- Preprocess
    - L - Rework loyalty_score calculation
    - Check total original rows vs rows after RFM to ensure the Customer IDs are reflected once to cover their entire lifetime as customers
    - AQC - Average Quantity calculation
    - Create separate df with customer ids and the RFM segment labels
    - CLV - customer lifetime value
- Clustering (without RFM labels)
    - Columns to cluster: `R`, `F`, `M`, `L`, `CLV`
    - Include loyalty_score and average quantity
    - For KMeans add - Silhouette scores, Calinski, Davis Bouldin
    - Agglomerative Clustering
    - Create `RFM_Profile` containing: `mode_weekday`, `mode_origin`, `mode_payment_method`, `mode_time_of_day`
- Presentation - Business case focussed
    - Case introduction
    - Workflow:
        - RFM Analysis
        - KMeans
        - Agglomerative
    - Description of the segments
    - Recommendations of campaigns for each segment
    - Further work:
        - Prediction of customer activity to be proactive with Churn and reactivation schemes

In [ ]:
```
# Import libraries
import pandas as pd
import numpy as np
import os
import csv
import warnings
from datetime import datetime
warnings.filterwarnings("ignore")
import matplotlib.pyplot as plt
import seaborn as sns
```

In [ ]:
```
# Creation of dataframes of the different csv files
dataframes = []
for dirname, _, filenames in os.walk('./datasets/1_SEGMENTATION'):
    for filename in filenames:
        file = filename.replace('.csv', '_df')
        filepath = os.path.join(dirname, filename)
```

```
        # Sniff the delimiter using csv.Sniffer
        with open(filepath, 'r', newline='') as csvfile:
            sniffer = csv.Sniffer()
            dialect = sniffer.sniff(csvfile.read(4096))  # Read a sample to sniff
            separator = dialect.delimiter
        # Read the CSV file with the detected separator
        df = pd.read_csv(filepath, sep=separator, encoding="UTF-8")
        globals()[file] = df.copy()
        dataframes.append(df)
        print(file,'-','\n','Rows:',df.shape[0],'\n','Columns:',df.shape[1])
print('Data imported')
```

```
RETAIL.txt -
 Rows: 20
 Columns: 1
RETAIL_PRODUCT_df -
 Rows: 2800
 Columns: 3
RETAIL_REGISTRY_df -
 Rows: 25727
 Columns: 4
RETAIL_SALES_df -
 Rows: 489967
 Columns: 6
RETAIL_SALES_DETAIL_df -
 Rows: 2047073
 Columns: 6
RFM_Final_df -
 Rows: 25727
 Columns: 6
RFM_Label_df -
 Rows: 25727
 Columns: 13
RFM_retention_df -
 Rows: 20
 Columns: 21
Data imported
```

In [ ]:
```
# Assigning the dataframes to the corresponding variables
rp_df = RETAIL_PRODUCT_df
rr_df = RETAIL_REGISTRY_df
rs_df = RETAIL_SALES_df
rsd_df = RETAIL_SALES_DETAIL_df
```

In [ ]:
```
# Merge the dataframes to create a unique dataframe
df = rsd_df.merge(rs_df, how = 'inner', on = ['CUSTOMER_ID', 'DATE'] )
# Merge the retail sales and retail sales detail to retail product
df = df.merge(rp_df, how = 'inner', on = ['PRODUCT_ID'], )
# Merge df to retail registry
df = df.merge(rr_df, how = 'inner', on = ['CUSTOMER_ID'])
# Fill the missing values with 0 in the special column
df['SPECIAL'] = df['SPECIAL'].fillna(0)
# Replace the values of the column special with 1 if the value is different from 0
df['SPECIAL'].replace({'Y': 1}, inplace = True)
```

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

Out[ ]:

	CUSTOMER_ID	DATE	PRODUCT_ID	QUANTITY	LIST_PRICE	SPECIAL	OUTLET_ID	PAYM
0	BF00404312	2020-01-17	1068	1.0	6.85	0	14	
1	BF00404312	2018-11-09	1068	1.0	6.65	0	14	
2	BF00404312	2020-01-17	94580	1.0	6.25	0	14	
3	BF00404312	2019-08-16	94580	1.0	6.25	0	14	
4	BF00404312	2019-11-10	94580	1.0	6.25	0	14	

In [ ]:
```
# Descibe the dataframe
df.describe()
```

Out[ ]:

	PRODUCT_ID	QUANTITY	LIST_PRICE	SPECIAL	OUTLET_ID	TOTAL_PO
count	2.047962e+06	2.047962e+06	2.026404e+06	2.047962e+06	2.047962e+06	1.994093
mean	7.404719e+04	1.136169e+00	8.106861e+00	1.851109e-03	4.941574e+01	8.663137
std	7.769339e+04	1.714687e+00	5.661384e+00	4.298468e-02	3.592643e+01	1.644398
min	3.600000e+01	-4.800000e+01	-3.048000e+02	0.000000e+00	0.000000e+00	-1.469150
25%	2.942000e+03	1.000000e+00	4.950000e+00	0.000000e+00	1.700000e+01	1.650000
50%	4.417800e+04	1.000000e+00	6.950000e+00	0.000000e+00	3.800000e+01	2.850000
75%	1.387970e+05	1.000000e+00	9.950000e+00	0.000000e+00	8.100000e+01	4.400000
max	2.537530e+05	1.000000e+03	3.704500e+02	1.000000e+00	1.410000e+02	9.180000

In [ ]:
```
# Descriptive statistics of the dataframe
df.describe(include = 'object')
```

Out[ ]:

	CUSTOMER_ID	DATE	PAYMENT_METHOD	TIME	CATEGORY_DESC	CREATION
count	2047962	2047962	2047962	2047962	2047962	2
unique	25727	498	5	45232	13	
top	LT01053024	2019-11-13	CASH	11:34:47	READY-MADE	200
freq	938	6861	1312025	172	559353	

In [ ]:
```
# Find the isnan values in the dataframe
df.isna().sum()
```

Out[ ]:
```
CUSTOMER_ID           0
DATE                  0
PRODUCT_ID            0
QUANTITY              0
LIST_PRICE        21558
SPECIAL               0
OUTLET_ID             0
PAYMENT_METHOD        0
TIME                  0
TOTAL_POINTS      53869
CATEGORY_ID           0
CATEGORY_DESC         0
CREATION_DATE      1246
REGIONAL_CODE         0
ORIGIN                0
dtype: int64
```

In [ ]:
```
# Fill the TOTAL_POINTS and LIST_PRICE column na values with 0
df['TOTAL_POINTS'] = df['TOTAL_POINTS'].fillna(0)
df['LIST_PRICE'] = df['LIST_PRICE'].fillna(0)
# Convert date to datetime
df['DATE'] = pd.to_datetime(df['DATE'])
# Fill the NaN values in CREATION_DATE with the earliest date in the DATE column ba
df['CREATION_DATE'] = df['CREATION_DATE'].fillna(df.groupby('CUSTOMER_ID')['DATE'].
# Convert CREATION_DATE to datetime
df['CREATION_DATE'] = pd.to_datetime(df['CREATION_DATE'])
# Rename 'CHECK' to 'CHEQUE' in PAYMENT_METHOD column
df['PAYMENT_METHOD'].replace({'CHECK': 'CHEQUE'}, inplace = True)
```

In [ ]:
```
df.isna().sum()
```

Out[ ]:
```
CUSTOMER_ID       0
DATE              0
PRODUCT_ID        0
QUANTITY          0
LIST_PRICE        0
SPECIAL           0
OUTLET_ID         0
PAYMENT_METHOD    0
TIME              0
TOTAL_POINTS      0
CATEGORY_ID       0
CATEGORY_DESC     0
CREATION_DATE     0
REGIONAL_CODE     0
ORIGIN            0
dtype: int64
```

In [ ]:
```
# Check the datatypes of the columns
df.dtypes
```

Out[ ]:
```
CUSTOMER_ID              object
DATE             datetime64[ns]
PRODUCT_ID                int64
QUANTITY                float64
LIST_PRICE              float64
SPECIAL                   int64
OUTLET_ID                 int64
PAYMENT_METHOD           object
TIME                     object
TOTAL_POINTS            float64
CATEGORY_ID               int64
CATEGORY_DESC            object
CREATION_DATE    datetime64[ns]
REGIONAL_CODE             int64
ORIGIN                   object
dtype: object
```

In [ ]:
```
# Determination of a customer's longevity based on the difference between the date
df['LONGEVITY'] = (df['DATE'] - df['CREATION_DATE']).dt.days

# If the customer doesn't have a CREATION_DATE, the LONGEVITY is earliest date per
df['LONGEVITY'] = df['LONGEVITY'].fillna(df.groupby('CUSTOMER_ID')['LONGEVITY'].tra
```

In [ ]:
```
# Extract the hour from the LONGEVITY column and convert it to int
def extract_hour(time_str):
    return int(time_str.split(':')[0])

df['TRANSACTION_HOUR'] = df['TIME'].apply(extract_hour)

# Add a column that shows the hour of the transaction as a period in the day (morni
def time_of_day(hour):
    if hour >= 6 and hour < 12:
        return 'morning'
    elif hour >= 12 and hour < 18:
        return 'afternoon'
```

```
    elif hour >= 18 and hour < 24:
        return 'evening'
    else:
        return 'night'

df['TIME_OF_DAY'] = df['TRANSACTION_HOUR'].apply(time_of_day)

df['MONTH'] = df['DATE'].dt.month
df['YEAR'] = df['DATE'].dt.year
df['DAY'] = df['DATE'].dt.day
df['MONTH_NAME'] = df['DATE'].dt.strftime('%B')
df['DAY_OF_WEEK'] = df['DATE'].dt.strftime('%A')

# Create `mode_weekday`, `mode_origin`, `mode_payment_method`, `mode_time_of_day` c
df['mode_weekday'] = df.groupby('CUSTOMER_ID')['DAY_OF_WEEK'].transform(lambda x: x
df['mode_origin'] = df.groupby('CUSTOMER_ID')['ORIGIN'].transform(lambda x: x.mode(
df['mode_payment_method'] = df.groupby('CUSTOMER_ID')['PAYMENT_METHOD'].transform(l
df['mode_time_of_day'] = df.groupby('CUSTOMER_ID')['TIME_OF_DAY'].transform(lambda

df.head()
```

Out[ ]:

	CUSTOMER_ID	DATE	PRODUCT_ID	QUANTITY	LIST_PRICE	SPECIAL	OUTLET_ID	PAYM
0	BF00404312	2020-01-17	1068	1.0	6.85	0	14	
1	BF00404312	2018-11-09	1068	1.0	6.65	0	14	
2	BF00404312	2020-01-17	94580	1.0	6.25	0	14	
3	BF00404312	2019-08-16	94580	1.0	6.25	0	14	
4	BF00404312	2019-11-10	94580	1.0	6.25	0	14	

5 rows × 27 columns

In [ ]:
```
# Calculation of the difference in time of the creation date and the date columns
def get_date_int(df, column):
    year = df[column].dt.year
    month = df[column].dt.month
    day = df[column].dt.day
    return year, month, day

def get_month(x): return datetime(x.year, x.month, 1)
```

In [ ]:
```
# Creation of Invoice_Month and Cohort_Month columns
df['INVOICE_MONTH'] = df['DATE']

df['INVOICE_MONTH'] = df['INVOICE_MONTH'].apply(get_month)
grouping = df.groupby('CUSTOMER_ID')['INVOICE_MONTH']
```

```
df['COHORT_MONTH'] = grouping.transform('min').apply(get_month)

df.head()
```

Out[ ]:

	CUSTOMER_ID	DATE	PRODUCT_ID	QUANTITY	LIST_PRICE	SPECIAL	OUTLET_ID	PAYM
0	BF00404312	2020-01-17	1068	1.0	6.85	0	14	
1	BF00404312	2018-11-09	1068	1.0	6.65	0	14	
2	BF00404312	2020-01-17	94580	1.0	6.25	0	14	
3	BF00404312	2019-08-16	94580	1.0	6.25	0	14	
4	BF00404312	2019-11-10	94580	1.0	6.25	0	14	

5 rows × 29 columns

In [ ]:
```
df.columns
```

Out[ ]:
```
Index(['CUSTOMER_ID', 'DATE', 'PRODUCT_ID', 'QUANTITY', 'LIST_PRICE',
       'SPECIAL', 'OUTLET_ID', 'PAYMENT_METHOD', 'TIME', 'TOTAL_POINTS',
       'CATEGORY_ID', 'CATEGORY_DESC', 'CREATION_DATE', 'REGIONAL_CODE',
       'ORIGIN', 'LONGEVITY', 'TRANSACTION_HOUR', 'TIME_OF_DAY', 'MONTH',
       'YEAR', 'DAY', 'MONTH_NAME', 'DAY_OF_WEEK', 'mode_weekday',
       'mode_origin', 'mode_payment_method', 'mode_time_of_day',
       'INVOICE_MONTH', 'COHORT_MONTH'],
      dtype='object')
```

In [ ]:
```
# Aggregate the data by the CUSTOMER_ID with the following conditions as a new data
# Drop the columns: PRODUCT_ID, OUTLET_ID, PAYMENT_METHOD, TIME, CATEGORY_ID, CATEG
# Sum the row values of the columns: QUANTITY, TOTAL_POINTS, LIST_PRICE, SPECIAL
# Get the first value of the columns: DATE, INVOICE_MONTH
# Get the last value of the columns: COHORT_MONTH, CREATION_DATE
# Select the max value of the columns: LONGEVITY

df_agg = df.groupby('CUSTOMER_ID').agg({
    'DATE': 'first',
    'INVOICE_MONTH': 'first',
    'COHORT_MONTH': 'last',
    'CREATION_DATE': 'last',
    'LONGEVITY': 'max',
    'QUANTITY': 'sum',
    'TOTAL_POINTS': 'sum',
    'LIST_PRICE': 'sum',
    'SPECIAL': 'sum',
    'mode_weekday': 'first',
    'mode_origin': 'first',
    'mode_payment_method': 'first',
    'mode_time_of_day': 'first'
```

```
}).reset_index()

df_agg.head()
```

Out[ ]:

	CUSTOMER_ID	DATE	INVOICE_MONTH	COHORT_MONTH	CREATION_DATE	LONGEVITY
0	AA00312188	2018-09-27	2018-09-01	2018-07-01	2005-11-05	517
1	AA00312390	2019-05-04	2019-05-01	2018-07-01	2009-01-17	402
2	AA00325975	2019-05-04	2019-05-01	2018-06-01	2005-01-04	549
3	AA00336843	2019-02-07	2019-02-01	2018-08-01	2014-03-12	213
4	AA00339761	2019-02-15	2019-02-01	2018-07-01	2004-02-13	580

In [ ]:
```
print(df.shape)
print(df_agg.shape)
```

```
(2047962, 29)
(25727, 14)
```

In [ ]:
```
invoice_year, invoice_month, _ = get_date_int(df_agg, 'INVOICE_MONTH')
cohort_year, cohort_month, _ = get_date_int(df_agg, 'COHORT_MONTH')

years_diff = invoice_year - cohort_year
months_diff = invoice_month - cohort_month

df_agg['COHORT_INDEX'] = (years_diff * 12) + months_diff + 1

df_agg.head()
```

Out[ ]:

	CUSTOMER_ID	DATE	INVOICE_MONTH	COHORT_MONTH	CREATION_DATE	LONGEVITY
0	AA00312188	2018-09-27	2018-09-01	2018-07-01	2005-11-05	517
1	AA00312390	2019-05-04	2019-05-01	2018-07-01	2009-01-17	402
2	AA00325975	2019-05-04	2019-05-01	2018-06-01	2005-01-04	549
3	AA00336843	2019-02-07	2019-02-01	2018-08-01	2014-03-12	213
4	AA00339761	2019-02-15	2019-02-01	2018-07-01	2004-02-13	580

In [ ]:

```
# Customer Retention Grouping
retention_grouping = df_agg.groupby(['COHORT_MONTH', 'COHORT_INDEX'])
cohort_data = retention_grouping['CUSTOMER_ID'].apply(pd.Series.nunique)
cohort_data = cohort_data.reset_index()
cohort_counts = cohort_data.pivot(index='COHORT_MONTH', columns='COHORT_INDEX', val

print(cohort_counts)
```

COHORT_INDEX	1	2	3	4	5	6	7	8	9
COHORT_MONTH									
2018-06-01	34.0	18.0	55.0	36.0	35.0	32.0	36.0	41.0	43.0
2018-07-01	563.0	682.0	458.0	436.0	313.0	350.0	402.0	293.0	281.0
2018-08-01	701.0	348.0	288.0	216.0	258.0	269.0	214.0	192.0	157.0
2018-09-01	208.0	83.0	54.0	58.0	54.0	43.0	39.0	38.0	89.0
2018-10-01	79.0	31.0	30.0	28.0	15.0	20.0	17.0	47.0	14.0
2018-11-01	53.0	22.0	13.0	17.0	11.0	10.0	18.0	17.0	8.0
2018-12-01	41.0	28.0	10.0	11.0	9.0	21.0	15.0	10.0	22.0
2019-01-01	63.0	33.0	22.0	12.0	37.0	20.0	13.0	24.0	24.0
2019-02-01	106.0	50.0	44.0	59.0	34.0	30.0	38.0	27.0	29.0
2019-03-01	99.0	54.0	108.0	50.0	22.0	52.0	37.0	32.0	32.0
2019-04-01	124.0	110.0	74.0	31.0	77.0	49.0	47.0	39.0	27.0
2019-05-01	163.0	100.0	44.0	79.0	57.0	46.0	26.0	19.0	36.0
2019-06-01	168.0	56.0	68.0	41.0	35.0	24.0	29.0	31.0	NaN
2019-07-01	55.0	24.0	20.0	16.0	10.0	7.0	17.0	NaN	NaN
2019-08-01	235.0	118.0	83.0	55.0	42.0	61.0	NaN	NaN	NaN
2019-09-01	200.0	161.0	79.0	66.0	69.0	NaN	NaN	NaN	NaN
2019-10-01	260.0	129.0	116.0	105.0	NaN	NaN	NaN	NaN	NaN
2019-11-01	151.0	63.0	69.0	NaN	NaN	NaN	NaN	NaN	NaN
2019-12-01	110.0	127.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2020-01-01	100.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

COHORT_INDEX	10	11	12	13	14	15	16	17	18
COHORT_MONTH									
2018-06-01	22.0	17.0	86.0	85.0	39.0	78.0	59.0	41.0	55.0
2018-07-01	267.0	1044.0	691.0	477.0	939.0	638.0	603.0	535.0	547.0
2018-08-01	585.0	341.0	170.0	654.0	426.0	387.0	322.0	355.0	582.0
2018-09-01	66.0	41.0	92.0	84.0	65.0	64.0	55.0	95.0	NaN
2018-10-01	16.0	34.0	23.0	26.0	21.0	19.0	32.0	NaN	NaN
2018-11-01	24.0	12.0	18.0	6.0	4.0	9.0	NaN	NaN	NaN
2018-12-01	19.0	13.0	12.0	16.0	22.0	NaN	NaN	NaN	NaN
2019-01-01	22.0	20.0	23.0	21.0	NaN	NaN	NaN	NaN	NaN
2019-02-01	25.0	28.0	43.0	NaN	NaN	NaN	NaN	NaN	NaN
2019-03-01	35.0	47.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2019-04-01	46.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2019-05-01	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2019-06-01	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2019-07-01	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2019-08-01	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2019-09-01	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2019-10-01	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2019-11-01	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2019-12-01	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2020-01-01	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

COHORT_INDEX	19	20
COHORT_MONTH		
2018-06-01	51.0	94.0
2018-07-01	1006.0	NaN
2018-08-01	NaN	NaN
2018-09-01	NaN	NaN
2018-10-01	NaN	NaN
2018-11-01	NaN	NaN
2018-12-01	NaN	NaN
2019-01-01	NaN	NaN

```
2019-02-01       NaN   NaN
2019-03-01       NaN   NaN
2019-04-01       NaN   NaN
2019-05-01       NaN   NaN
2019-06-01       NaN   NaN
2019-07-01       NaN   NaN
2019-08-01       NaN   NaN
2019-09-01       NaN   NaN
2019-10-01       NaN   NaN
2019-11-01       NaN   NaN
2019-12-01       NaN   NaN
2020-01-01       NaN   NaN
```

In [ ]:

```python
cohort_sizes = cohort_counts.iloc[:,0]
retention = cohort_counts.divide(cohort_sizes, axis=0)
retention = retention.round(3)*100
retention = retention.round(1)

retention.index = retention.index.strftime('%Y-%m')
retention = retention.apply(pd.to_numeric, errors='coerce')

# Set NaN values to 0
retention = retention.fillna(0)

print(retention)
```

COHORT_INDEX	1	2	3	4	5	6	7	8	9
COHORT_MONTH									
2018-06	100.0	52.9	161.8	105.9	102.9	94.1	105.9	120.6	126.5
2018-07	100.0	121.1	81.3	77.4	55.6	62.2	71.4	52.0	49.9
2018-08	100.0	49.6	41.1	30.8	36.8	38.4	30.5	27.4	22.4
2018-09	100.0	39.9	26.0	27.9	26.0	20.7	18.8	18.3	42.8
2018-10	100.0	39.2	38.0	35.4	19.0	25.3	21.5	59.5	17.7
2018-11	100.0	41.5	24.5	32.1	20.8	18.9	34.0	32.1	15.1
2018-12	100.0	68.3	24.4	26.8	22.0	51.2	36.6	24.4	53.7
2019-01	100.0	52.4	34.9	19.0	58.7	31.7	20.6	38.1	38.1
2019-02	100.0	47.2	41.5	55.7	32.1	28.3	35.8	25.5	27.4
2019-03	100.0	54.5	109.1	50.5	22.2	52.5	37.4	32.3	32.3
2019-04	100.0	88.7	59.7	25.0	62.1	39.5	37.9	31.5	21.8
2019-05	100.0	61.3	27.0	48.5	35.0	28.2	16.0	11.7	22.1
2019-06	100.0	33.3	40.5	24.4	20.8	14.3	17.3	18.5	0.0
2019-07	100.0	43.6	36.4	29.1	18.2	12.7	30.9	0.0	0.0
2019-08	100.0	50.2	35.3	23.4	17.9	26.0	0.0	0.0	0.0
2019-09	100.0	80.5	39.5	33.0	34.5	0.0	0.0	0.0	0.0
2019-10	100.0	49.6	44.6	40.4	0.0	0.0	0.0	0.0	0.0
2019-11	100.0	41.7	45.7	0.0	0.0	0.0	0.0	0.0	0.0
2019-12	100.0	115.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020-01	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

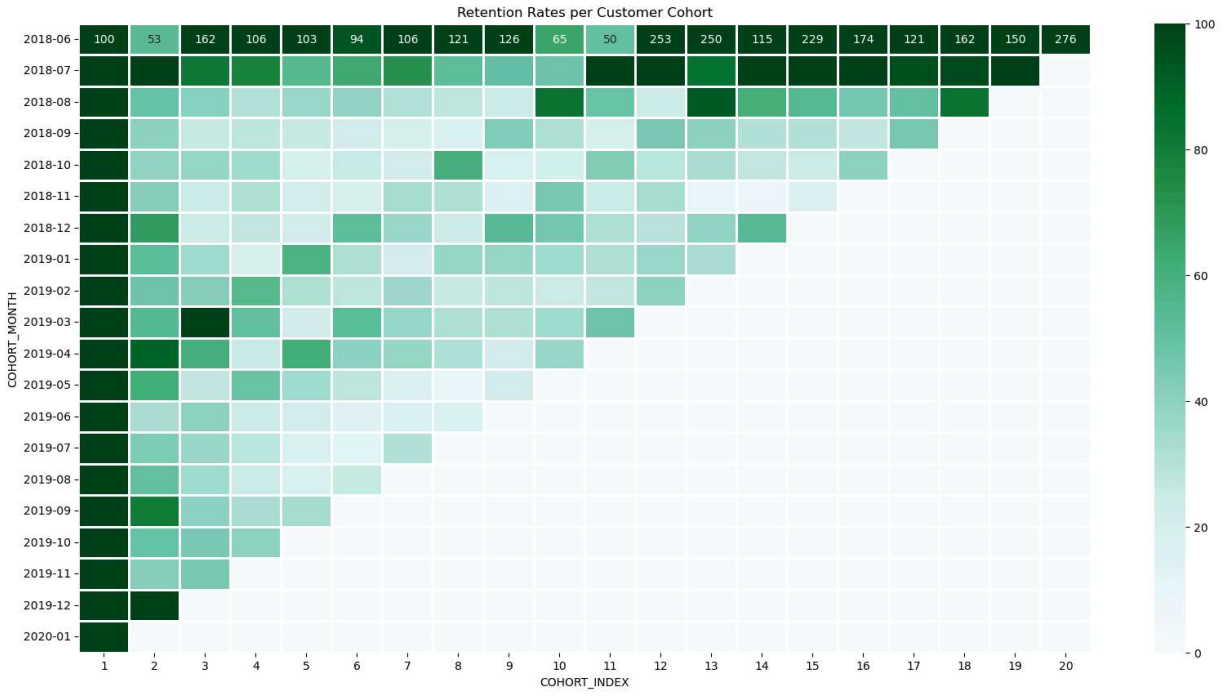
COHORT_INDEX	10	11	12	13	14	15	16	17	18
COHORT_MONTH									
2018-06	64.7	50.0	252.9	250.0	114.7	229.4	173.5	120.6	161.8
2018-07	47.4	185.4	122.7	84.7	166.8	113.3	107.1	95.0	97.2
2018-08	83.5	48.6	24.3	93.3	60.8	55.2	45.9	50.6	83.0
2018-09	31.7	19.7	44.2	40.4	31.2	30.8	26.4	45.7	0.0
2018-10	20.3	43.0	29.1	32.9	26.6	24.1	40.5	0.0	0.0
2018-11	45.3	22.6	34.0	11.3	7.5	17.0	0.0	0.0	0.0
2018-12	46.3	31.7	29.3	39.0	53.7	0.0	0.0	0.0	0.0
2019-01	34.9	31.7	36.5	33.3	0.0	0.0	0.0	0.0	0.0
2019-02	23.6	26.4	40.6	0.0	0.0	0.0	0.0	0.0	0.0
2019-03	35.4	47.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2019-04	37.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2019-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2019-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2019-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2019-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2019-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2019-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2019-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2019-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

COHORT_INDEX	19	20
COHORT_MONTH		
2018-06	150.0	276.5
2018-07	178.7	0.0
2018-08	0.0	0.0
2018-09	0.0	0.0
2018-10	0.0	0.0
2018-11	0.0	0.0
2018-12	0.0	0.0
2019-01	0.0	0.0

```
2019-02         0.0    0.0
2019-03         0.0    0.0
2019-04         0.0    0.0
2019-05         0.0    0.0
2019-06         0.0    0.0
2019-07         0.0    0.0
2019-08         0.0    0.0
2019-09         0.0    0.0
2019-10         0.0    0.0
2019-11         0.0    0.0
2019-12         0.0    0.0
2020-01         0.0    0.0
```

In [ ]:
```
# save retention as csv
retention.to_csv('./datasets/1_SEGMENTATION/RFM_retention.csv')
```

In [ ]:
```
# Plot a heatmap of the retention rates
plt.figure(figsize=(20, 10))
plt.title('Retention Rates per Customer Cohort')
sns.heatmap(data=retention,
            annot = True,
            cmap = 'BuGn',
            fmt = '.0f',
            vmin=0,
            vmax=100,
            linewidths=1,
            )
plt.show()
```



In [ ]:
```
# Convert total points to int
df_agg['TOTAL_POINTS'] = df_agg['TOTAL_POINTS'].astype(int)

# Calculation of the absolute sum of negative values in the column TOTAL_POINTS for
df_agg['POINTS_USED'] = df_agg['TOTAL_POINTS'].apply(lambda x: abs(x) if x < 0 else
```

In [ ]:
```
df_agg.head()
```

Out[ ]:

	CUSTOMER_ID	DATE	INVOICE_MONTH	COHORT_MONTH	CREATION_DATE	LONGEVIT
0	AA00312188	2018-09-27	2018-09-01	2018-07-01	2005-11-05	517
1	AA00312390	2019-05-04	2019-05-01	2018-07-01	2009-01-17	402
2	AA00325975	2019-05-04	2019-05-01	2018-06-01	2005-01-04	549
3	AA00336843	2019-02-07	2019-02-01	2018-08-01	2014-03-12	213
4	AA00339761	2019-02-15	2019-02-01	2018-07-01	2004-02-13	580

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

Out[ ]:

	CUSTOMER_ID	DATE	PRODUCT_ID	QUANTITY	LIST_PRICE	SPECIAL	OUTLET_ID	PAYM
0	BF00404312	2020-01-17	1068	1.0	6.85	0	14	
1	BF00404312	2018-11-09	1068	1.0	6.65	0	14	
2	BF00404312	2020-01-17	94580	1.0	6.25	0	14	
3	BF00404312	2019-08-16	94580	1.0	6.25	0	14	
4	BF00404312	2019-11-10	94580	1.0	6.25	0	14	

5 rows × 29 columns

In [ ]:
```
# Processing of loyalty points
# Definition of the metric: 1 L is equivalent to 100 POINTS_USED
df_agg['L'] = df_agg['POINTS_USED']/100
df_agg['L'] = df_agg['L'].astype(int)

# Determine the average quantity of products purchased by each CUSTOMER_ID from the
df_agg['AQC'] = df.groupby('CUSTOMER_ID')['QUANTITY'].mean().reset_index()['QUANTIT
df_agg['AQC'] = df_agg['AQC'].round(2)

df_agg.head()
```

Out[ ]:

	CUSTOMER_ID	DATE	INVOICE_MONTH	COHORT_MONTH	CREATION_DATE	LONGEVITY
0	AA00312188	2018-09-27	2018-09-01	2018-07-01	2005-11-05	517
1	AA00312390	2019-05-04	2019-05-01	2018-07-01	2009-01-17	402
2	AA00325975	2019-05-04	2019-05-01	2018-06-01	2005-01-04	549
3	AA00336843	2019-02-07	2019-02-01	2018-08-01	2014-03-12	213
4	AA00339761	2019-02-15	2019-02-01	2018-07-01	2004-02-13	580

In [ ]:
```
df.columns
```

Out[ ]:
```
Index(['CUSTOMER_ID', 'DATE', 'PRODUCT_ID', 'QUANTITY', 'LIST_PRICE',
       'SPECIAL', 'OUTLET_ID', 'PAYMENT_METHOD', 'TIME', 'TOTAL_POINTS',
       'CATEGORY_ID', 'CATEGORY_DESC', 'CREATION_DATE', 'REGIONAL_CODE',
       'ORIGIN', 'LONGEVITY', 'TRANSACTION_HOUR', 'TIME_OF_DAY', 'MONTH',
       'YEAR', 'DAY', 'MONTH_NAME', 'DAY_OF_WEEK', 'mode_weekday',
       'mode_origin', 'mode_payment_method', 'mode_time_of_day',
       'INVOICE_MONTH', 'COHORT_MONTH'],
      dtype='object')
```

In [ ]:
```
# Refactor of transaction type and transaction value calculation
df_agg['TRANSACTION_VALUE'] = df_agg['LIST_PRICE'] * df_agg['QUANTITY']
# Set TRANSACTION_VALUE to float
df_agg['TRANSACTION_VALUE'] = df_agg['TRANSACTION_VALUE'].astype(float)
df_agg.head()
```

Out[ ]:

	CUSTOMER_ID	DATE	INVOICE_MONTH	COHORT_MONTH	CREATION_DATE	LONGEVITY
0	AA00312188	2018-09-27	2018-09-01	2018-07-01	2005-11-05	517
1	AA00312390	2019-05-04	2019-05-01	2018-07-01	2009-01-17	402
2	AA00325975	2019-05-04	2019-05-01	2018-06-01	2005-01-04	549
3	AA00336843	2019-02-07	2019-02-01	2018-08-01	2014-03-12	213
4	AA00339761	2019-02-15	2019-02-01	2018-07-01	2004-02-13	580

In [ ]:
```
# Determination of day of the week with the highest transaction value order by the
# Determination of the hour of the day with the highest transaction value
```

```
# Determine the ORIGIN_ with the highest transaction value
# Determine the region with the highest transaction value
```

In [ ]:
```
snapshot_date = df_agg['DATE'].max() + pd.DateOffset(days=1)
```

In [ ]:
```
# Determining Recency - Lower the value, the better (Obtained from aggregated dataf
recency_datamart = df_agg.groupby('CUSTOMER_ID').agg({'DATE': lambda x: (snapshot_d

# Determining Frequency - Higher the value, the better (Obtained from original data
frequency_datamart = df.groupby('CUSTOMER_ID').agg({'DATE': 'count'}).reset_index()

# Determining Monetary - Higher the value, the better (Obtained from aggregated dat
monetary_datamart = df_agg.groupby('CUSTOMER_ID').agg({'TRANSACTION_VALUE': 'sum'})

# Merge the recency, frequency, and monetary dataframes
rfm_datamart = recency_datamart.merge(frequency_datamart, on = 'CUSTOMER_ID')
rfm_datamart = rfm_datamart.merge(monetary_datamart, on = 'CUSTOMER_ID')

# Rename the columns
rfm_datamart.columns = ['CUSTOMER_ID', 'Recency', 'Frequency', 'Monetary']

RFM = rfm_datamart
RFM.head()
```

Out[ ]:

	CUSTOMER_ID	Recency	Frequency	Monetary
0	AA00312188	487	102	102182.25
1	AA00312390	268	58	36476.70
2	AA00325975	268	205	282986.00
3	AA00336843	354	69	33192.50
4	AA00339761	346	59	32488.30

In [ ]:
```
# CLV calculation
df_agg['CLV'] = ((df.groupby('CUSTOMER_ID')['LIST_PRICE'].mean().reset_index()['LIS
df_agg.head()
```

Out[ ]:

	CUSTOMER_ID	DATE	INVOICE_MONTH	COHORT_MONTH	CREATION_DATE	LONGEVIT
0	AA00312188	2018-09-27	2018-09-01	2018-07-01	2005-11-05	517
1	AA00312390	2019-05-04	2019-05-01	2018-07-01	2009-01-17	402
2	AA00325975	2019-05-04	2019-05-01	2018-06-01	2005-01-04	549
3	AA00336843	2019-02-07	2019-02-01	2018-08-01	2014-03-12	213
4	AA00339761	2019-02-15	2019-02-01	2018-07-01	2004-02-13	580

In [ ]:
```
# Add the L and AQC column to the RFM dataframe (Loyalty Score, Average Quantity of
RFM = RFM.merge(df_agg, on = 'CUSTOMER_ID')
RFM.head()
```

Out[ ]:

	CUSTOMER_ID	Recency	Frequency	Monetary	DATE	INVOICE_MONTH	COHORT_MON
0	AA00312188	487	102	102182.25	2018-09-27	2018-09-01	2018-07
1	AA00312390	268	58	36476.70	2019-05-04	2019-05-01	2018-07
2	AA00325975	268	205	282986.00	2019-05-04	2019-05-01	2018-06
3	AA00336843	354	69	33192.50	2019-02-07	2019-02-01	2018-08
4	AA00339761	346	59	32488.30	2019-02-15	2019-02-01	2018-07

5 rows × 23 columns

In [ ]:
```
RFM.columns
```

Out[ ]:
```
Index(['CUSTOMER_ID', 'Recency', 'Frequency', 'Monetary', 'DATE',
       'INVOICE_MONTH', 'COHORT_MONTH', 'CREATION_DATE', 'LONGEVITY',
       'QUANTITY', 'TOTAL_POINTS', 'LIST_PRICE', 'SPECIAL', 'mode_weekday',
       'mode_origin', 'mode_payment_method', 'mode_time_of_day',
       'COHORT_INDEX', 'POINTS_USED', 'L', 'AQC', 'TRANSACTION_VALUE', 'CLV'],
      dtype='object')
```

In [ ]:
```
# Drop excess columns from RFM
RFM.drop(['DATE', 'INVOICE_MONTH', 'COHORT_MONTH', 'CREATION_DATE', 'LONGEVITY',
       'QUANTITY', 'TOTAL_POINTS', 'LIST_PRICE', 'SPECIAL', 'COHORT_INDEX', 'POINTS
```

In [ ]:
```
# Recency quartile
r_labels = range(4, 0, -1)
r_quartiles = pd.qcut(RFM['Recency'], 4, labels = r_labels)
RFM = RFM.assign(R = r_quartiles.values)

# Frequency quartile
f_labels = range(1, 5)
f_quartiles = pd.qcut(RFM['Frequency'], 4, labels = f_labels)
RFM = RFM.assign(F = f_quartiles.values)

# Monetary quartile
m_labels = range(1, 5)
RFM['Monetary'] = pd.to_numeric(RFM['Monetary'], errors='coerce')
m_quartiles = pd.qcut(RFM['Monetary'], 4, labels = m_labels)
RFM = RFM.assign(M = m_quartiles.values)

RFM.head()
```

Out[ ]:

	CUSTOMER_ID	Recency	Frequency	Monetary	mode_weekday	mode_origin	mode_pay
0	AA00312188	487	102	102182.25	Thursday	WEB	
1	AA00312390	268	58	36476.70	Saturday	WEB	
2	AA00325975	268	205	282986.00	Saturday	WEB	
3	AA00336843	354	69	33192.50	Thursday	WEB	
4	AA00339761	346	59	32488.30	Friday	WEB	

In [ ]:
```
def merge_rfm(x): return str(x['R']) + str(x['F']) + str(x['M'])
RFM['RFM_Segment'] = RFM.apply(merge_rfm, axis=1)
RFM['RFM_Score'] = RFM[['R', 'F', 'M']].sum(axis = 1)

RFM.head()
```

Out[ ]:

	CUSTOMER_ID	Recency	Frequency	Monetary	mode_weekday	mode_origin	mode_pay
0	AA00312188	487	102	102182.25	Thursday	WEB	
1	AA00312390	268	58	36476.70	Saturday	WEB	
2	AA00325975	268	205	282986.00	Saturday	WEB	
3	AA00336843	354	69	33192.50	Thursday	WEB	
4	AA00339761	346	59	32488.30	Friday	WEB	

In [ ]:
```
RFM.groupby('RFM_Score').agg({
    'Recency': 'mean',
    'Frequency': 'mean',
    'Monetary': ['mean', 'count'],
    'L': 'mean',
```

```
    'AQC': 'mean',
    'CLV': 'mean'
}).round(1)
```

Out[ ]:

	Recency	Frequency	Monetary		L	AQC	CLV
	mean	mean	mean	count	mean	mean	mean
RFM_Score							
3	474.1	18.5	3336.4	1152	1.3	1.1	1141.4
4	296.1	21.0	4059.7	1682	1.0	1.2	1050.7
5	295.7	30.9	9849.6	3301	2.8	1.2	1984.3
6	173.4	32.3	11468.4	3757	2.5	1.1	1991.1
7	300.5	61.8	37329.1	3211	13.2	1.1	4829.8
8	181.8	66.6	44516.4	3084	14.3	1.1	5407.3
9	299.9	126.8	205143.9	3375	76.5	1.2	11522.0
10	157.7	130.6	211112.5	3084	69.6	1.1	12081.6
11	136.2	170.1	328236.7	1729	125.0	1.2	16119.7
12	40.6	177.0	335832.7	1352	157.6	1.1	17034.1

In [ ]:

```
# Add the segment labels as Gold, Silver, Bronze based on the RFM_Score as segment_
def segment_me(df):
    if df['RFM_Score'] >= 9:
        return 'Gold'
    elif (df['RFM_Score'] >= 5) and (df['RFM_Score'] < 9):
        return 'Silver'
    else:
        return 'Bronze'

RFM['General_Segment'] = RFM.apply(segment_me, axis=1)
RFM.groupby('General_Segment').agg({
    'Recency': 'mean',
    'Frequency': 'mean',
    'Monetary': ['mean', 'count'],
    'L': 'mean',
    'AQC': 'mean',
    'CLV': 'mean'
}).round(1)
```

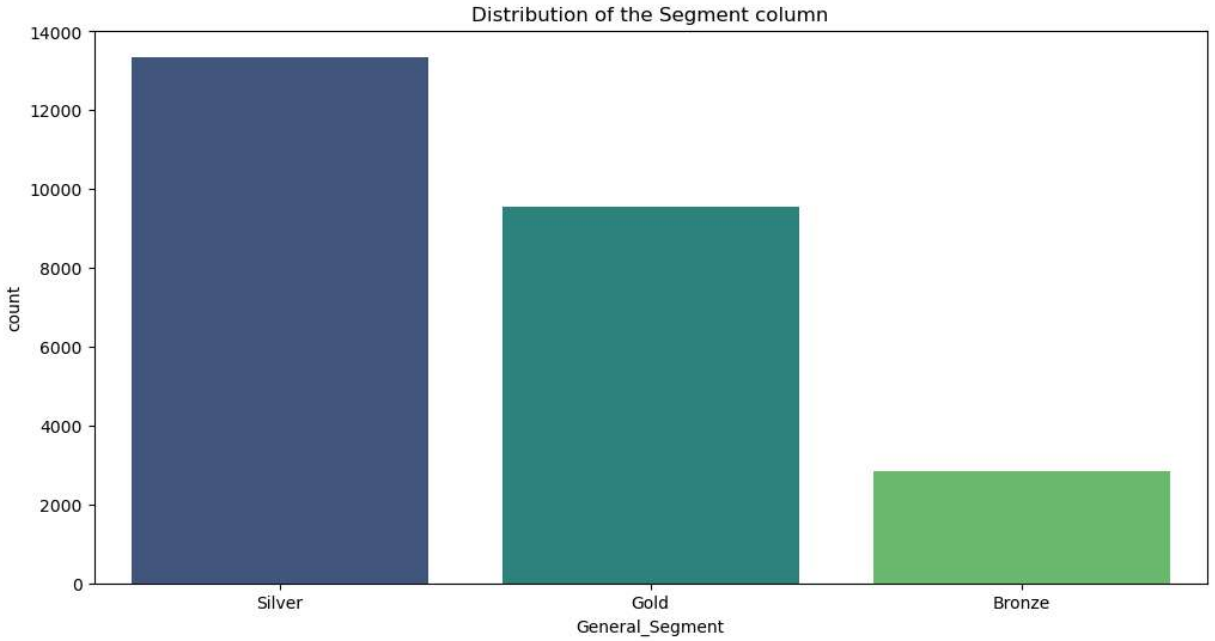
Out[ ]:

	Recency	Frequency	Monetary		L	AQC	CLV
	mean	mean	mean	count	mean	mean	mean
General_Segment							
Bronze	368.5	20.0	3765.7	2834	1.1	1.2	1087.6
Gold	187.5	143.0	247903.4	9540	94.6	1.1	13317.3
Silver	236.2	47.0	24919.7	13353	7.9	1.1	3461.1

In [ ]:
```
# Check the unique value of the RFM_Segment
RFM['RFM_Segment'].unique()
```

Out[ ]:
```
array(['134', '223', '244', '233', '123', '344', '444', '144', '222',
       '122', '434', '422', '334', '111', '333', '133', '433', '211',
       '311', '322', '411', '312', '323', '143', '423', '332', '132',
       '112', '421', '343', '243', '221', '212', '432', '234', '121',
       '443', '412', '321', '232', '213', '324', '424', '313', '113',
       '124', '224', '413'], dtype=object)
```

In [ ]:
```
# Plot the distribution of the General_Segment column
plt.figure(figsize=(12, 6))
sns.countplot(data=RFM, x='General_Segment', palette='viridis')
plt.title('Distribution of the Segment column')
plt.show()
```



In [ ]:
```
RFM.columns
```

Out[ ]:
```
Index(['CUSTOMER_ID', 'Recency', 'Frequency', 'Monetary', 'mode_weekday',
       'mode_origin', 'mode_payment_method', 'mode_time_of_day', 'L', 'AQC',
       'CLV', 'R', 'F', 'M', 'RFM_Segment', 'RFM_Score', 'General_Segment'],
      dtype='object')
```

In [ ]:

```
# Create new csv file from RFM_Final
RFM.to_csv('./datasets/1_SEGMENTATION/RFM_Label.csv', index=False)
# Drop the General_Segment column from the RFM dataframe and save it as a new csv f
RFM_ = RFM.copy()
# Drop AQC, R, F, M, RFM_Segment, RFM_Score, General_Segment columns
RFM_.drop(['AQC', 'R', 'F', 'M', 'RFM_Segment', 'RFM_Score', 'General_Segment', 'mo
       'mode_origin', 'mode_payment_method', 'mode_time_of_day'], axis = 1, inplace
RFM_.to_csv('./datasets/1_SEGMENTATION/Pre_Cluster.csv', index=False)
```