Potato_chip_lesson_2

June 6, 2021

0.1 Import Statements / Import Data

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from scipy import stats
import warnings
warnings.filterwarnings('ignore')
%matplotlib inline
sns.set()
```

[2]:
```
df = pd.read_csv('QVI_data.csv')
df.head(10)
```

[2]:
```
   LYLTY_CARD_NBR        DATE  STORE_NBR  TXN_ID  PROD_NBR  \
0            1000  10/17/2018          1       1         5
1            1002   9/16/2018          1       2        58
2            1003    3/7/2019          1       3        52
3            1003    3/8/2019          1       4       106
4            1004   11/2/2018          1       5        96
5            1005  12/28/2018          1       6        86
6            1007   12/4/2018          1       7        49
7            1007   12/5/2018          1       8        10
8            1009  11/20/2018          1       9        20
9            1010    9/9/2018          1      10        51

                                  PROD_NAME  PROD_QTY  TOT_SALES  PACK_SIZE  \
0    Natural Chip        Compny SeaSalt175g         2        6.0        175
1     Red Rock Deli Chikn&Garlic Aioli 150g         1        2.7        150
2     Grain Waves Sour    Cream&Chives 210G         1        3.6        210
3    Natural ChipCo      Hony Soy Chckn175g         1        3.0        175
4            WW Original Stacked Chips 160g         1        1.9        160
5                        Cheetos Puffs 165g         1        2.8        165
6  Infuzions SourCream&Herbs Veg Strws 110g         1        3.8        110
7       RRD SR Slow Rst     Pork Belly 150g         1        2.7        150
8          Doritos Cheese      Supreme 330g         1        5.7        330
9                  Doritos Mexicana    170g         2        8.8        170
```

```
        BRAND              LIFESTAGE PREMIUM_CUSTOMER
0     NATURAL  YOUNG SINGLES/COUPLES          Premium
1         RRD  YOUNG SINGLES/COUPLES       Mainstream
2     GRNWVES         YOUNG FAMILIES           Budget
3     NATURAL         YOUNG FAMILIES           Budget
4  WOOLWORTHS  OLDER SINGLES/COUPLES       Mainstream
5     CHEETOS MIDAGE SINGLES/COUPLES       Mainstream
6   INFUZIONS  YOUNG SINGLES/COUPLES           Budget
7         RRD  YOUNG SINGLES/COUPLES           Budget
8     DORITOS           NEW FAMILIES          Premium
9     DORITOS  YOUNG SINGLES/COUPLES       Mainstream
```

[3]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 264834 entries, 0 to 264833
Data columns (total 12 columns):
 #   Column            Non-Null Count   Dtype
---  ------            --------------   -----
 0   LYLTY_CARD_NBR    264834 non-null  int64
 1   DATE              264834 non-null  object
 2   STORE_NBR         264834 non-null  int64
 3   TXN_ID            264834 non-null  int64
 4   PROD_NBR          264834 non-null  int64
 5   PROD_NAME         264834 non-null  object
 6   PROD_QTY          264834 non-null  int64
 7   TOT_SALES         264834 non-null  float64
 8   PACK_SIZE         264834 non-null  int64
 9   BRAND             264834 non-null  object
 10  LIFESTAGE         264834 non-null  object
 11  PREMIUM_CUSTOMER  264834 non-null  object
dtypes: float64(1), int64(6), object(5)
memory usage: 24.2+ MB
```

0.2 Initial Copy / Wrangling Date

[4]:

```
df_copy = df.copy()
```

[5]:

```
df_copy['MONTH'] = pd.to_datetime(df_copy['DATE'], format='%m/%d/%Y').dt.month.
 ↪astype(str)
df_copy['YEAR'] = pd.to_datetime(df_copy['DATE'], format='%m/%d/%Y').dt.year.
 ↪astype(str)
df_copy['M_Y'] = df_copy['MONTH'] + '-' + df_copy['YEAR']
df_copy['MONTH'] = df_copy['MONTH'].astype(int)
df_copy = df_copy.sort_values(by=['YEAR', 'MONTH'])
df_copy = df_copy.reset_index(drop=True)
```

```
[6]: df_copy['M_Y'].value_counts()
```

```
[6]: 12-2018    22835
     3-2019     22592
     7-2018     22562
     8-2018     22410
     5-2019     22391
     10-2018    22288
     1-2019     22161
     11-2018    21852
     6-2019     21829
     4-2019     21766
     9-2018     21743
     2-2019     20405
     Name: M_Y, dtype: int64
```

```
[7]: df_copy.head()
```

```
[7]:    LYLTY_CARD_NBR       DATE  STORE_NBR  TXN_ID  PROD_NBR  \
     0            1011  7/29/2018          1      12        84
     1            1027   7/6/2018          1      34        38
     2            1042  7/21/2018          1      45        94
     3            1055   7/8/2018          1      62        43
     4            1057   7/6/2018          1      64        23

                                      PROD_NAME  PROD_QTY  TOT_SALES  PACK_SIZE  \
     0    GrnWves Plus Btroot & Chilli Jam 180g         2        6.2        180
     1  Infuzions Mango     Chutny Papadums 70g         1        2.4         70
     2                        Burger Rings 220g         1        2.3        220
     3       Smith Crinkle Cut    Bolognese 150g         1        2.6        150
     4                     Cheezels Cheese 330g         1        5.7        330

            BRAND               LIFESTAGE PREMIUM_CUSTOMER  MONTH  YEAR     M_Y
     0    GRNWVES   OLDER SINGLES/COUPLES       Mainstream      7  2018  7-2018
     1  INFUZIONS          OLDER FAMILIES          Premium      7  2018  7-2018
     2     BURGER   YOUNG SINGLES/COUPLES          Premium      7  2018  7-2018
     3     SMITHS                RETIREES       Mainstream      7  2018  7-2018
     4   CHEEZELS  MIDAGE SINGLES/COUPLES       Mainstream      7  2018  7-2018
```

```
[8]: df_copy.tail()
```

```
[8]:         LYLTY_CARD_NBR       DATE  STORE_NBR  TXN_ID  PROD_NBR  \
     264829         2330081  6/22/2019         77  236723        30
     264830         2330171  6/20/2019         77  236737         5
     264831         2330271  6/29/2019         77  236749       114
     264832         2330291  6/18/2019         77  236754        83
     264833         2330501  6/20/2019         77  236780        63
```

```
                                       PROD_NAME  PROD_QTY  TOT_SALES  \
264829  Doritos Corn Chips  Cheese Supreme 170g         2        8.8
264830   Natural Chip        Compny SeaSalt175g         2        6.0
264831    Kettle Sensations   Siracha Lime 150g         2        9.2
264832        WW D/Style Chip      Sea Salt 200g         1        1.9
264833             Kettle 135g Swt Pot Sea Salt         1        4.2

        PACK_SIZE       BRAND              LIFESTAGE PREMIUM_CUSTOMER  MONTH  \
264829        170     DORITOS               RETIREES       Mainstream      6
264830        175     NATURAL               RETIREES       Mainstream      6
264831        150      KETTLE         YOUNG FAMILIES       Mainstream      6
264832        200  WOOLWORTHS  OLDER SINGLES/COUPLES       Mainstream      6
264833        135      KETTLE  OLDER SINGLES/COUPLES           Budget      6

        YEAR     M_Y
264829  2019  6-2019
264830  2019  6-2019
264831  2019  6-2019
264832  2019  6-2019
264833  2019  6-2019
```

[9]:
```
df_copy['STORE_NBR'].value_counts()
```

[9]:
```
226    2020
88     1873
93     1832
165    1819
237    1785
       …
11        2
31        2
206       2
76        1
92        1
Name: STORE_NBR, Length: 272, dtype: int64
```

0.3 Sales Magnitude and Pearson Correlations

[10]:
```
df_copy_1 = df_copy[['STORE_NBR', 'M_Y', 'MONTH', 'TOT_SALES']].groupby(by =␣
 ↪['STORE_NBR', 'MONTH', 'M_Y'], as_index=False).sum()
df_copy_1
```

[10]:
```
      STORE_NBR  MONTH     M_Y  TOT_SALES
0             1      1  1-2019     154.80
1             1      2  2-2019     225.40
2             1      3  3-2019     192.90
```

```
3              1      4   4-2019     192.90
4              1      5   5-2019     221.40
…          …    …      …         …
3164         272      8   8-2018     372.85
3165         272      9   9-2018     304.70
3166         272     10  10-2018     430.60
3167         272     11  11-2018     376.20
3168         272     12  12-2018     403.90

[3169 rows x 4 columns]
```

```
[11]: df_copy_1 = df_copy_1.query('MONTH >= 7 or MONTH <= 2')
      df_copy_1['MONTH'] = df_copy_1['MONTH'].replace([1,2], [13,14])
      df_copy_1 = df_copy_1.sort_values(by=['STORE_NBR', 'MONTH'])
      df_copy_1 = df_copy_1.reset_index(drop=True)
      df_copy_1
```

```
[11]:       STORE_NBR  MONTH      M_Y  TOT_SALES
      0             1      7   7-2018      206.9
      1             1      8   8-2018      176.1
      2             1      9   9-2018      278.8
      3             1     10  10-2018      188.1
      4             1     11  11-2018      192.6
      …          …    …      …         …
      2107        272     10  10-2018      430.6
      2108        272     11  11-2018      376.2
      2109        272     12  12-2018      403.9
      2110        272     13   1-2019      423.0
      2111        272     14   2-2019      395.5

      [2112 rows x 4 columns]
```

```
[12]: df_copy_1.describe()
```

```
[12]:          STORE_NBR        MONTH    TOT_SALES
      count  2112.000000  2112.000000  2112.000000
      mean    136.689867    10.495739   610.676349
      std      78.454451     2.292860   390.435611
      min       1.000000     7.000000     1.800000
      25%      68.000000     8.000000   258.550000
      50%     137.000000    10.000000   676.750000
      75%     204.000000    12.000000   929.525000
      max     272.000000    14.000000  1659.600000
```

```
[13]: store_nums = df_copy_1['STORE_NBR'].drop_duplicates()
```

[14]:

```
sales_corr_77 = []
sales_corr_86 = []
sales_corr_88 = []

def corr_compare(control, trial):
    df_corr_con = df_copy_1[df_copy_1['STORE_NBR'] == control]
    df_corr_tri = df_copy_1[df_copy_1['STORE_NBR'] == trial]
    sales_corr = (stats.pearsonr(df_corr_con['TOT_SALES'],␣
 ↪df_corr_tri['TOT_SALES'])[0])
    if trial == 77:
        sales_corr_77.append(sales_corr)
    elif trial == 86:
        sales_corr_86.append(sales_corr)
    else:
        sales_corr_88.append(sales_corr)
```

[15]:

```
store_list = []
df_copy_2 = df_copy_1.copy()
for i in store_nums:
    if i == 77 or i == 86 or i == 88:
        continue
    else:
        try:
            corr_compare(i, 77)
            corr_compare(i, 86)
            corr_compare(i, 88)
            store_list.append(i)
        except ValueError:
            df_copy_2 = df_copy_2[df_copy_2['STORE_NBR'] != i]

df_copy_2 = df_copy_2.reset_index(drop=True)
```

[16]:

```
df_copy_2['DIFF_77'] = df_copy_2['TOT_SALES']
df_copy_2['DIFF_86'] = df_copy_2['TOT_SALES']
df_copy_2['DIFF_88'] = df_copy_2['TOT_SALES']
df_copy_2.head()
```

[16]:

```
   STORE_NBR  MONTH      M_Y  TOT_SALES  DIFF_77  DIFF_86  DIFF_88
0          1      7   7-2018      206.9    206.9    206.9    206.9
1          1      8   8-2018      176.1    176.1    176.1    176.1
2          1      9   9-2018      278.8    278.8    278.8    278.8
3          1     10  10-2018      188.1    188.1    188.1    188.1
4          1     11  11-2018      192.6    192.6    192.6    192.6
```

[17]:

```
df_copy_2.query('STORE_NBR == 77')
```

```
[17]:      STORE_NBR  MONTH      M_Y  TOT_SALES  DIFF_77  DIFF_86  DIFF_88
      576         77      7   7-2018      296.8    296.8    296.8    296.8
      577         77      8   8-2018      255.5    255.5    255.5    255.5
      578         77      9   9-2018      225.2    225.2    225.2    225.2
      579         77     10  10-2018      204.5    204.5    204.5    204.5
      580         77     11  11-2018      245.3    245.3    245.3    245.3
      581         77     12  12-2018      267.3    267.3    267.3    267.3
      582         77     13   1-2019      204.4    204.4    204.4    204.4
      583         77     14   2-2019      235.0    235.0    235.0    235.0
```

```
[18]: df_copy_2.query('STORE_NBR == 86')
```

```
[18]:      STORE_NBR  MONTH      M_Y  TOT_SALES  DIFF_77  DIFF_86  DIFF_88
      640         86      7   7-2018     892.20   892.20   892.20   892.20
      641         86      8   8-2018     764.05   764.05   764.05   764.05
      642         86      9   9-2018     914.60   914.60   914.60   914.60
      643         86     10  10-2018     948.40   948.40   948.40   948.40
      644         86     11  11-2018     918.00   918.00   918.00   918.00
      645         86     12  12-2018     841.20   841.20   841.20   841.20
      646         86     13   1-2019     841.40   841.40   841.40   841.40
      647         86     14   2-2019     913.20   913.20   913.20   913.20
```

```
[19]: df_copy_2.query('STORE_NBR == 88')
```

```
[19]:      STORE_NBR  MONTH      M_Y  TOT_SALES  DIFF_77  DIFF_86  DIFF_88
      656         88      7   7-2018     1310.0   1310.0   1310.0   1310.0
      657         88      8   8-2018     1323.8   1323.8   1323.8   1323.8
      658         88      9   9-2018     1423.0   1423.0   1423.0   1423.0
      659         88     10  10-2018     1352.4   1352.4   1352.4   1352.4
      660         88     11  11-2018     1382.8   1382.8   1382.8   1382.8
      661         88     12  12-2018     1325.2   1325.2   1325.2   1325.2
      662         88     13   1-2019     1266.4   1266.4   1266.4   1266.4
      663         88     14   2-2019     1370.2   1370.2   1370.2   1370.2
```

```
[20]: for i in range(df_copy_2.shape[0]):
          df_copy_2['DIFF_77'][i] = abs(df_copy_2['TOT_SALES'][i] -␣
       ↪df_copy_2['TOT_SALES'][(i%8)+576])
          df_copy_2['DIFF_86'][i] = abs(df_copy_2['TOT_SALES'][i] -␣
       ↪df_copy_2['TOT_SALES'][(i%8)+640])
          df_copy_2['DIFF_88'][i] = abs(df_copy_2['TOT_SALES'][i] -␣
       ↪df_copy_2['TOT_SALES'][(i%8)+656])
```

```
[21]: df_copy_2['SALES_MAG_77'] = 1 - (df_copy_2['DIFF_77'] / df_copy_2['DIFF_77'].
       ↪max())
      df_copy_2['SALES_MAG_86'] = 1 - (df_copy_2['DIFF_86'] / df_copy_2['DIFF_86'].
       ↪max())
```

```
df_copy_2['SALES_MAG_88'] = 1 - (df_copy_2['DIFF_88'] / df_copy_2['DIFF_88'].
 ↪max())
```

[22]:
```
df_copy_2.describe()
```

[22]:
```
          STORE_NBR        MONTH    TOT_SALES      DIFF_77      DIFF_86  \
count   2080.000000  2080.000000  2080.000000  2080.000000  2080.000000
mean     136.892308    10.500000   619.759014   432.480649   377.291322
std       78.446754     2.291839   386.437545   325.253111   278.284035
min        1.000000     7.000000     2.700000     0.000000     0.000000
25%       68.750000     8.750000   269.650000   121.375000   111.250000
50%      137.500000    10.500000   700.300000   449.400000   366.000000
75%      203.250000    12.250000   931.475000   696.300000   617.087500
max      272.000000    14.000000  1659.600000  1392.300000   945.700000

            DIFF_88  SALES_MAG_77  SALES_MAG_86  SALES_MAG_88
count   2080.000000   2080.000000   2080.000000   2080.000000
mean     726.935024      0.689377      0.601045      0.484882
std      385.271690      0.233608      0.294262      0.273010
min        0.000000      0.000000      0.000000      0.000000
25%      405.950000      0.499892      0.347481      0.237635
50%      649.575000      0.677225      0.612985      0.539700
75%     1075.850000      0.912824      0.882362      0.712337
max     1411.200000      1.000000      1.000000      1.000000
```

[23]:
```
df_mag = df_copy_2[['STORE_NBR', 'SALES_MAG_77', 'SALES_MAG_86',␣
 ↪'SALES_MAG_88']].groupby(by='STORE_NBR', as_index=False).mean()
```

[24]:
```
df_mag
```

[24]:
```
     STORE_NBR  SALES_MAG_77  SALES_MAG_86  SALES_MAG_88
0            1      0.961494      0.283500      0.190272
1            2      0.940198      0.237978      0.159767
2            3      0.390411      0.776515      0.820193
3            4      0.274905      0.598584      0.872414
4            5      0.593056      0.915096      0.620261
..         …           …             …             …
255        268      0.962252      0.296949      0.199285
256        269      0.489541      0.914898      0.722391
257        270      0.494330      0.864479      0.717665
258        271      0.589052      0.913748      0.624212
259        272      0.891739      0.485408      0.325578

[260 rows x 4 columns]
```

0.4 Customer Magnitude and Pearson Correlations

[25]:

```
df_copy_3 = df_copy[['STORE_NBR', 'M_Y', 'MONTH', 'LYLTY_CARD_NBR']]
df_copy_3['LYLTY_CARD_NBR'] = df_copy_3['LYLTY_CARD_NBR'].astype(str)
df_copy_3['M_Y + LYLTY_CARD_NBR'] = df_copy_3['M_Y'] + '-' +␣
 ↪df_copy_3['LYLTY_CARD_NBR']
df_copy_3 = df_copy_3.drop_duplicates(subset='M_Y + LYLTY_CARD_NBR')
df_copy_3 = df_copy_3.drop('M_Y + LYLTY_CARD_NBR', axis=1)
df_copy_3 = df_copy_3.groupby(by=['STORE_NBR', 'M_Y', 'MONTH'], as_index=False).
 ↪count()
df_copy_3 = df_copy_3.rename(columns={'LYLTY_CARD_NBR':'CUST_COUNT'})
df_copy_3
```

[25]:

```
      STORE_NBR      M_Y  MONTH  CUST_COUNT
0             1   1-2019      1          35
1             1  10-2018     10          44
2             1  11-2018     11          46
3             1  12-2018     12          42
4             1   2-2019      2          52
…           …        …   …         …
3164        272   5-2019      5          34
3165        272   6-2019      6          34
3166        272   7-2018      7          48
3167        272   8-2018      8          44
3168        272   9-2018      9          32

[3169 rows x 4 columns]
```

[26]:

```
df_copy_3.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 3169 entries, 0 to 3168
Data columns (total 4 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   STORE_NBR   3169 non-null   int64
 1   M_Y         3169 non-null   object
 2   MONTH       3169 non-null   int64
 3   CUST_COUNT  3169 non-null   int64
dtypes: int64(3), object(1)
memory usage: 123.8+ KB
```

[27]:

```
df_copy_3 = df_copy_3.query('MONTH >= 7 or MONTH <= 2')
df_copy_3['MONTH'] = df_copy_3['MONTH'].replace([1,2], [13,14])
df_copy_3 = df_copy_3.sort_values(by=['STORE_NBR', 'MONTH'])
df_copy_3 = df_copy_3.reset_index(drop=True)
df_copy_3
```

[27]:

```
      STORE_NBR      M_Y  MONTH  CUST_COUNT
0             1   7-2018      7          49
1             1   8-2018      8          42
2             1   9-2018      9          59
3             1  10-2018     10          44
4             1  11-2018     11          46
…         …      …    …         …
2107        272  10-2018     10          44
2108        272  11-2018     11          41
2109        272  12-2018     12          47
2110        272   1-2019     13          46
2111        272   2-2019     14          45

[2112 rows x 4 columns]
```

[28]:

```python
df_copy_3.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2112 entries, 0 to 2111
Data columns (total 4 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   STORE_NBR   2112 non-null   int64
 1   M_Y         2112 non-null   object
 2   MONTH       2112 non-null   int64
 3   CUST_COUNT  2112 non-null   int64
dtypes: int64(3), object(1)
memory usage: 66.1+ KB
```

[29]:

```python
cust_corr_77 = []
cust_corr_86 = []
cust_corr_88 = []

def cust_corr_compare(control, trial):
    df_corr_con = df_copy_3[df_copy_3['STORE_NBR'] == control]
    df_corr_tri = df_copy_3[df_copy_3['STORE_NBR'] == trial]
    cust_corr = (stats.pearsonr(df_corr_con['CUST_COUNT'],␣
 ↪df_corr_tri['CUST_COUNT'])[0])
    if trial == 77:
        cust_corr_77.append(cust_corr)
    elif trial == 86:
        cust_corr_86.append(cust_corr)
    else:
        cust_corr_88.append(cust_corr)
```

[30]:

```python
df_copy_4 = df_copy_3.copy()
for i in store_nums:
    if i == 77 or i == 86 or i == 88:
        continue
    else:
        try:
            cust_corr_compare(i, 77)
            cust_corr_compare(i, 86)
            cust_corr_compare(i, 88)

        except ValueError:
            df_copy_4 = df_copy_4[df_copy_4['STORE_NBR'] != i]

df_copy_4 = df_copy_4.reset_index(drop=True)
df_copy_4
```

```
[30]:       STORE_NBR      M_Y  MONTH  CUST_COUNT
      0             1   7-2018      7          49
      1             1   8-2018      8          42
      2             1   9-2018      9          59
      3             1  10-2018     10          44
      4             1  11-2018     11          46
      …         …      …    …         …
      2075        272  10-2018     10          44
      2076        272  11-2018     11          41
      2077        272  12-2018     12          47
      2078        272   1-2019     13          46
      2079        272   2-2019     14          45

      [2080 rows x 4 columns]
```

```
[31]: df_copy_4['DIFF_77'] = df_copy_4['CUST_COUNT']
      df_copy_4['DIFF_86'] = df_copy_4['CUST_COUNT']
      df_copy_4['DIFF_88'] = df_copy_4['CUST_COUNT']
      df_copy_4.head()
```

```
[31]:    STORE_NBR      M_Y  MONTH  CUST_COUNT  DIFF_77  DIFF_86  DIFF_88
      0          1   7-2018      7          49       49       49       49
      1          1   8-2018      8          42       42       42       42
      2          1   9-2018      9          59       59       59       59
      3          1  10-2018     10          44       44       44       44
      4          1  11-2018     11          46       46       46       46
```

```
[32]: df_copy_4.query('STORE_NBR == 77')
```

```
[32]:      STORE_NBR      M_Y  MONTH  CUST_COUNT  DIFF_77  DIFF_86  DIFF_88
      576         77   7-2018      7          51       51       51       51
      577         77   8-2018      8          47       47       47       47
      578         77   9-2018      9          42       42       42       42
      579         77  10-2018     10          37       37       37       37
```

```
580          77  11-2018     11          41      41      41      41
581          77  12-2018     12          46      46      46      46
582          77   1-2019     13          35      35      35      35
583          77   2-2019     14          45      45      45      45
```

[33]:

```
df_copy_4.query('STORE_NBR == 86')
```

[33]:

```
     STORE_NBR      M_Y  MONTH  CUST_COUNT  DIFF_77  DIFF_86  DIFF_88
640         86   7-2018      7          99       99       99       99
641         86   8-2018      8          94       94       94       94
642         86   9-2018      9         103      103      103      103
643         86  10-2018     10         109      109      109      109
644         86  11-2018     11         100      100      100      100
645         86  12-2018     12          98       98       98       98
646         86   1-2019     13          94       94       94       94
647         86   2-2019     14         107      107      107      107
```

[34]:

```
df_copy_4.query('STORE_NBR == 88')
```

[34]:

```
     STORE_NBR      M_Y  MONTH  CUST_COUNT  DIFF_77  DIFF_86  DIFF_88
656         88   7-2018      7         129      129      129      129
657         88   8-2018      8         131      131      131      131
658         88   9-2018      9         124      124      124      124
659         88  10-2018     10         123      123      123      123
660         88  11-2018     11         130      130      130      130
661         88  12-2018     12         126      126      126      126
662         88   1-2019     13         117      117      117      117
663         88   2-2019     14         124      124      124      124
```

[35]:

```
for i in range(df_copy_4.shape[0]):
    df_copy_4['DIFF_77'][i] = abs(df_copy_4['CUST_COUNT'][i] -␣
 ↪df_copy_4['CUST_COUNT'][(i%8)+576])
    df_copy_4['DIFF_86'][i] = abs(df_copy_4['CUST_COUNT'][i] -␣
 ↪df_copy_4['CUST_COUNT'][(i%8)+640])
    df_copy_4['DIFF_88'][i] = abs(df_copy_4['CUST_COUNT'][i] -␣
 ↪df_copy_4['CUST_COUNT'][(i%8)+656])
```

[36]:

```
df_copy_4['CUST_MAG_77'] = 1 - (df_copy_4['DIFF_77'] / df_copy_4['DIFF_77'].
 ↪max())
df_copy_4['CUST_MAG_86'] = 1 - (df_copy_4['DIFF_86'] / df_copy_4['DIFF_86'].
 ↪max())
df_copy_4['CUST_MAG_88'] = 1 - (df_copy_4['DIFF_88'] / df_copy_4['DIFF_88'].
 ↪max())
```

[37]:

```
df_copy_4.describe()
```

[37]:
```
          STORE_NBR        MONTH   CUST_COUNT      DIFF_77      DIFF_86  \
count  2080.000000  2080.000000  2080.000000  2080.000000  2080.000000
mean    136.892308    10.500000    70.779327    37.216827    36.638942
std      78.446754     2.291839    36.208788    26.819594    29.822127
min       1.000000     7.000000     1.000000     0.000000     0.000000
25%      68.750000     8.750000    41.000000     8.000000     9.000000
50%     137.500000    10.500000    82.500000    42.000000    28.500000
75%     203.250000    12.250000   103.000000    60.000000    60.000000
max     272.000000    14.000000   150.000000   104.000000   108.000000

           DIFF_88  CUST_MAG_77  CUST_MAG_86  CUST_MAG_88
count  2080.000000  2080.000000  2080.000000  2080.000000
mean     54.946635     0.642146     0.660751     0.574057
std      36.065151     0.257881     0.276131     0.279575
min       0.000000     0.000000     0.000000     0.000000
25%      23.000000     0.423077     0.444444     0.348837
50%      45.000000     0.596154     0.736111     0.651163
75%      84.000000     0.923077     0.916667     0.821705
max     129.000000     1.000000     1.000000     1.000000
```

[38]:
```
df_mag_1 = df_copy_4[['STORE_NBR', 'CUST_MAG_77', 'CUST_MAG_86',␣
 ↪'CUST_MAG_88']].groupby(by='STORE_NBR', as_index=False).mean()
df_mag_1
```

[38]:
```
     STORE_NBR  CUST_MAG_77  CUST_MAG_86  CUST_MAG_88
0            1     0.943510     0.496528     0.384690
1            2     0.919471     0.417824     0.318798
2            3     0.379808     0.921296     0.860465
3            4     0.283654     0.805556     0.905039
4            5     0.526442     0.916667     0.742248
..         …          …          …          …
255        268     0.939904     0.462963     0.356589
256        269     0.393029     0.931713     0.849806
257        270     0.418269     0.900463     0.829457
258        271     0.526442     0.923611     0.742248
259        272     0.957933     0.471065     0.363372

[260 rows x 4 columns]
```

[39]:
```
df_mag = df_mag.merge(df_mag_1, on='STORE_NBR')
```

[40]:
```
df_mag.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 260 entries, 0 to 259
Data columns (total 7 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
```

```
 0   STORE_NBR     260 non-null    int64
 1   SALES_MAG_77  260 non-null    float64
 2   SALES_MAG_86  260 non-null    float64
 3   SALES_MAG_88  260 non-null    float64
 4   CUST_MAG_77   260 non-null    float64
 5   CUST_MAG_86   260 non-null    float64
 6   CUST_MAG_88   260 non-null    float64
dtypes: float64(6), int64(1)
memory usage: 16.2 KB
```

0.5 Creating Comparison Data Frame / Finding Control Stores

[41]:
```
d = {'STORE_NBR':store_list, 'SALES_CORR_77':sales_corr_77, 'SALES_CORR_86':
 ↪sales_corr_86, 'SALES_CORR_88':sales_corr_88,
     'CUST_CORR_77':cust_corr_77, 'CUST_CORR_86':cust_corr_86, 'CUST_CORR_88':
 ↪cust_corr_88}
df_corr = pd.DataFrame(data=d)
df_corr.head()
```

[41]:
```
   STORE_NBR  SALES_CORR_77  SALES_CORR_86  SALES_CORR_88  CUST_CORR_77  \
0          1       0.050163       0.478355       0.823306      0.350572
1          2      -0.200796      -0.453556      -0.151853     -0.455226
2          3       0.616574      -0.081104      -0.288716      0.756913
3          4      -0.094125      -0.204603      -0.619880     -0.302046
4          5      -0.045765       0.067263       0.038594      0.277619

   CUST_CORR_86  CUST_CORR_88
0      0.559062      0.242805
1     -0.428881     -0.156135
2      0.026475      0.341899
3     -0.462982     -0.122544
4     -0.391022      0.028866
```

[42]:
```
df_corr.describe()
```

[42]:
```
        STORE_NBR  SALES_CORR_77  SALES_CORR_86  SALES_CORR_88  CUST_CORR_77  \
count  257.000000     257.000000     257.000000     257.000000    257.000000
mean   137.513619       0.054833      -0.029873      -0.091776      0.031999
std     78.823780       0.336567       0.385558       0.356382      0.349286
min      1.000000      -0.674915      -0.876296      -0.825262     -0.700131
25%     68.000000      -0.187933      -0.347284      -0.327081     -0.211958
50%    139.000000       0.050163      -0.032578      -0.112723      0.004218
75%    204.000000       0.323690       0.224196       0.136432      0.277619
max    272.000000       0.894375       0.841589       0.895637      0.990542

       CUST_CORR_86  CUST_CORR_88
count    257.000000    257.000000
```

```
mean      -0.150912     0.064728
std        0.357292     0.349681
min       -0.877478    -0.827778
25%       -0.412005    -0.189143
50%       -0.184714     0.051040
75%        0.086323     0.296430
max        0.772289     0.942232
```

```
[43]: df_control = df_corr.merge(df_mag, on='STORE_NBR')
```

```
[44]: df_control.tail()
```

```
[44]:      STORE_NBR  SALES_CORR_77  SALES_CORR_86  SALES_CORR_88  CUST_CORR_77  \
252        268       0.350807      -0.494257      -0.100489      0.283287
253        269      -0.315842       0.681775      -0.165132     -0.492708
254        270       0.324937      -0.747037      -0.737748     -0.176932
255        271       0.362891       0.409585      -0.166019     -0.056788
256        272       0.114645       0.011432      -0.747878      0.238448

     CUST_CORR_86  CUST_CORR_88  SALES_MAG_77  SALES_MAG_86  SALES_MAG_88  \
252     -0.203460      0.668599      0.962252      0.296949      0.199285
253     -0.236966     -0.214158      0.489541      0.914898      0.722391
254     -0.803394     -0.045451      0.494330      0.864479      0.717665
255     -0.024829      0.048096      0.589052      0.913748      0.624212
256     -0.247201      0.009256      0.891739      0.485408      0.325578

     CUST_MAG_77  CUST_MAG_86  CUST_MAG_88
252     0.939904     0.462963     0.356589
253     0.393029     0.931713     0.849806
254     0.418269     0.900463     0.829457
255     0.526442     0.923611     0.742248
256     0.957933     0.471065     0.363372
```

```
[45]: df_control['SALES_SCORE_77'] = (0.5*df_control['SALES_CORR_77'] + 0.
       ↪5*df_control['SALES_MAG_77'])
      df_control['SALES_SCORE_86'] = (0.5*df_control['SALES_CORR_86'] + 0.
       ↪5*df_control['SALES_MAG_86'])
      df_control['SALES_SCORE_88'] = (0.5*df_control['SALES_CORR_88'] + 0.
       ↪5*df_control['SALES_MAG_88'])
      df_control['CUST_SCORE_77'] = (0.5*df_control['CUST_CORR_77'] + 0.
       ↪5*df_control['CUST_MAG_77'])
      df_control['CUST_SCORE_86'] = (0.5*df_control['CUST_CORR_86'] + 0.
       ↪5*df_control['CUST_MAG_86'])
      df_control['CUST_SCORE_88'] = (0.5*df_control['CUST_CORR_88'] + 0.
       ↪5*df_control['CUST_MAG_88'])
      df_control.head()
```

[45]:

```
   STORE_NBR  SALES_CORR_77  SALES_CORR_86  SALES_CORR_88  CUST_CORR_77  \
0          1       0.050163       0.478355       0.823306      0.350572   
1          2      -0.200796      -0.453556      -0.151853     -0.455226   
2          3       0.616574      -0.081104      -0.288716      0.756913   
3          4      -0.094125      -0.204603      -0.619880     -0.302046   
4          5      -0.045765       0.067263       0.038594      0.277619   

   CUST_CORR_86  CUST_CORR_88  SALES_MAG_77  SALES_MAG_86  SALES_MAG_88  \
0      0.559062      0.242805      0.961494      0.283500      0.190272   
1     -0.428881     -0.156135      0.940198      0.237978      0.159767   
2      0.026475      0.341899      0.390411      0.776515      0.820193   
3     -0.462982     -0.122544      0.274905      0.598584      0.872414   
4     -0.391022      0.028866      0.593056      0.915096      0.620261   

   CUST_MAG_77  CUST_MAG_86  CUST_MAG_88  SALES_SCORE_77  SALES_SCORE_86  \
0     0.943510     0.496528     0.384690        0.505828        0.380927   
1     0.919471     0.417824     0.318798        0.369701       -0.107789   
2     0.379808     0.921296     0.860465        0.503492        0.347706   
3     0.283654     0.805556     0.905039        0.090390        0.196991   
4     0.526442     0.916667     0.742248        0.273645        0.491180   

   SALES_SCORE_88  CUST_SCORE_77  CUST_SCORE_86  CUST_SCORE_88  
0        0.506789       0.647041       0.527795       0.313748  
1        0.003957       0.232122      -0.005528       0.081332  
2        0.265738       0.568360       0.473886       0.601182  
3        0.126267      -0.009196       0.171287       0.391247  
4        0.329428       0.402031       0.262822       0.385557  
```

[46]:

```
df_control['TOTAL_SCORE_77'] = (0.5*df_control['SALES_SCORE_77'] + 0.
 ↪5*df_control['CUST_SCORE_77'])
df_control['TOTAL_SCORE_86'] = (0.5*df_control['SALES_SCORE_86'] + 0.
 ↪5*df_control['CUST_SCORE_86'])
df_control['TOTAL_SCORE_88'] = (0.5*df_control['SALES_SCORE_88'] + 0.
 ↪5*df_control['CUST_SCORE_88'])
df_control.head()
```

[46]:

```
   STORE_NBR  SALES_CORR_77  SALES_CORR_86  SALES_CORR_88  CUST_CORR_77  \
0          1       0.050163       0.478355       0.823306      0.350572   
1          2      -0.200796      -0.453556      -0.151853     -0.455226   
2          3       0.616574      -0.081104      -0.288716      0.756913   
3          4      -0.094125      -0.204603      -0.619880     -0.302046   
4          5      -0.045765       0.067263       0.038594      0.277619   

   CUST_CORR_86  CUST_CORR_88  SALES_MAG_77  SALES_MAG_86  SALES_MAG_88  …  \
0      0.559062      0.242805      0.961494      0.283500      0.190272  …   
1     -0.428881     -0.156135      0.940198      0.237978      0.159767  …   
2      0.026475      0.341899      0.390411      0.776515      0.820193  …   
```

```
3     -0.462982     -0.122544      0.274905      0.598584      0.872414  …
4     -0.391022      0.028866      0.593056      0.915096      0.620261  …

   CUST_MAG_88  SALES_SCORE_77  SALES_SCORE_86  SALES_SCORE_88  CUST_SCORE_77  \
0     0.384690        0.505828        0.380927        0.506789       0.647041
1     0.318798        0.369701       -0.107789        0.003957       0.232122
2     0.860465        0.503492        0.347706        0.265738       0.568360
3     0.905039        0.090390        0.196991        0.126267      -0.009196
4     0.742248        0.273645        0.491180        0.329428       0.402031

   CUST_SCORE_86  CUST_SCORE_88  TOTAL_SCORE_77  TOTAL_SCORE_86  \
0       0.527795       0.313748        0.576435        0.454361
1      -0.005528       0.081332        0.300912       -0.056659
2       0.473886       0.601182        0.535926        0.410796
3       0.171287       0.391247        0.040597        0.184139
4       0.262822       0.385557        0.337838        0.377001

   TOTAL_SCORE_88
0        0.410269
1        0.042644
2        0.433460
3        0.258757
4        0.357492

[5 rows x 22 columns]
```

[47]:
```
df_result = df_control[['STORE_NBR','TOTAL_SCORE_77', 'TOTAL_SCORE_86',␣
 ↪'TOTAL_SCORE_88']]
df_result
```

[47]:
```
     STORE_NBR  TOTAL_SCORE_77  TOTAL_SCORE_86  TOTAL_SCORE_88
0            1        0.576435        0.454361        0.410269
1            2        0.300912       -0.056659        0.042644
2            3        0.535926        0.410796        0.433460
3            4        0.040597        0.184139        0.258757
4            5        0.337838        0.377001        0.357492
..         …             …             …             …
252        268        0.634063        0.015549        0.280996
253        269        0.018505        0.572855        0.298227
254        270        0.265151        0.053628        0.190981
255        271        0.355399        0.555529        0.312134
256        272        0.550691        0.180176       -0.012418

[257 rows x 4 columns]
```

[48]:
```
df_result.describe()
```

[48]:

```
        STORE_NBR  TOTAL_SCORE_77  TOTAL_SCORE_86  TOTAL_SCORE_88
count  257.000000      257.000000      257.000000      257.000000
mean   137.513619        0.355163        0.269976        0.257118
std     78.823780        0.198052        0.227057        0.186415
min      1.000000       -0.100813       -0.304428       -0.162293
25%     68.000000        0.223326        0.101460        0.125600
50%    139.000000        0.337444        0.265018        0.250181
75%    204.000000        0.471012        0.427682        0.404595
max    272.000000        0.966567        0.857325        0.810943
```

[49]:

```
control_store_1 = df_result[df_result['TOTAL_SCORE_77'] ==␣
 ↪df_result['TOTAL_SCORE_77'].max()]
control_store_1.drop(['TOTAL_SCORE_86', 'TOTAL_SCORE_88'], axis = 1, inplace =␣
 ↪True)
control_store_1
```

[49]:

```
     STORE_NBR  TOTAL_SCORE_77
218        233        0.966567
```

[50]:

```
control_store_2 = df_result[df_result['TOTAL_SCORE_86'] ==␣
 ↪df_result['TOTAL_SCORE_86'].max()]
control_store_2.drop(['TOTAL_SCORE_77', 'TOTAL_SCORE_88'], axis = 1, inplace =␣
 ↪True)
control_store_2
```

[50]:

```
     STORE_NBR  TOTAL_SCORE_86
144        155        0.857325
```

[51]:

```
control_store_3 = df_result[df_result['TOTAL_SCORE_88'] ==␣
 ↪df_result['TOTAL_SCORE_88'].max()]
control_store_3.drop(['TOTAL_SCORE_77', 'TOTAL_SCORE_86'], axis = 1, inplace =␣
 ↪True)
control_store_3
```

[51]:

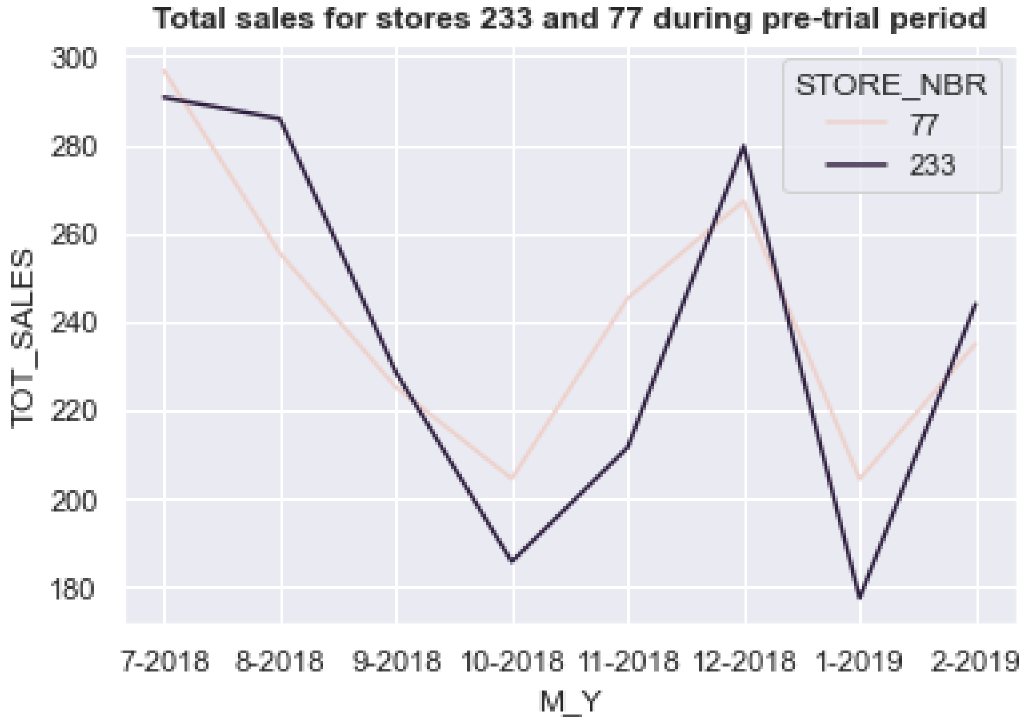
```
     STORE_NBR  TOTAL_SCORE_88
222        237        0.810943
```

[201]:

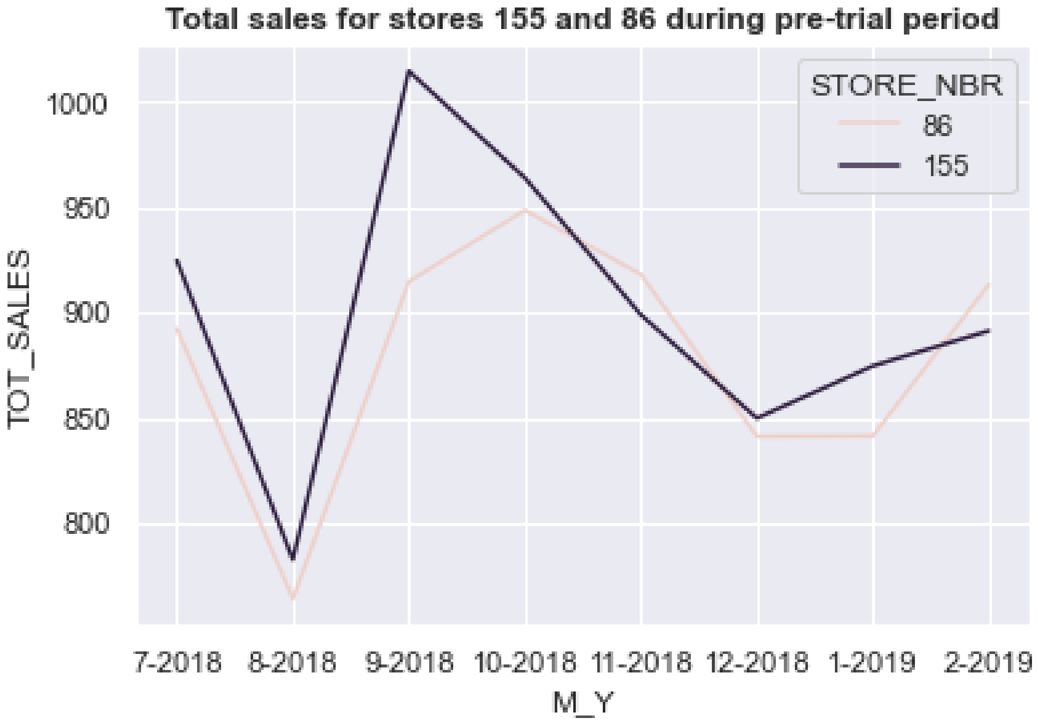
```
def sales_graph(control, trial):
    query_string = 'STORE_NBR == ' + str(control) + ' or STORE_NBR == ' +␣
 ↪str(trial)
    df_graph = df_copy_1.query(query_string)
    g = sns.lineplot(data = df_graph, x='M_Y', y='TOT_SALES', hue='STORE_NBR')
    title = 'Total sales for stores ' + str(control) + ' and ' + str(trial) + '␣
 ↪during pre-trial period'
    g.set_title(title, weight = 'bold');
```

[202]:

```
sales_graph(233, 77)
```

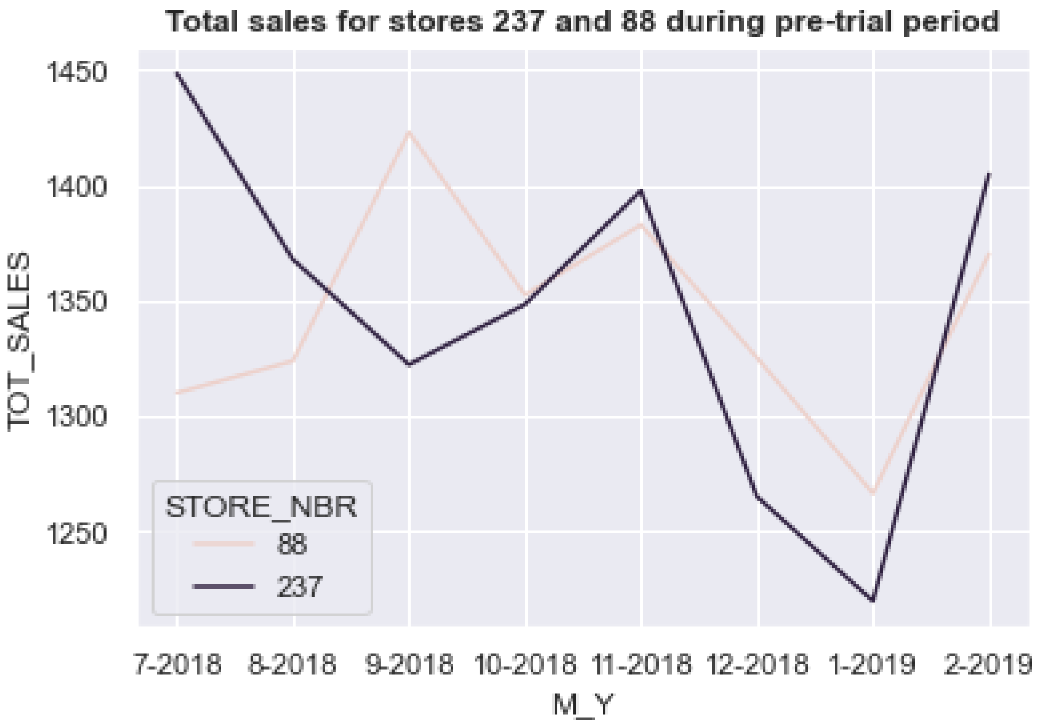


[203]:
```
sales_graph(155, 86)
```



[204]:

```
sales_graph(237, 88)
```

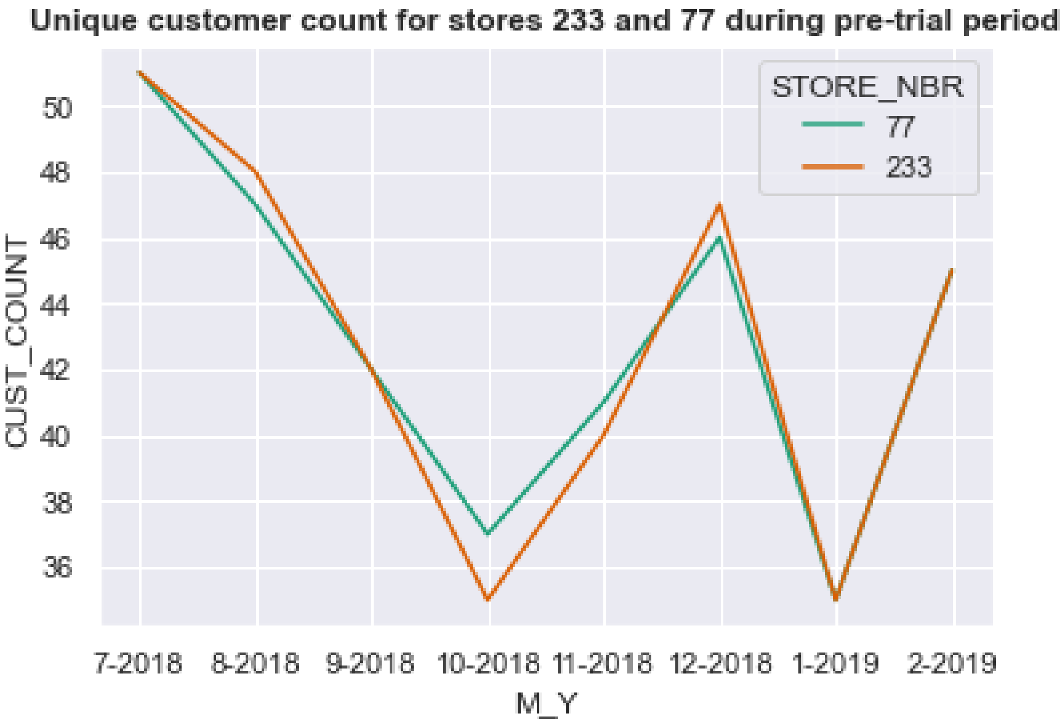


[232]:

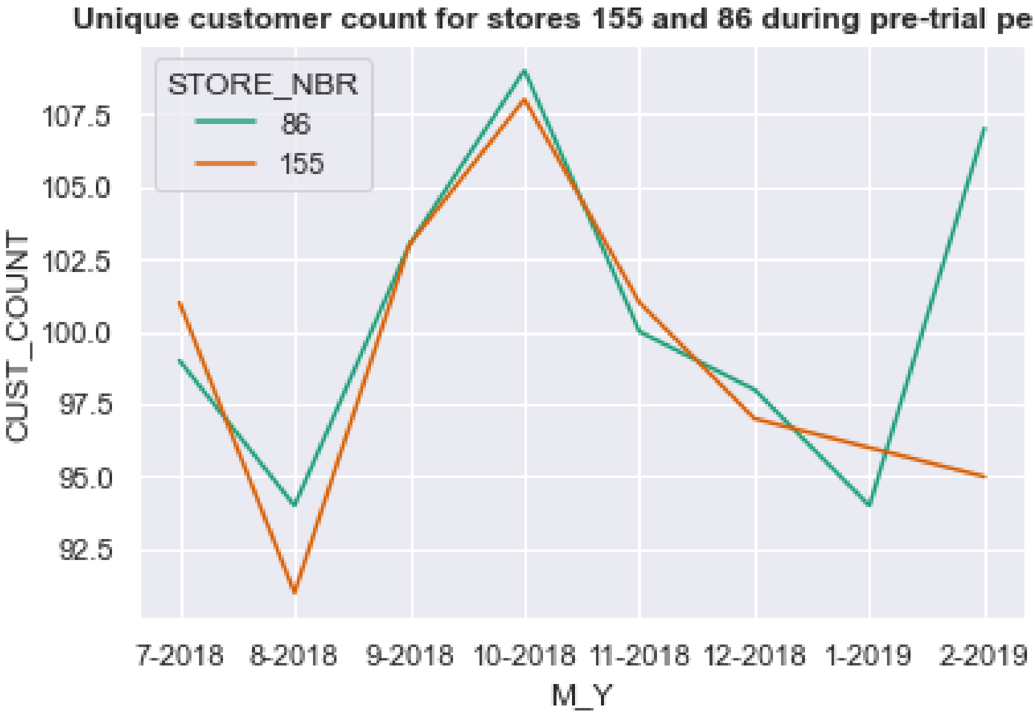
```
def cust_graph(control, trial):
    query_string = 'STORE_NBR == ' + str(control) + ' or STORE_NBR == ' +␣
 ↪str(trial)
    df_graph = df_copy_3.query(query_string)
    g = sns.lineplot(data = df_graph, x='M_Y', y='CUST_COUNT', hue='STORE_NBR',␣
 ↪palette = 'Dark2')
    title = 'Unique customer count for stores ' + str(control) + ' and ' +␣
 ↪str(trial) + ' during pre-trial period'
    g.set_title(title, weight = 'bold');
```

[233]:

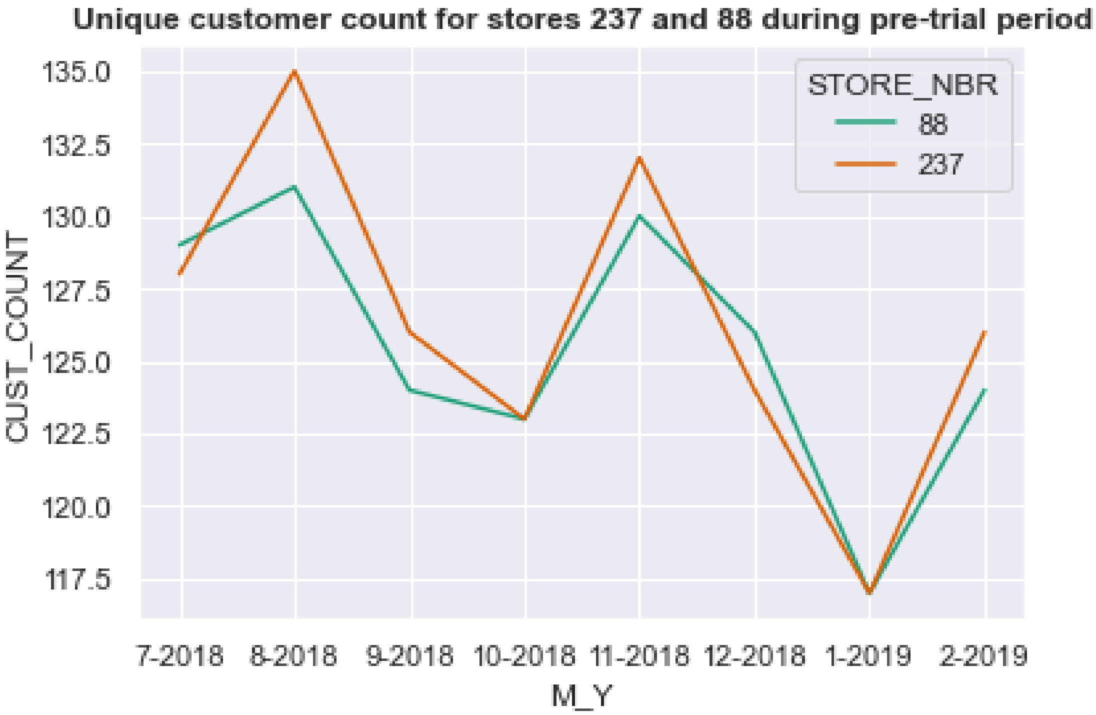
```
cust_graph(233, 77)
```



```
[220]: cust_graph(155, 86)
```



[221]:
```
cust_graph(237, 88)
```



0.5.1 The control stores for stores 77, 86, and 88 are 233, 155, and 237, respectively.

0.6 Comparing Trial Stores to Control Stores

[146]:
```
query_trial_string = 'STORE_NBR == 77 or STORE_NBR == 86 or STORE_NBR == 88 or '
query_control_string = 'STORE_NBR == 155 or STORE_NBR == 233 or STORE_NBR ==␣
 ↪237'
query_string = query_trial_string + query_control_string
df_compare = df_copy.query(query_string)
df_compare.head()
```

[146]:
```
      LYLTY_CARD_NBR       DATE  STORE_NBR  TXN_ID  PROD_NBR  \
6316           77004  7/18/2018         77   74918        30
6317           77004  7/26/2018         77   74919        46
6318           77015   7/7/2018         77   74931        85
6319           77018  7/18/2018         77   74933        50
6320           77049  7/14/2018         77   74964        93

                                   PROD_NAME  PROD_QTY  TOT_SALES  PACK_SIZE  \
6316  Doritos Corn Chips  Cheese Supreme 170g         1        4.4        170
```

```
6317                     Kettle Original 175g         2       10.8         175
6318            RRD Honey Soy       Chicken 165g         2        6.0         165
6319             Tostitos Lightly     Salted 175g         1        4.4         175
6320  Doritos Corn Chip Southern Chicken 150g         1        3.9         150

         BRAND              LIFESTAGE PREMIUM_CUSTOMER  MONTH  YEAR     M_Y
6316   DORITOS               RETIREES           Budget      7  2018  7-2018
6317    KETTLE               RETIREES           Budget      7  2018  7-2018
6318       RRD         YOUNG FAMILIES          Premium      7  2018  7-2018
6319  TOSTITOS  OLDER SINGLES/COUPLES           Budget      7  2018  7-2018
6320   DORITOS  YOUNG SINGLES/COUPLES       Mainstream      7  2018  7-2018
```

[147]:
```
df_compare.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 7829 entries, 6316 to 264833
Data columns (total 15 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   LYLTY_CARD_NBR    7829 non-null   int64
 1   DATE              7829 non-null   object
 2   STORE_NBR         7829 non-null   int64
 3   TXN_ID            7829 non-null   int64
 4   PROD_NBR          7829 non-null   int64
 5   PROD_NAME         7829 non-null   object
 6   PROD_QTY          7829 non-null   int64
 7   TOT_SALES         7829 non-null   float64
 8   PACK_SIZE         7829 non-null   int64
 9   BRAND             7829 non-null   object
 10  LIFESTAGE         7829 non-null   object
 11  PREMIUM_CUSTOMER  7829 non-null   object
 12  MONTH             7829 non-null   int32
 13  YEAR              7829 non-null   object
 14  M_Y               7829 non-null   object
dtypes: float64(1), int32(1), int64(6), object(7)
memory usage: 948.0+ KB
```

[88]:
```
df_compare['STORE_NBR'].value_counts()
```

[88]:
```
88     1873
237    1785
86     1538
155    1535
77      563
233     535
Name: STORE_NBR, dtype: int64
```

```
[89]: df_compare = df_compare[['STORE_NBR', 'TOT_SALES', 'MONTH', 'M_Y',␣
       ↪'LYLTY_CARD_NBR']]
      df_compare.head()
```

```
[89]:       STORE_NBR  TOT_SALES  MONTH     M_Y  LYLTY_CARD_NBR
      6316         77        4.4      7  7-2018           77004
      6317         77       10.8      7  7-2018           77004
      6318         77        6.0      7  7-2018           77015
      6319         77        4.4      7  7-2018           77018
      6320         77        3.9      7  7-2018           77049
```

```
[90]: df_compare.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 7829 entries, 6316 to 264833
Data columns (total 5 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   STORE_NBR       7829 non-null   int64
 1   TOT_SALES       7829 non-null   float64
 2   MONTH           7829 non-null   int32
 3   M_Y             7829 non-null   object
 4   LYLTY_CARD_NBR  7829 non-null   int64
dtypes: float64(1), int32(1), int64(2), object(1)
memory usage: 336.4+ KB
```

```
[91]: df_compare['LYLTY_CARD_NBR'] = df_compare['LYLTY_CARD_NBR'].astype(str)
      df_compare['M_Y+LYLTY_CARD_NBR'] = df_compare['LYLTY_CARD_NBR'] + '-' +␣
       ↪df_compare['M_Y']
      df_compare.head()
```

```
[91]:       STORE_NBR  TOT_SALES  MONTH     M_Y LYLTY_CARD_NBR M_Y+LYLTY_CARD_NBR
      6316         77        4.4      7  7-2018          77004       77004-7-2018
      6317         77       10.8      7  7-2018          77004       77004-7-2018
      6318         77        6.0      7  7-2018          77015       77015-7-2018
      6319         77        4.4      7  7-2018          77018       77018-7-2018
      6320         77        3.9      7  7-2018          77049       77049-7-2018
```

```
[98]: df_cust_compare = df_compare.drop_duplicates(subset='M_Y+LYLTY_CARD_NBR')
      df_cust_compare.drop(['M_Y+LYLTY_CARD_NBR', 'TOT_SALES'], axis=1, inplace=True)
      df_cust_compare = df_cust_compare.groupby(['STORE_NBR', 'M_Y', 'MONTH'],␣
       ↪as_index=False).count()
      df_cust_compare = df_cust_compare.rename(columns={'LYLTY_CARD_NBR':
       ↪'CUST_COUNT'})
      df_cust_compare['MONTH'] = df_cust_compare['MONTH'].
       ↪replace([1,2,3,4,5,6],[13,14,15,16,17,18])
      df_cust_compare.sort_values(by=['STORE_NBR','MONTH'], inplace=True)
      df_cust_compare = df_cust_compare.reset_index(drop=True)
```

```
df_cust_compare.head(13)
```

[98]:

```
    STORE_NBR      M_Y  MONTH  CUST_COUNT
0          77   7-2018      7          51
1          77   8-2018      8          47
2          77   9-2018      9          42
3          77  10-2018     10          37
4          77  11-2018     11          41
5          77  12-2018     12          46
6          77   1-2019     13          35
7          77   2-2019     14          45
8          77   3-2019     15          50
9          77   4-2019     16          47
10         77   5-2019     17          55
11         77   6-2019     18          41
12         86   7-2018      7          99
```

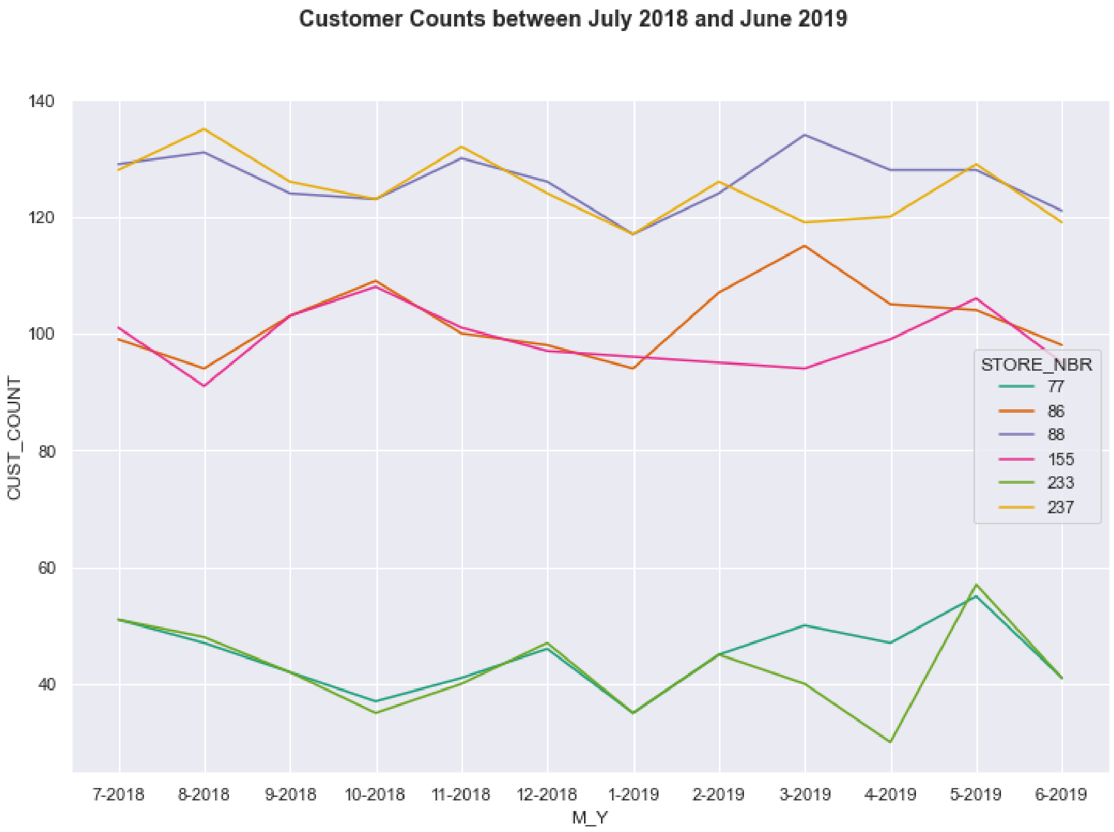
[100]:

```
df_cust_compare['CUST_DIFF'] = 0
df_cust_compare.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 72 entries, 0 to 71
Data columns (total 5 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   STORE_NBR   72 non-null     int64
 1   M_Y         72 non-null     object
 2   MONTH       72 non-null     int64
 3   CUST_COUNT  72 non-null     int64
 4   CUST_DIFF   72 non-null     int64
dtypes: int64(4), object(1)
memory usage: 2.9+ KB
```

[163]:

```
fig = plt.figure(figsize=[12,8])
fig.suptitle('Customer Counts between July 2018 and June 2019', weight='bold')
sns.lineplot(data=df_cust_compare, x='M_Y', y='CUST_COUNT', hue='STORE_NBR',␣
 ↪palette='Dark2');
```



```
[149]: def cust_t_test (trial, control):
           query_control = 'STORE_NBR == ' + str(control)
           query_trial = 'STORE_NBR == ' + str(trial)
           query_string = query_control + 'or ' + query_trial
           df = df_cust_compare.query(query_string)
           df = df.reset_index(drop=True)
           for i in range(df.shape[0]):
               if df['STORE_NBR'][i] == control:
                   df['CUST_DIFF'][i] = abs(df['CUST_COUNT'][i] -␣
        ↪df['CUST_COUNT'][i+12])
           df_control = df.query('MONTH < 14 and ' + query_control)
           df_trial = df.query('MONTH >= 14 and MONTH < 17 and ' + query_control)
           print(stats.ttest_ind(df_control['CUST_DIFF'], df_trial['CUST_DIFF']))
           #print('April: ' , stats.ttest_ind(df_control_apr['TOT_SALES'],␣
        ↪df_trial_apr['TOT_SALES']))
           #print('May: ' , stats.ttest_ind(df_control_may['TOT_SALES'],␣
        ↪df_trial_may['TOT_SALES']))
```

```
[150]: cust_t_test(233, 77)
```

```
Ttest_indResult(statistic=-2.7782272846411047, pvalue=0.023990097088668012)
```

```
[151]: cust_t_test(155, 86)
```

```
Ttest_indResult(statistic=-4.3347956653826865, pvalue=0.0024958096834224014)
```

```
[152]: cust_t_test(237, 88)
```

```
Ttest_indResult(statistic=-2.8231118423307824, pvalue=0.022386349173828999)
```

```
[164]: df_compare.head()
```

```
[164]:       LYLTY_CARD_NBR       DATE  STORE_NBR  TXN_ID  PROD_NBR  \
       6316           77004  7/18/2018         77   74918        30
       6317           77004  7/26/2018         77   74919        46
       6318           77015   7/7/2018         77   74931        85
       6319           77018  7/18/2018         77   74933        50
       6320           77049  7/14/2018         77   74964        93

                                          PROD_NAME  PROD_QTY  TOT_SALES  PACK_SIZE  \
       6316  Doritos Corn Chips  Cheese Supreme 170g         1        4.4        170
       6317                    Kettle Original 175g         2       10.8        175
       6318         RRD Honey Soy        Chicken 165g         2        6.0        165
       6319           Tostitos Lightly     Salted 175g         1        4.4        175
       6320  Doritos Corn Chip Southern Chicken 150g         1        3.9        150

                BRAND              LIFESTAGE PREMIUM_CUSTOMER  MONTH  YEAR     M_Y
       6316   DORITOS               RETIREES           Budget      7  2018  7-2018
       6317    KETTLE               RETIREES           Budget      7  2018  7-2018
       6318       RRD         YOUNG FAMILIES          Premium      7  2018  7-2018
       6319  TOSTITOS  OLDER SINGLES/COUPLES           Budget      7  2018  7-2018
       6320   DORITOS  YOUNG SINGLES/COUPLES       Mainstream      7  2018  7-2018
```

```
[171]: df_sales_compare = df_compare[['STORE_NBR', 'TOT_SALES', 'MONTH', 'M_Y']]
       df_sales_compare = df_sales_compare.groupby(by=['STORE_NBR', 'MONTH', 'M_Y'],␣
        ↪as_index=False).sum()
       df_sales_compare['MONTH'] = df_sales_compare['MONTH'].
        ↪replace([1,2,3,4,5,6],[13,14,15,16,17,18])
       df_sales_compare.sort_values(by=['STORE_NBR', 'MONTH'], inplace=True)
       df_sales_compare.reset_index(drop=True, inplace=True)
       df_sales_compare.head(13)
```

```
[171]:    STORE_NBR  MONTH      M_Y  TOT_SALES
       0         77      7   7-2018      296.8
       1         77      8   8-2018      255.5
       2         77      9   9-2018      225.2
       3         77     10  10-2018      204.5
       4         77     11  11-2018      245.3
       5         77     12  12-2018      267.3
```

```
6          77     13   1-2019      204.4
7          77     14   2-2019      235.0
8          77     15   3-2019      278.5
9          77     16   4-2019      263.5
10         77     17   5-2019      299.3
11         77     18   6-2019      264.7
12         86      7   7-2018      892.2
```

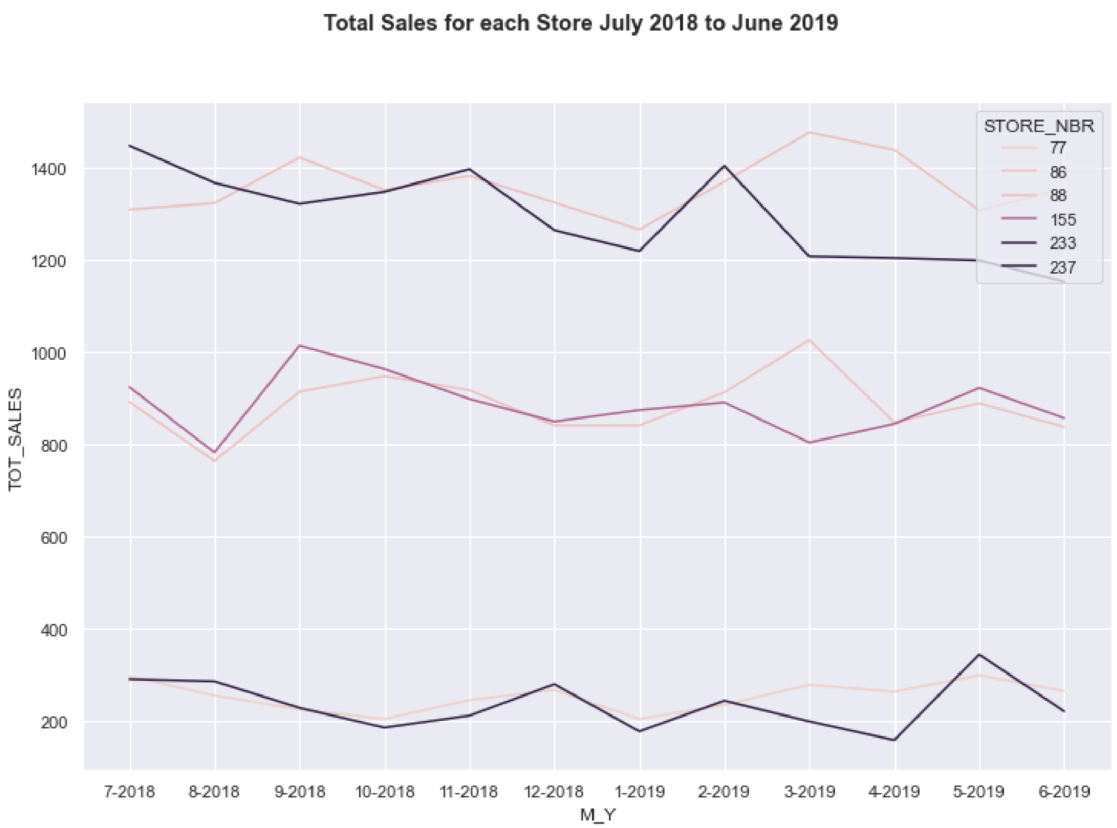
[175]:

```
df_sales_compare['SALES_DIFF'] = 0
df_sales_compare.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 72 entries, 0 to 71
Data columns (total 5 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   STORE_NBR   72 non-null     int64
 1   MONTH       72 non-null     int64
 2   M_Y         72 non-null     object
 3   TOT_SALES   72 non-null     float64
 4   SALES_DIFF  72 non-null     int64
dtypes: float64(1), int64(3), object(1)
memory usage: 2.9+ KB
```

[173]:

```
fig = plt.figure(figsize=[12,8])
fig.suptitle('Total Sales for each Store July 2018 to June 2019', weight='bold')
sns.lineplot(data=df_sales_compare, x='M_Y', y='TOT_SALES', hue='STORE_NBR',␣
 ↪color='Dark2');
```



```
[176]: def sales_t_test (trial, control):
           query_control = 'STORE_NBR == ' + str(control)
           query_trial = 'STORE_NBR == ' + str(trial)
           query_string = query_control + 'or ' + query_trial
           df = df_sales_compare.query(query_string)
           df = df.reset_index(drop=True)
           for i in range(df.shape[0]):
               if df['STORE_NBR'][i] == control:
                   df['SALES_DIFF'][i] = abs(df['TOT_SALES'][i] -␣
        ↪df['TOT_SALES'][i+12])
           df_control = df.query('MONTH < 14 and ' + query_control)
           df_trial = df.query('MONTH >= 14 and MONTH < 17 and ' + query_control)
           print(stats.ttest_ind(df_control['SALES_DIFF'], df_trial['SALES_DIFF']))
           #print('April: ' , stats.ttest_ind(df_control_apr['TOT_SALES'],␣
        ↪df_trial_apr['TOT_SALES']))
           #print('May: ' , stats.ttest_ind(df_control_may['TOT_SALES'],␣
        ↪df_trial_may['TOT_SALES']))
```

```
[177]: sales_t_test(233, 77)
```

```
Ttest_indResult(statistic=-2.4845549222870376, pvalue=0.03784202458851265)
```

```
[178]: sales_t_test(155, 86)
```

```
Ttest_indResult(statistic=-1.1002256939442643, pvalue=0.30323515424681996)
```

```
[179]: sales_t_test(237, 88)
```

```
Ttest_indResult(statistic=-2.3249925736853405, pvalue=0.04853964305544441)
```

0.6.1 Sales in trial period are statistically significant for stores 77 and 88 with p-values < 0.05. Sales are not statistically significant for store 86 for trial period (p-value $= 0.3$). However, number of unique customers in trial period is statistically significant for all stores in comparison to pre-trial period.