0  …
2                        4.0                         5.0  …
3                        2.0                         6.0  …
4                        1.0                         3.0  …

   nbre_session_septembre_2022  nbre_session_octobre_2022  \
0                          1.0                        2.0
1                          5.0                        3.0
2                          6.0                        3.0
3                          3.0                        2.0
4                          2.0                        2.0

   nbre_session_novembre_2022  nbre_session_decembre_2022  \
0                         1.0                         2.0
1                         3.0                         6.0
2                        10.0                         3.0
```

```
3                          4.0                          5.0
4                          0.0                          3.0

   nbre_session_janvier_2023  nbre_session_fevrier_2023  gender  \
0                        1.0                        1.0       f
1                        5.0                        4.0       m
2                        8.0                        6.0       m
3                        3.0                        3.0       f
4                        1.0                        6.0       f

   year_of_birth  freq_moy  age
0           1967         1   56
1           1960         4   63
2           1988         5   35
3           1989         4   34
4           1956         2   67

[5 rows x 29 columns]
```

[1287]:
```
distrib_age.head()
```

[1287]:
```
   year_of_birth  client_count  age
0           1929             3   94
1           1930             4   93
2           1931             4   92
3           1932             6   91
4           1933             8   90
```

[1288]:
```
distrib_age["frequence_moyenne"] = 0
```

[1302]:
```
for i in range (len(distrib_age)):
    x = 0
    for j in range (1,25):
        df = frequence_achat.iloc[:,[0,j,26]].
 ↪loc[frequence_achat["year_of_birth"] == distrib_age.iloc[i,0]]
        x = x +(round(df.iloc[:,1].mean()))
    distrib_age.iloc[i,3] = x
```

[1675]:
```
stats.spearmanr(frequence_achat["age"], frequence_achat["freq_moy"])
```

[1675]:
```
SignificanceResult(statistic=0.2063334374492564, pvalue=2.4623995443053336e-83)
```

[ ]:
```
colors= ['green'] * 8600
go.Figure(data=go.Scatter(
    x=frequence_achat["age"],
    y=frequence_achat["freq_moy"],
    mode = 'markers',
```

```
    marker_color=colors),
          layout_title_text="fréquence d'achats en fonction des âges sur toute␣
↪la période").update_yaxes(title_text="fréquence d'achats")
```

[1764]:
```
frequence_achat.nlargest(4, "freq_moy")
```

[1764]:

	client_id	nbre_session_mars_2021	nbre_session_avril_2021	\
6	c_1609	436.0	407.0	
32	c_3454	218.0	209.0	
107	c_4958	158.0	139.0	
135	c_6714	104.0	95.0	

	nbre_session_mai_2021	nbre_session_juin_2021	nbre_session_juillet_2021	\
6	420.0	404.0	361.0	
32	206.0	198.0	182.0	
107	137.0	164.0	165.0	
135	107.0	107.0	81.0	

	nbre_session_aout_2021	nbre_session_septembre_2021	\
6	335.0	487.0	
32	164.0	223.0	
107	149.0	115.0	
135	65.0	115.0	

	nbre_session_octobre_2021	nbre_session_novembre_2021	…	\
6	388.0	487.0	…	
32	107.0	231.0	…	
107	75.0	165.0	…	
135	97.0	110.0	…	

	nbre_session_septembre_2022	nbre_session_octobre_2022	\
6	424.0	391.0	
32	201.0	197.0	
107	135.0	150.0	
135	80.0	94.0	

	nbre_session_novembre_2022	nbre_session_decembre_2022	\
6	433.0	444.0	
32	203.0	217.0	
107	163.0	168.0	
135	102.0	124.0	

	nbre_session_janvier_2023	nbre_session_fevrier_2023	gender	\
6	368.0	399.0	m	
32	197.0	201.0	m	
107	118.0	132.0	m	
135	94.0	93.0	f	

```
     year_of_birth  freq_moy  age
6             1980       418   43
32            1969       210   54
107           1999       146   24
135           1968        98   55

[4 rows x 29 columns]
```

[1768]:
```
df = df.drop(df[df.client_id == 'c_6714'].index)
#enlever le B to B
```

[ ]:
```
colors= ['green'] * 8600
go.Figure(data=go.Scatter(
    x=df["age"],
    y=df["freq_moy"],
    mode = 'markers',
    marker_color=colors),
          layout_title_text="fréquence d'achats en fonction des âges sur toute la période").update_yaxes(title_text="fréquence d'achats")
```

[1703]:
```
#data = pd.merge(df_transactions.groupby("client_id").agg({"product_id": "count"}).reset_index(), df_customers, on='client_id', how='left')
```

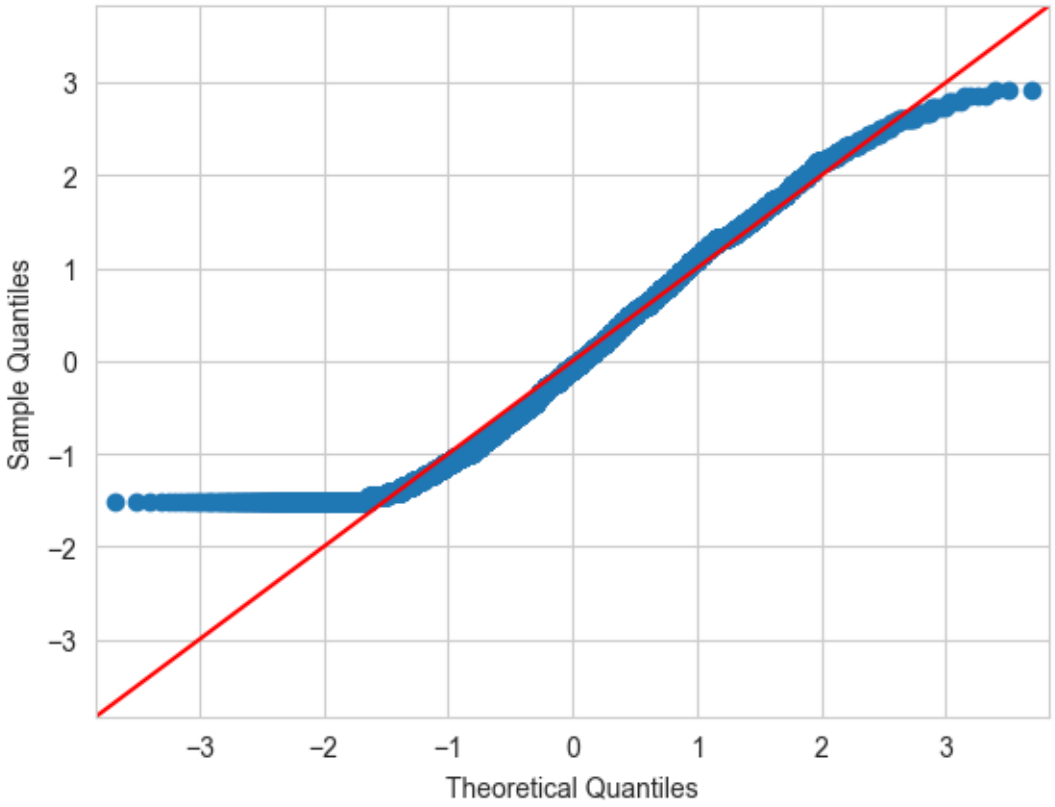
[1703]:
```
     client_id  product_id gender  year_of_birth
0          c_1          43      m           1955
1         c_10          58      m           1956
2        c_100           8      m           1992
3       c_1000         126      f           1966
4       c_1001         103      m           1982
…          …          …     …              …
8595     c_995          14      m           1955
8596     c_996          96      f           1970
8597     c_997          59      f           1994
8598     c_998          55      m           2001
8599     c_999          46      m           1964

[8600 rows x 4 columns]
```

[ ]:
```
#Perform simple exponential smoothing
#model = sm.tsa.SimpleExpSmoothing(CA_total['CA_total_mois'])
#ses_model = model.fit(smoothing_level=0.3)
#CA_total['Forecast'] = ses_model.fittedvalues
# Plotting
#plt.pyplot.figure(figsize=(10, 6))
#plt.pyplot.plot(CA_total['CA_total_mois'], label='Actual Sales', marker='o', markersize=4)
```

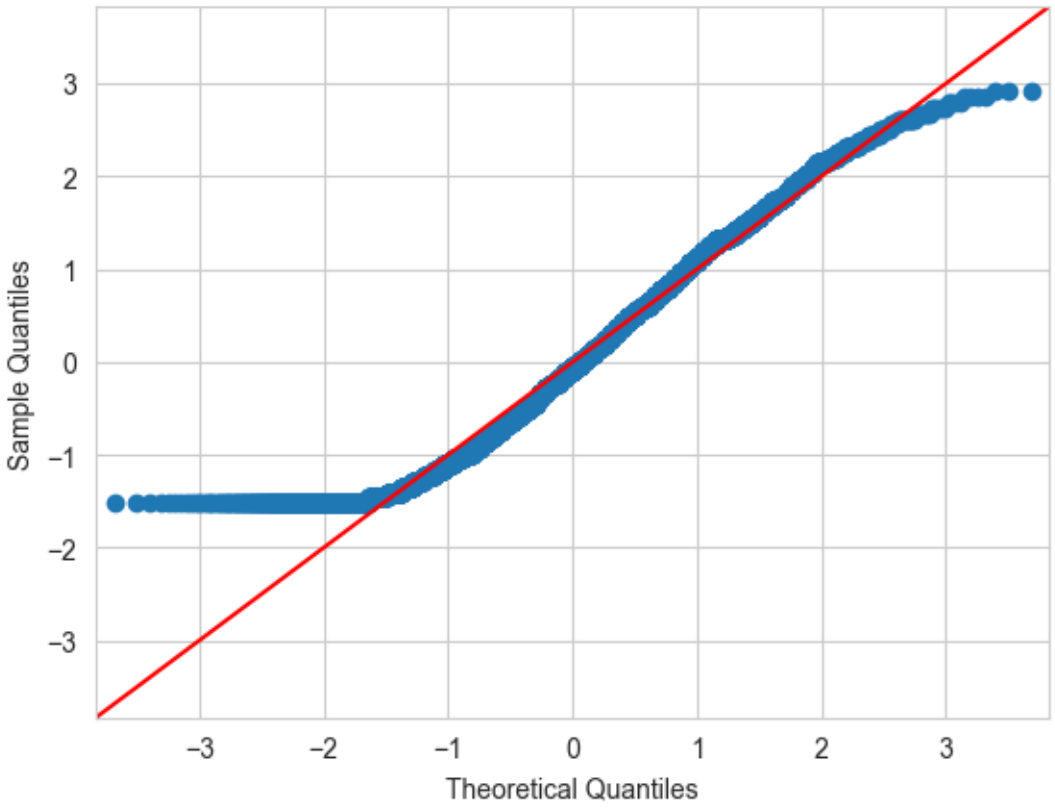
```
#plt.pyplot.plot(CA_total['Forecast'], label='Forecast')
#plt.pyplot.xlabel('Month')
#plt.pyplot.ylabel('Sales')
#plt.title('Simple Exponential Smoothing Forecast')
#plt.pyplot.legend()
```

[1781]:
```
sm.qqplot(2023 - df_customers["year_of_birth"], line='45', fit=True)
```

[1781]:




```
<Figure size 500x500 with 0 Axes>
```



[2040]:
```
#correlation entre age du client et categorie du livre : test de kruskal wallis


new_df = pd.merge(pd.merge(df_transactions, df_customers, on="client_id",␣
↪how="left"), df_products, on="product_id", how="left")
```

[2041]:
```
new_df = new_df.drop(columns=["date_heure_transaction", "session_id",␣
↪"transaction_id", "price"])
```

[2043]:
```
new_df["age"] = 2023 - new_df["year_of_birth"]
```

[2045]:
```
new_df.loc[new_df["categ"] == 0]
```

[2045]:

	product_id	client_id	date_transaction	gender	year_of_birth	categ	age
0	0_1259	c_329	2021-03-01	f	1967	0	56
1	0_1390	c_664	2021-03-01	m	1960	0	63
2	0_1352	c_580	2021-03-01	m	1988	0	35
3	0_1458	c_7912	2021-03-01	f	1989	0	34
4	0_1358	c_2033	2021-03-01	f	1956	0	67
…	…	…	…	…	…	…	…
687523	0_1435	c_7481	2023-02-28	m	1986	0	37

```
687524     0_1039    c_7144      2023-02-28     f          1984      0   39
687527      0_998    c_4476      2023-02-28     f          1977      0   46
687532     0_1547    c_4848      2023-02-28     m          1953      0   70
687533     0_1398    c_3575      2023-02-28     f          1981      0   42

[415459 rows x 7 columns]
```

[2054]:
```
categ_0 = new_df.loc[new_df["categ"] == 0].drop_duplicates(subset='client_id',␣
↪keep='first').loc[:,"age"]
```

[2053]:
```
categ_1 = new_df.loc[new_df["categ"] == 1].drop_duplicates(subset='client_id',␣
↪keep='first').loc[:,"age"]
```

[2055]:
```
categ_2 = new_df.loc[new_df["categ"] == 2].drop_duplicates(subset='client_id',␣
↪keep='first').loc[:,"age"]
```

[2056]:
```
stats.kruskal(categ_0, categ_1, categ_2)
```

[2056]:
```
KruskalResult(statistic=1250.0719347083564, pvalue=3.550817789517929e-272)
```

[ ]:
```

```