

task02

January 14, 2024

```
[1]: import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.dates as mdates
%matplotlib inline
```

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

```
[2]:
```

	LYLTY_CARD_NBR	DATE	STORE_NBR	TXN_ID	PROD_NBR	\
0	1000	2018-10-17	1	1	5	
1	1002	2018-09-16	1	2	58	
2	1003	2019-03-07	1	3	52	
3	1003	2019-03-08	1	4	106	
4	1004	2018-11-02	1	5	96	

		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	

	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

```
[3]: df.shape
```

```
[3]: (264834, 12)
```

```
[4]: 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

```
[5]: df.dtypes
```

```
[5]: LYLTY_CARD_NBR      int64
      DATE              object
      STORE_NBR        int64
      TXN_ID            int64
      PROD_NBR          int64
      PROD_NAME         object
      PROD_QTY          int64
      TOT_SALES         float64
      PACK_SIZE         int64
      BRAND             object
      LIFESTAGE         object
      PREMIUM_CUSTOMER  object
      dtype: object
```

```
[6]: df.isnull().sum()
```

```
[6]: LYLTY_CARD_NBR      0
      DATE              0
      STORE_NBR        0
      TXN_ID            0
      PROD_NBR          0
      PROD_NAME         0
      PROD_QTY          0
      TOT_SALES         0
      PACK_SIZE         0
      BRAND             0
      LIFESTAGE         0
```

```
PREMIUM_CUSTOMER    0
dtype: int64
```

```
[7]: df.count()
```

```
[7]: LYLTY_CARD_NBR    264834
      DATE            264834
      STORE_NBR       264834
      TXN_ID          264834
      PROD_NBR        264834
      PROD_NAME       264834
      PROD_QTY        264834
      TOT_SALES       264834
      PACK_SIZE       264834
      BRAND           264834
      LIFESTAGE       264834
      PREMIUM_CUSTOMER 264834
dtype: int64
```

```
[8]: df.nunique()
```

```
[8]: LYLTY_CARD_NBR    72636
      DATE            364
      STORE_NBR       272
      TXN_ID          263125
      PROD_NBR        114
      PROD_NAME       114
      PROD_QTY         5
      TOT_SALES       111
      PACK_SIZE       21
      BRAND           21
      LIFESTAGE        7
      PREMIUM_CUSTOMER 3
dtype: int64
```

The first task is selecting the control stores. We need to keep in mind that the client already selected stores 77, 86 and 88 as trial stores and we need the control stores to be similar to the trial stores prior to the trial period of Feb 2019 to compare them.

The main metrics we will consider here are:

Monthly overall sales revenue

Monthly number of customers

Monthly number of transactions per customer

```
[10]: # Assuming 'DATE' column is in string format, convert it to datetime
      df['DATE'] = pd.to_datetime(df['DATE'])
      # df['YEARMONTH'] = df['year'] + df['month']
```

```
df['YEARMONTH'] = df['DATE'].dt.year.astype(str) + df['DATE'].dt.month.map("{:
↪02}".format).astype(str)
df['YEARMONTH'] = pd.to_numeric(df['YEARMONTH'])
print(df['YEARMONTH'])
```

```
0      201810
1      201809
2      201903
3      201903
4      201811
...
264829  201812
264830  201810
264831  201810
264832  201810
264833  201812
Name: YEARMONTH, Length: 264834, dtype: int64
```

```
[11]: # sum of total monthly store sales
Sales = df.groupby(['STORE_NBR', 'YEARMONTH']).TOT_SALES.sum()
Sales
```

```
[11]: STORE_NBR  YEARMONTH
1      201807      206.9
      201808      176.1
      201809      278.8
      201810      188.1
      201811      192.6
...
272    201902      395.5
      201903      442.3
      201904      445.1
      201905      314.6
      201906      312.1
Name: TOT_SALES, Length: 3169, dtype: float64
```

```
[12]: # Count of number of customers using specific store in each month
Customers = df.groupby(['STORE_NBR', 'YEARMONTH']).LYLTY_CARD_NBR.nunique()
Customers
```

```
[12]: STORE_NBR  YEARMONTH
1      201807      49
      201808      42
      201809      59
      201810      44
      201811      46
..
```

272	201902	45
	201903	50
	201904	54
	201905	34
	201906	34

Name: LYLTY_CARD_NBR, Length: 3169, dtype: int64

```
[13]: # Transactions per customer for each store per month
TPC = df.groupby(['STORE_NBR', 'YEARMONTH']).TXN_ID.nunique()/df.
      ↳groupby(['STORE_NBR', 'YEARMONTH']).LYLTY_CARD_NBR.nunique()
TPC
```

```
[13]: STORE_NBR  YEARMONTH
1          201807      1.061224
          201808      1.023810
          201809      1.050847
          201810      1.022727
          201811      1.021739
          ...
272        201902      1.066667
          201903      1.060000
          201904      1.018519
          201905      1.176471
          201906      1.088235
Length: 3169, dtype: float64
```

```
[14]: # Total number of chips per transaction for each store and month
CPT = df.groupby(['STORE_NBR', 'YEARMONTH']).PROD_QTY.sum() / df.
      ↳groupby(['STORE_NBR', 'YEARMONTH']).TXN_ID.nunique()
CPT
```

```
[14]: STORE_NBR  YEARMONTH
1          201807      1.192308
          201808      1.255814
          201809      1.209677
          201810      1.288889
          201811      1.212766
          ...
272        201902      1.895833
          201903      1.905660
          201904      1.909091
          201905      1.775000
          201906      1.891892
Length: 3169, dtype: float64
```

```
[15]: # Monthly average price per unit (store)
```

```
PPU = df.groupby(['STORE_NBR', 'YEARMONTH']).TOT_SALES.sum() / df.  
    ↳groupby(['STORE_NBR', 'YEARMONTH']).PROD_QTY.sum()  
PPU
```

```
[15]: STORE_NBR  YEARMONTH  
1      201807      3.337097  
      201808      3.261111  
      201809      3.717333  
      201810      3.243103  
      201811      3.378947  
      ...  
272    201902      4.346154  
      201903      4.379208  
      201904      4.239048  
      201905      4.430986  
      201906      4.458571  
Length: 3169, dtype: float64
```

```
[16]: # Concatenating the above generated dataframes.  
conc_dfs = [Sales, Customers, TPC, CPT, PPU]  
conc_dfs
```

```
[16]: [STORE_NBR  YEARMONTH  
1      201807      206.9  
      201808      176.1  
      201809      278.8  
      201810      188.1  
      201811      192.6  
      ...  
272    201902      395.5  
      201903      442.3  
      201904      445.1  
      201905      314.6  
      201906      312.1  
Name: TOT_SALES, Length: 3169, dtype: float64,  
STORE_NBR  YEARMONTH  
1      201807      49  
      201808      42  
      201809      59  
      201810      44  
      201811      46  
      ..  
272    201902      45  
      201903      50  
      201904      54  
      201905      34  
      201906      34
```

Name: LYLTY_CARD_NBR, Length: 3169, dtype: int64,

STORE_NBR	YEARMONTH	
1	201807	1.061224
	201808	1.023810
	201809	1.050847
	201810	1.022727
	201811	1.021739

...

272	201902	1.066667
	201903	1.060000
	201904	1.018519
	201905	1.176471
	201906	1.088235

Length: 3169, dtype: float64,

STORE_NBR	YEARMONTH	
1	201807	1.192308
	201808	1.255814
	201809	1.209677
	201810	1.288889
	201811	1.212766

...

272	201902	1.895833
	201903	1.905660
	201904	1.909091
	201905	1.775000
	201906	1.891892

Length: 3169, dtype: float64,

STORE_NBR	YEARMONTH	
1	201807	3.337097
	201808	3.261111
	201809	3.717333
	201810	3.243103
	201811	3.378947

...

272	201902	4.346154
	201903	4.379208
	201904	4.239048
	201905	4.430986
	201906	4.458571

Length: 3169, dtype: float64]

```
[17]: type(conc_dfs)
```

```
[17]: list
```

```
[18]: over_time_measure = pd.concat(conc_dfs, join = 'outer', axis = 1)
over_time_measure
```

```
[18]:
```

		TOT_SALES	LYLTY_CARD_NBR		0	1	2
STORE_NBR	YEARMONTH						
1	201807	206.9	49	1.061224	1.192308	3.337097	
	201808	176.1	42	1.023810	1.255814	3.261111	
	201809	278.8	59	1.050847	1.209677	3.717333	
	201810	188.1	44	1.022727	1.288889	3.243103	
	201811	192.6	46	1.021739	1.212766	3.378947	
...		
272	201902	395.5	45	1.066667	1.895833	4.346154	
	201903	442.3	50	1.060000	1.905660	4.379208	
	201904	445.1	54	1.018519	1.909091	4.239048	
	201905	314.6	34	1.176471	1.775000	4.430986	
	201906	312.1	34	1.088235	1.891892	4.458571	

[3169 rows x 5 columns]

```
[19]: type(over_time_measure)
```

```
[19]: pandas.core.frame.DataFrame
```

```
[20]: over_time_measure.rename(columns = {'TOT_SALES': 'totSales', 'LYLTY_CARD_NBR':
    ↳ 'nCustomers', 0: 'nChipsPerCust', 1: 'nChipsPerTxn', 2: 'avgPricePerUnit'},
    ↳ inplace = True)
over_time_measure.head()
```

```
[20]:
```

		totSales	nCustomers	nChipsPerCust	nChipsPerTxn	\
STORE_NBR	YEARMONTH					
1	201807	206.9	49	1.061224	1.192308	
	201808	176.1	42	1.023810	1.255814	
	201809	278.8	59	1.050847	1.209677	
	201810	188.1	44	1.022727	1.288889	
	201811	192.6	46	1.021739	1.212766	

		avgPricePerUnit
STORE_NBR	YEARMONTH	
1	201807	3.337097
	201808	3.261111
	201809	3.717333
	201810	3.243103
	201811	3.378947

```
[21]: # Which stores do not have full observation i.e. have months where there is no
    ↳ transaction for chips
check_nulls = pd.pivot_table(df, index = 'STORE_NBR', columns = 'YEARMONTH',
    ↳ values = 'TXN_ID', aggfunc = 'count')
check_nulls
```



```
[21]: YEARMONTH 201807 201808 201809 201810 201811 201812 201901 201902 \
STORE_NBR
1          52.0    43.0    62.0    45.0    47.0    47.0    36.0    55.0
2          41.0    43.0    37.0    43.0    40.0    38.0    45.0    32.0
3          138.0   134.0   119.0   119.0   118.0   129.0   121.0   139.0
4          160.0   151.0   138.0   155.0   139.0   133.0   168.0   102.0
5          120.0   112.0   125.0   107.0   111.0   125.0   118.0   106.0
...
268        52.0    54.0    34.0    48.0    51.0    43.0    38.0    37.0
269        139.0   132.0   124.0   148.0   136.0   133.0   144.0   133.0
270        139.0   154.0   126.0   119.0   133.0   149.0   155.0   125.0
271        129.0   101.0   114.0   114.0   122.0   117.0   120.0   102.0
272        52.0    48.0    36.0    51.0    45.0    47.0    50.0    48.0
```

```
YEARMONTH 201903 201904 201905 201906
STORE_NBR
1          49.0    43.0    51.0    43.0
2          46.0    49.0    50.0    42.0
3          130.0   110.0   123.0   122.0
4          135.0   137.0   126.0   134.0
5          97.0    109.0   104.0   127.0
...
268        47.0    50.0    52.0    40.0
269        122.0   139.0   130.0   127.0
270        143.0   132.0   128.0   127.0
271        101.0   109.0   127.0   129.0
272        53.0    56.0    40.0    37.0
```

[272 rows x 12 columns]

```
[22]: check_nulls.isnull().sum()
```

```
[22]: YEARMONTH
201807    6
201808    9
201809    8
201810    7
201811    8
201812    9
201901    9
201902    8
201903    7
201904    7
201905    9
201906    8
dtype: int64
```

```
[23]: check_nulls.isnull().any()
```

```
[23]: YEARMONTH
201807    True
201808    True
201809    True
201810    True
201811    True
201812    True
201901    True
201902    True
201903    True
201904    True
201905    True
201906    True
dtype: bool
```

```
[24]: check_nulls.isnull().any(axis=1)
```

```
[24]: STORE_NBR
1      False
2      False
3      False
4      False
5      False
...
268    False
269    False
270    False
271    False
272    False
Length: 272, dtype: bool
```

```
[26]: check_nulls[check_nulls.isnull().any(axis=1)]
```

```
[26]: YEARMONTH  201807  201808  201809  201810  201811  201812  201901  201902  \
STORE_NBR
11          NaN      NaN      NaN      1.0      NaN      1.0      NaN      NaN
31          NaN      NaN      1.0      NaN      1.0      NaN      NaN      NaN
44          4.0      NaN      3.0      5.0      4.0      7.0      5.0      4.0
76          NaN      NaN      NaN      1.0      NaN      NaN      NaN      NaN
85          3.0      NaN      NaN      NaN      NaN      NaN      NaN      NaN
92          NaN      NaN      NaN      NaN      NaN      NaN      NaN      NaN
117         1.0      4.0      4.0      7.0      7.0      8.0      NaN      2.0
193         NaN      NaN      NaN      NaN      NaN      NaN      1.0      1.0
206         1.0      NaN      NaN      NaN      NaN      NaN      NaN      NaN
211         1.0      NaN      NaN      NaN      NaN      NaN      NaN      NaN
```

218	6.0	11.0	5.0	9.0	8.0	NaN	7.0	1.0
252	NaN	1.0	NaN	NaN	NaN	NaN	NaN	NaN

YEARMONTH	201903	201904	201905	201906
STORE_NBR				
11	NaN	NaN	NaN	NaN
31	NaN	NaN	NaN	NaN
44	6.0	5.0	6.0	9.0
76	NaN	NaN	NaN	NaN
85	NaN	NaN	NaN	NaN
92	1.0	NaN	NaN	NaN
117	2.0	5.0	4.0	2.0
193	NaN	NaN	NaN	1.0
206	NaN	1.0	NaN	NaN
211	NaN	1.0	NaN	NaN
218	5.0	7.0	4.0	4.0
252	1.0	NaN	NaN	NaN

```
[27]: check_nulls[check_nulls.isnull().any(axis=1)].index
```

```
[27]: Int64Index([11, 31, 44, 76, 85, 92, 117, 193, 206, 211, 218, 252],
dtype='int64', name='STORE_NBR')
```

```
[28]: null_store = check_nulls[check_nulls.isnull().any(axis=1)].index.tolist()
null_store
```

```
[28]: [11, 31, 44, 76, 85, 92, 117, 193, 206, 211, 218, 252]
```

```
[29]: len(null_store)
```

```
[29]: 12
```

```
[30]: over_time_measure.index
```

```
[30]: MultiIndex([( 1, 201807),
( 1, 201808),
( 1, 201809),
( 1, 201810),
( 1, 201811),
( 1, 201812),
( 1, 201901),
( 1, 201902),
( 1, 201903),
( 1, 201904),
...
(272, 201809),
(272, 201810),
```

```

(272, 201811),
(272, 201812),
(272, 201901),
(272, 201902),
(272, 201903),
(272, 201904),
(272, 201905),
(272, 201906)],
names=['STORE_NBR', 'YEARMONTH'], length=3169)

```

```

[31]: over_time_measure.reset_index(inplace=True)
over_time_measure.head()

```

```

[31]:  STORE_NBR  YEARMONTH  totSales  nCustomers  nChipsPerCust  nChipsPerTxn  \
0         1      201807      206.9          49      1.061224      1.192308
1         1      201808      176.1          42      1.023810      1.255814
2         1      201809      278.8          59      1.050847      1.209677
3         1      201810      188.1          44      1.022727      1.288889
4         1      201811      192.6          46      1.021739      1.212766

      avgPricePerUnit
0         3.337097
1         3.261111
2         3.717333
3         3.243103
4         3.378947

```

```

[32]: over_time_measure['STORE_NBR'].isin(null_store)

```

```

[32]: 0      False
1      False
2      False
3      False
4      False
...
3164   False
3165   False
3166   False
3167   False
3168   False
Name: STORE_NBR, Length: 3169, dtype: bool

```

```

[33]: over_time_measure = over_time_measure[~over_time_measure['STORE_NBR'].
      ↪isin(null_store)]
over_time_measure

```

```
[33]:
```

	STORE_NBR	YEARMONTH	totSales	nCustomers	nChipsPerCust	nChipsPerTxn	\
0	1	201807	206.9	49	1.061224	1.192308	
1	1	201808	176.1	42	1.023810	1.255814	
2	1	201809	278.8	59	1.050847	1.209677	
3	1	201810	188.1	44	1.022727	1.288889	
4	1	201811	192.6	46	1.021739	1.212766	
...	
3164	272	201902	395.5	45	1.066667	1.895833	
3165	272	201903	442.3	50	1.060000	1.905660	
3166	272	201904	445.1	54	1.018519	1.909091	
3167	272	201905	314.6	34	1.176471	1.775000	
3168	272	201906	312.1	34	1.088235	1.891892	

	avgPricePerUnit
0	3.337097
1	3.261111
2	3.717333
3	3.243103
4	3.378947
...	...
3164	4.346154
3165	4.379208
3166	4.239048
3167	4.430986
3168	4.458571

[3120 rows x 7 columns]

```
[34]: # Filter to pre-trial period i.e. before 201902
preTrialMeasures = over_time_measure.loc[over_time_measure['YEARMONTH'] <
↳201902, :]
preTrialMeasures
```

```
[34]:
```

	STORE_NBR	YEARMONTH	totSales	nCustomers	nChipsPerCust	nChipsPerTxn	\
0	1	201807	206.9	49	1.061224	1.192308	
1	1	201808	176.1	42	1.023810	1.255814	
2	1	201809	278.8	59	1.050847	1.209677	
3	1	201810	188.1	44	1.022727	1.288889	
4	1	201811	192.6	46	1.021739	1.212766	
...	
3159	272	201809	304.7	32	1.125000	1.972222	
3160	272	201810	430.6	44	1.136364	1.980000	
3161	272	201811	376.2	41	1.097561	1.933333	
3162	272	201812	403.9	47	1.000000	1.893617	
3163	272	201901	423.0	46	1.086957	1.920000	

	avgPricePerUnit
--	-----------------

```

0          3.337097
1          3.261111
2          3.717333
3          3.243103
4          3.378947
...
3159       4.291549
3160       4.349495
3161       4.324138
3162       4.538202
3163       4.406250

```

[1820 rows x 7 columns]

```

[35]: # Function which calculates the correlation between trial store and other
      ↪ stores based on a metric.

```

```

def calculateCorrelation(inputTable, metric, trial_store):
    output = pd.DataFrame({'Store1': [], 'Store2': [], 'Correlation': []})
    a = inputTable.loc[inputTable['STORE_NBR'] == trial_store, metric]
    a.reset_index(drop = True, inplace = True)
    storeNumbers = inputTable['STORE_NBR'].unique()
    for i in storeNumbers:
        b = inputTable.loc[inputTable['STORE_NBR'] == i, metric]
        b.reset_index(drop = True, inplace = True)
        output = output.append({'Store1': trial_store, 'Store2': i,
      ↪ 'Correlation': b.corr(a)}, ignore_index = True)
    return output

```

```

[36]: def calculateMagnitudeDistance(inputTable, metric, trial_store):
      """
      This function calculates a standardised magnitude difference.
      """
      output = pd.DataFrame({'Store1': [], 'Store2': [], 'Magnitude' : []})
      a = inputTable.loc[inputTable['STORE_NBR'] == trial_store, metric]
      a.reset_index(drop = True, inplace = True)
      storeNumbers = inputTable['STORE_NBR'].unique()
      for i in storeNumbers:
          b = inputTable.loc[inputTable['STORE_NBR'] == i, metric]
          b.reset_index(drop = True, inplace = True)
          c = abs(a-b)
          d = np.mean(1-(c-min(c))/(max(c)-min(c)))
          output = output.append({'Store1': trial_store, 'Store2': i, 'Magnitude':
      ↪ d}, ignore_index = True)
      return output

```

```
[37]: trial_store = 77
corr_nSales = calculateCorrelation(preTrialMeasures, 'totSales', trial_store)
corr_nCustomers = calculateCorrelation(preTrialMeasures, 'nCustomers',
    ↪ trial_store)
magnitude_nSales = calculateMagnitudeDistance(preTrialMeasures, 'totSales',
    ↪ trial_store)
magnitude_nCustomers = calculateMagnitudeDistance(preTrialMeasures,
    ↪ 'nCustomers', trial_store)

corr_nSales.head()
```

<ipython-input-35-a3748f302ffc>:11: FutureWarning: The frame.append method is deprecated and will be removed from pandas in a future version. Use pandas.concat instead.

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[illegible]

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```

```
[37]:
```

	Store1	Store2	Correlation
0	77.0	1.0	0.075218
1	77.0	2.0	-0.263079
2	77.0	3.0	0.806644
3	77.0	4.0	-0.263300
4	77.0	5.0	-0.110652

```
[38]: magnitude_nSales.head()
```

```
[38]:
```

	Store1	Store2	Magnitude
0	77.0	1.0	0.408163
1	77.0	2.0	0.590119
2	77.0	3.0	0.522914
3	77.0	4.0	0.644934
4	77.0	5.0	0.516320

```
[39]: score_nSales = pd.concat([corr_nSales, magnitude_nSales['Magnitude']], axis = 1)
score_nSales.head()
```

```
[39]:
```

	Store1	Store2	Correlation	Magnitude
0	77.0	1.0	0.075218	0.408163
1	77.0	2.0	-0.263079	0.590119
2	77.0	3.0	0.806644	0.522914
3	77.0	4.0	-0.263300	0.644934
4	77.0	5.0	-0.110652	0.516320

```
[40]: # add average weight.
corr_weight = 0.5
score_nSales['scoreNSales'] = corr_weight * score_nSales['Correlation'] + (1 -
    ↪corr_weight) * score_nSales['Magnitude']
score_nSales.head()
```

```
[40]:
```

	Store1	Store2	Correlation	Magnitude	scoreNSales
0	77.0	1.0	0.075218	0.408163	0.241691
1	77.0	2.0	-0.263079	0.590119	0.163520
2	77.0	3.0	0.806644	0.522914	0.664779
3	77.0	4.0	-0.263300	0.644934	0.190817
4	77.0	5.0	-0.110652	0.516320	0.202834

repeat the same steps above for 'nCustomers'.

```
[41]: score_nCustomers = pd.concat([corr_nCustomers,
    ↪magnitude_nCustomers['Magnitude']], axis = 1)
score_nCustomers['scoreNCust'] = corr_weight * score_nCustomers['Correlation']
    ↪+ (1 - corr_weight) * score_nCustomers['Magnitude']
score_nCustomers.head()
```

```
[41]:
```

	Store1	Store2	Correlation	Magnitude	scoreNCust
0	77.0	1.0	0.322168	0.663866	0.493017
1	77.0	2.0	-0.572051	0.471429	-0.050311
2	77.0	3.0	0.834207	0.489796	0.662002
3	77.0	4.0	-0.295639	0.498258	0.101310
4	77.0	5.0	0.370659	0.512605	0.441632

```
[42]: # Reset the index and concatenate the two dataframes above.
score_nSales.set_index(['Store1', 'Store2'], inplace = True)
score_nCustomers.set_index(['Store1', 'Store2'], inplace = True)

score_Control = pd.concat([score_nSales['scoreNSales'],
    ↪score_nCustomers['scoreNCust']], axis = 1)
score_Control
```

```
[42]:
```

		scoreNSales	scoreNCust
Store1	Store2		
77.0	1.0	0.241691	0.493017
	2.0	0.163520	-0.050311

3.0	0.664779	0.662002
4.0	0.190817	0.101310
5.0	0.202834	0.441632
...
268.0	0.387272	0.470473
269.0	0.121684	0.005090
270.0	0.453489	0.202710
271.0	0.348289	0.174100
272.0	0.320626	0.384336

[260 rows x 2 columns]

```
[43]: score_Control['finalControlScore'] = 0.5 * (score_Control['scoreNSales'] +
↪score_Control['scoreNCust'])
score_Control.head()
```

```
[43]:
```

		scoreNSales	scoreNCust	finalControlScore
Store1	Store2			
77.0	1.0	0.241691	0.493017	0.367354
	2.0	0.163520	-0.050311	0.056604
	3.0	0.664779	0.662002	0.663390
	4.0	0.190817	0.101310	0.146064
	5.0	0.202834	0.441632	0.322233

```
[44]: score_Control.sort_values(by = 'finalControlScore', ascending = False).head()
```

```
[44]:
```

		scoreNSales	scoreNCust	finalControlScore
Store1	Store2			
77.0	233.0	0.697290	0.816607	0.756949
	71.0	0.789497	0.663123	0.726310
	84.0	0.656972	0.715000	0.685986
	119.0	0.636046	0.729729	0.682887
	115.0	0.708347	0.645155	0.676751

Store 233 matches store 77 better than other according to the finalControlScore.

```
[45]: control_store = 233

pastSales = preTrialMeasures

# Create a new column within 'pastSales' which categorises store type
store_type = []

for i in pastSales['STORE_NBR']:
    if i == trial_store:
        store_type.append('Trial Store')
    elif i == control_store:
```

```

        store_type.append('Control Store')
    else:
        store_type.append('Other Stores')

pastSales['store_type'] = store_type
pastSales['store_type'].unique()

```

<ipython-input-45-5fe971dcc61f>:16: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
pastSales['store_type'] = store_type

```
[45]: array(['Other Stores', 'Trial Store', 'Control Store'], dtype=object)
```

```
[46]: pastSales.head()
```

```
[46]:
```

	STORE_NBR	YEARMONTH	totSales	nCustomers	nChipsPerCust	nChipsPerTxn	\
0	1	201807	206.9	49	1.061224	1.192308	
1	1	201808	176.1	42	1.023810	1.255814	
2	1	201809	278.8	59	1.050847	1.209677	
3	1	201810	188.1	44	1.022727	1.288889	
4	1	201811	192.6	46	1.021739	1.212766	

	avgPricePerUnit	store_type
0	3.337097	Other Stores
1	3.261111	Other Stores
2	3.717333	Other Stores
3	3.243103	Other Stores
4	3.378947	Other Stores

```
[48]: pastSales.dtypes
```

```
[48]:
```

STORE_NBR	int64
YEARMONTH	int64
totSales	float64
nCustomers	int64
nChipsPerCust	float64
nChipsPerTxn	float64
avgPricePerUnit	float64
store_type	object
dtype:	object

```
[49]: pastSales['TransactionMonth'] = pd.to_datetime(pastSales['YEARMONTH'].
↳ astype(str), format = '%Y%m')
```

```
pastSales.head()
```

```
<ipython-input-49-f5e6154bf741>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead
```

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

```
pastSales['TransactionMonth'] =
pd.to_datetime(pastSales['YEARMONTH'].astype(str), format = '%Y%m')
```

```
[49]:
```

	STORE_NBR	YEARMONTH	totSales	nCustomers	nChipsPerCust	nChipsPerTxn	\
0	1	201807	206.9	49	1.061224	1.192308	
1	1	201808	176.1	42	1.023810	1.255814	
2	1	201809	278.8	59	1.050847	1.209677	
3	1	201810	188.1	44	1.022727	1.288889	
4	1	201811	192.6	46	1.021739	1.212766	

	avgPricePerUnit	store_type	TransactionMonth
0	3.337097	Other Stores	2018-07-01
1	3.261111	Other Stores	2018-08-01
2	3.717333	Other Stores	2018-09-01
3	3.243103	Other Stores	2018-10-01
4	3.378947	Other Stores	2018-11-01

```
[50]: controlSalesPlot = pastSales.loc[pastSales['store_type'] == 'Control Store',
↳ ['TransactionMonth', 'totSales']]
controlSalesPlot
```

```
[50]:
```

	TransactionMonth	totSales
2699	2018-07-01	290.7
2700	2018-08-01	285.9
2701	2018-09-01	228.6
2702	2018-10-01	185.7
2703	2018-11-01	211.6
2704	2018-12-01	279.8
2705	2019-01-01	177.5

```
[51]: controlSalesPlot.set_index('TransactionMonth', inplace = True)
controlSalesPlot
```

```
[51]:
```

	totSales
TransactionMonth	
2018-07-01	290.7
2018-08-01	285.9
2018-09-01	228.6
2018-10-01	185.7

2018-11-01	211.6
2018-12-01	279.8
2019-01-01	177.5

```
[52]: controlSalesPlot.rename(columns = {'totSales': 'Control Store'}, inplace = True)
controlSalesPlot
```

```
[52]:
```

Control Store	
TransactionMonth	
2018-07-01	290.7
2018-08-01	285.9
2018-09-01	228.6
2018-10-01	185.7
2018-11-01	211.6
2018-12-01	279.8
2019-01-01	177.5

```
[53]: # The same has been done for Trail and Others.
trialSalesPlot = pastSales.loc[pastSales['store_type'] == 'Trial Store',
    ↳ ['TransactionMonth', 'totSales']]
trialSalesPlot.set_index('TransactionMonth', inplace = True)
trialSalesPlot.rename(columns = {'totSales': 'Trial Store'}, inplace = True)
otherSalesPlot = pastSales.loc[pastSales['store_type'] == 'Other Stores',
    ↳ ['TransactionMonth', 'totSales']]
otherSalesPlot = pd.DataFrame(otherSalesPlot.groupby('TransactionMonth').
    ↳ totSales.mean())
otherSalesPlot.rename(columns = {'totSales': 'Other Stores'}, inplace = True)
```

```
[54]: trialSalesPlot
```

```
[54]:
```

Trial Store	
TransactionMonth	
2018-07-01	296.8
2018-08-01	255.5
2018-09-01	225.2
2018-10-01	204.5
2018-11-01	245.3
2018-12-01	267.3
2019-01-01	204.4

```
[55]: otherSalesPlot
```

```
[55]:
```

Other Stores	
TransactionMonth	
2018-07-01	638.004651
2018-08-01	610.223450
2018-09-01	620.198450

2018-10-01	635.314729
2018-11-01	618.864341
2018-12-01	648.453876
2019-01-01	628.684496

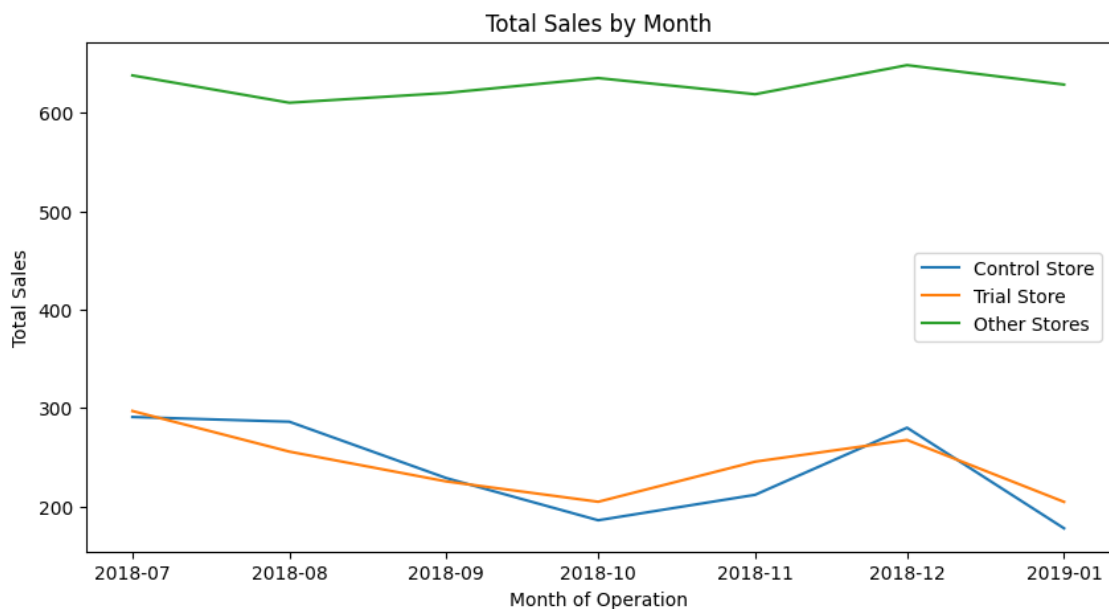
```
[56]: combineSalesPlot = pd.concat([controlSalesPlot, trialSalesPlot,
    ↪ otherSalesPlot], axis = 1)
combineSalesPlot
```

```
[56]:
```

	Control Store	Trial Store	Other Stores
TransactionMonth			
2018-07-01	290.7	296.8	638.004651
2018-08-01	285.9	255.5	610.223450
2018-09-01	228.6	225.2	620.198450
2018-10-01	185.7	204.5	635.314729
2018-11-01	211.6	245.3	618.864341
2018-12-01	279.8	267.3	648.453876
2019-01-01	177.5	204.4	628.684496

```
[57]: plt.figure(figsize = (10, 5))
plt.plot(combineSalesPlot)
plt.title('Total Sales by Month')
plt.xlabel('Month of Operation')
plt.ylabel('Total Sales')
plt.legend(['Control Store', 'Trial Store', 'Other Stores'], loc = 5)
```

```
[57]: <matplotlib.legend.Legend at 0x7a3add6f9ba0>
```



```
[58]: # First create relevant dataframes
controlCustomersPlot = pastSales.loc[pastSales['store_type'] == 'Control_
↳Store', ['TransactionMonth', 'nCustomers']]
controlCustomersPlot.set_index('TransactionMonth', inplace = True)
controlCustomersPlot.rename(columns = {'nCustomers': 'Control Store'}, inplace_
↳= True)
trialCustomersPlot = pastSales.loc[pastSales['store_type'] == 'Trial Store',_
↳['TransactionMonth', 'nCustomers']]
trialCustomersPlot.set_index('TransactionMonth', inplace = True)
trialCustomersPlot.rename(columns = {'nCustomers': 'Trial Store'}, inplace =_
↳True)
otherCustomersPlot = pastSales.loc[pastSales['store_type'] == 'Other Stores',_
↳['TransactionMonth', 'nCustomers']]
otherCustomersPlot = pd.DataFrame(otherCustomersPlot.
↳groupby('TransactionMonth').nCustomers.mean())
otherCustomersPlot.rename(columns = {'nCustomers': 'Other Stores'}, inplace =_
↳True)

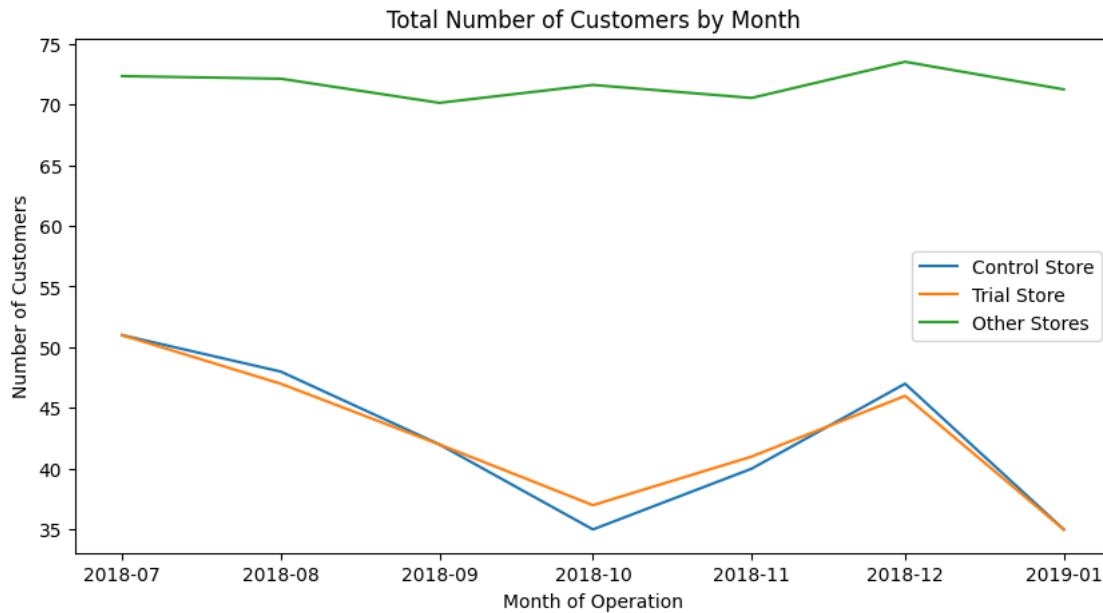
# Concatenate
combineCustomersPlot = pd.concat([controlCustomersPlot, trialCustomersPlot,_
↳otherCustomersPlot], axis = 1)
combineCustomersPlot
```

```
[58]:
```

	Control Store	Trial Store	Other Stores
TransactionMonth			
2018-07-01	51	51	72.333333
2018-08-01	48	47	72.120155
2018-09-01	42	42	70.131783
2018-10-01	35	37	71.608527
2018-11-01	40	41	70.534884
2018-12-01	47	46	73.515504
2019-01-01	35	35	71.240310

```
[59]: plt.figure(figsize = (10, 5))
plt.plot(combineCustomersPlot)
plt.title('Total Number of Customers by Month')
plt.xlabel('Month of Operation')
plt.ylabel('Number of Customers')
plt.legend(['Control Store', 'Trial Store', 'Other Stores'], loc = 5)
```

```
[59]: <matplotlib.legend.Legend at 0x7a3add607490>
```



uplift in the chips sales in the trail period (start of February 2019 to end of April 2019)?
 Calculate it by dividing sum of 'totSales' for trial store by sum of 'totSales' for control store.

```
[60]: trial_sum = preTrialMeasures.loc[preTrialMeasures['store_type'] == 'Trial_
      ↪Store', 'totSales'].sum()
      control_sum = preTrialMeasures.loc[preTrialMeasures['store_type'] == 'Control_
      ↪Store', 'totSales'].sum()
      scalingFactorSales = trial_sum / control_sum
      scalingFactorSales
```

```
[60]: 1.023617303289553
```

pick up the control store which was 233 from the measureOverTime dataframe.

```
[61]: scaledControlSales = over_time_measure.loc[over_time_measure['STORE_NBR'] ==
      ↪control_store]
      scaledControlSales
```

```
[61]:
```

	STORE_NBR	YEARMONTH	totSales	nCustomers	nChipsPerCust	nChipsPerTxn \
2699	233	201807	290.7	51	1.058824	1.629630
2700	233	201808	285.9	48	1.041667	1.600000
2701	233	201809	228.6	42	1.071429	1.555556
2702	233	201810	185.7	35	1.028571	1.555556
2703	233	201811	211.6	40	1.025000	1.512195
2704	233	201812	279.8	47	1.063830	1.500000
2705	233	201901	177.5	35	1.000000	1.342857
2706	233	201902	244.0	45	1.044444	1.489362

2707	233	201903	199.1	40	1.025000	1.439024
2708	233	201904	158.6	30	1.066667	1.437500
2709	233	201905	344.4	57	1.087719	1.483871
2710	233	201906	221.0	41	1.000000	1.487805

	avgPricePerUnit
2699	3.303409
2700	3.573750
2701	3.265714
2702	3.316071
2703	3.412903
2704	3.730667
2705	3.776596
2706	3.485714
2707	3.374576
2708	3.447826
2709	3.743478
2710	3.622951

```
[62]: scaledControlSales['controlSales'] = scaledControlSales['totSales'] * \
      ↪ scalingFactorSales
scaledControlSales.head()
```

<ipython-input-62-82672d3615e3>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
 scaledControlSales['controlSales'] = scaledControlSales['totSales'] *
 scalingFactorSales

```
[62]:
```

	STORE_NBR	YEARMONTH	totSales	nCustomers	nChipsPerCust	nChipsPerTxn	\
2699	233	201807	290.7	51	1.058824	1.629630	
2700	233	201808	285.9	48	1.041667	1.600000	
2701	233	201809	228.6	42	1.071429	1.555556	
2702	233	201810	185.7	35	1.028571	1.555556	
2703	233	201811	211.6	40	1.025000	1.512195	

	avgPricePerUnit	controlSales
2699	3.303409	297.565550
2700	3.573750	292.652187
2701	3.265714	233.998916
2702	3.316071	190.085733
2703	3.412903	216.597421

```
[63]: # Create 'percentageDiff' dataframe
percentageDiff = scaledControlSales[['YEARMONTH', 'controlSales']]
percentageDiff.reset_index(drop = True, inplace = True)

# Concatenate with trial store 'totSales'
trialSales = over_time_measure.loc[over_time_measure['STORE_NBR'] ==
    ↳ trial_store, 'totSales']
trialSales.reset_index(drop = True, inplace = True)
percentageDiff = pd.concat([percentageDiff, trialSales], axis = 1)
percentageDiff.rename(columns = {'totSales': 'trialSales'}, inplace = True)
percentageDiff
```

```
[63]:
```

	YEARMONTH	controlSales	trialSales
0	201807	297.565550	296.8
1	201808	292.652187	255.5
2	201809	233.998916	225.2
3	201810	190.085733	204.5
4	201811	216.597421	245.3
5	201812	286.408121	267.3
6	201901	181.692071	204.4
7	201902	249.762622	235.0
8	201903	203.802205	278.5
9	201904	162.345704	263.5
10	201905	352.533799	299.3
11	201906	226.219424	264.7

```
[64]: percentageDiff['percentageDiff'] = abs(percentDiff.controlSales -
    ↳ percentDiff.trialSales) / percentDiff.controlSales
percentageDiff
```

```
[64]:
```

	YEARMONTH	controlSales	trialSales	percentageDiff
0	201807	297.565550	296.8	0.002573
1	201808	292.652187	255.5	0.126950
2	201809	233.998916	225.2	0.037602
3	201810	190.085733	204.5	0.075830
4	201811	216.597421	245.3	0.132516
5	201812	286.408121	267.3	0.066716
6	201901	181.692071	204.4	0.124980
7	201902	249.762622	235.0	0.059107
8	201903	203.802205	278.5	0.366521
9	201904	162.345704	263.5	0.623080
10	201905	352.533799	299.3	0.151003
11	201906	226.219424	264.7	0.170103

The null hypothesis is such that the trial period is the same as the pre-trial period. Take the standard deviation based on the scaled percentage difference in the pre-trial period.

```
[66]: import statistics

stdDev = statistics.stdev(percentageDiff.loc[percentageDiff['YEARMONTH'] <=
↳201902, 'percentageDiff'])
stdDev
```

```
[66]: 0.049940762641425364
```

Since we have 8 pre-trial months, the degree of freedom = 8 - 1 = 7. We will test with a null hypothesis of there being 0 difference between trial and control stores.

```
[67]: dof = 7
percentageDiff['tValue'] = (percentageDiff['percentageDiff'] - 0) / stdDev
percentageDiff.loc[(percentageDiff['YEARMONTH'] > 201901) &
↳(percentageDiff['YEARMONTH'] < 201905), 'tValue']
```

```
[67]: 7      1.183534
      8      7.339116
      9     12.476373
      Name: tValue, dtype: float64
```

```
[71]: scaledControlSales['TransactionMonth'] = pd.
↳to_datetime(scaledControlSales['YEARMONTH'].astype(str), format = '%Y%m')
scaledControlSales
```

<ipython-input-71-ae82d5f8dc79>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

```
scaledControlSales['TransactionMonth'] =
pd.to_datetime(scaledControlSales['YEARMONTH'].astype(str), format = '%Y%m')
```

```
[71]:
```

	STORE_NBR	YEARMONTH	totSales	nCustomers	nChipsPerCust	nChipsPerTxn	\
2699	233	201807	290.7	51	1.058824	1.629630	
2700	233	201808	285.9	48	1.041667	1.600000	
2701	233	201809	228.6	42	1.071429	1.555556	
2702	233	201810	185.7	35	1.028571	1.555556	
2703	233	201811	211.6	40	1.025000	1.512195	
2704	233	201812	279.8	47	1.063830	1.500000	
2705	233	201901	177.5	35	1.000000	1.342857	
2706	233	201902	244.0	45	1.044444	1.489362	
2707	233	201903	199.1	40	1.025000	1.439024	
2708	233	201904	158.6	30	1.066667	1.437500	
2709	233	201905	344.4	57	1.087719	1.483871	
2710	233	201906	221.0	41	1.000000	1.487805	

	avgPricePerUnit	controlSales	TransactionMonth
2699	3.303409	297.565550	2018-07-01
2700	3.573750	292.652187	2018-08-01
2701	3.265714	233.998916	2018-09-01
2702	3.316071	190.085733	2018-10-01
2703	3.412903	216.597421	2018-11-01
2704	3.730667	286.408121	2018-12-01
2705	3.776596	181.692071	2019-01-01
2706	3.485714	249.762622	2019-02-01
2707	3.374576	203.802205	2019-03-01
2708	3.447826	162.345704	2019-04-01
2709	3.743478	352.533799	2019-05-01
2710	3.622951	226.219424	2019-06-01

```
[72]: controlSales = scaledControlSales.loc[:, ['TransactionMonth', 'controlSales']]
controlSales.set_index('TransactionMonth', inplace = True)
controlSales.rename(columns = {'controlSales': 'Control Sales'}, inplace = True)
controlSales
```

```
[72]:
```

TransactionMonth	Control Sales
2018-07-01	297.565550
2018-08-01	292.652187
2018-09-01	233.998916
2018-10-01	190.085733
2018-11-01	216.597421
2018-12-01	286.408121
2019-01-01	181.692071
2019-02-01	249.762622
2019-03-01	203.802205
2019-04-01	162.345704
2019-05-01	352.533799
2019-06-01	226.219424

```
[73]: over_time_measure['TransactionMonth'] = pd.
↳to_datetime(over_time_measure['YEARMONTH'].astype(str), format = '%Y%m')
over_time_measure.head()
```

<ipython-input-73-fac04b19719c>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

```
over_time_measure['TransactionMonth'] =
pd.to_datetime(over_time_measure['YEARMONTH'].astype(str), format = '%Y%m')
```

```
[73]: STORE_NBR  YEARMONTH  totSales  nCustomers  nChipsPerCust  nChipsPerTxn  \
0          1      201807      206.9           49        1.061224      1.192308
1          1      201808      176.1           42        1.023810      1.255814
2          1      201809      278.8           59        1.050847      1.209677
3          1      201810      188.1           44        1.022727      1.288889
4          1      201811      192.6           46        1.021739      1.212766
```

```
      avgPricePerUnit  TransactionMonth
0          3.337097      2018-07-01
1          3.261111      2018-08-01
2          3.717333      2018-09-01
3          3.243103      2018-10-01
4          3.378947      2018-11-01
```

```
[74]: trialSales = over_time_measure.loc[over_time_measure['STORE_NBR'] == 1
      ↪ trial_store, ['TransactionMonth', 'totSales']]
trialSales.set_index('TransactionMonth', inplace = True)
trialSales.rename(columns = {'totSales': 'Trial Sales'}, inplace = True)
trialSales
```

```
[74]:          Trial Sales
TransactionMonth
2018-07-01      296.8
2018-08-01      255.5
2018-09-01      225.2
2018-10-01      204.5
2018-11-01      245.3
2018-12-01      267.3
2019-01-01      204.4
2019-02-01      235.0
2019-03-01      278.5
2019-04-01      263.5
2019-05-01      299.3
2019-06-01      264.7
```

```
[75]: controlSales['Control 5% Confidence Interval'] = controlSales['Control Sales']_
      ↪ * (1 - stdDev*2)
controlSales['Control 95% Confidence Interval'] = controlSales['Control Sales']_
      ↪ * (1 + stdDev*2)
controlSales
```

```
[75]:          Control Sales  Control 5% Confidence Interval  \
TransactionMonth
2018-07-01      297.565550      267.844249
2018-08-01      292.652187      263.421640
2018-09-01      233.998916      210.626747
2018-10-01      190.085733      171.099680
```


2018-11-01	216.597421	194.963341
2018-12-01	286.408121	257.801241
2019-01-01	181.692071	163.544390
2019-02-01	249.762622	224.815950
2019-03-01	203.802205	183.446130
2019-04-01	162.345704	146.130368
2019-05-01	352.533799	317.322186
2019-06-01	226.219424	203.624283

Control 95% Confidence Interval

TransactionMonth	
2018-07-01	327.286851
2018-08-01	321.882734
2018-09-01	257.371084
2018-10-01	209.071786
2018-11-01	238.231502
2018-12-01	315.015001
2019-01-01	199.839753
2019-02-01	274.709294
2019-03-01	224.158280
2019-04-01	178.561041
2019-05-01	387.745413
2019-06-01	248.814565

```
[76]: combineSales = pd.merge(controlSales, trialSales, left_index = True,
    ↪right_index = True)
combineSales
```

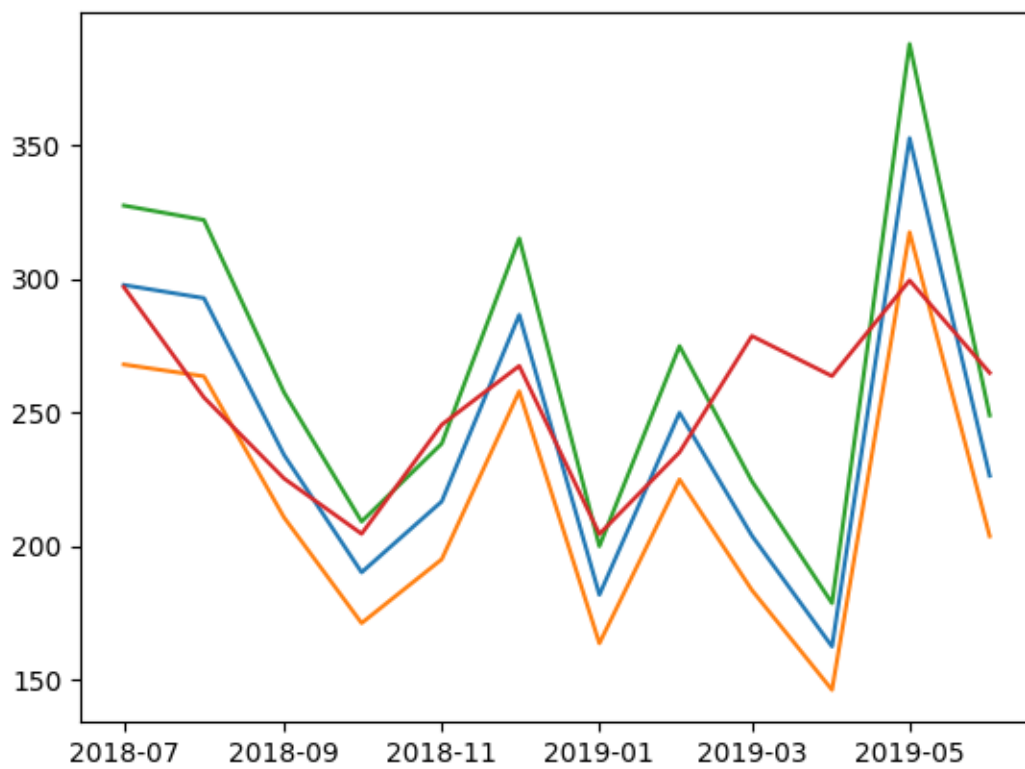
```
[76]:
```

	Control Sales	Control 5% Confidence Interval \
TransactionMonth		
2018-07-01	297.565550	267.844249
2018-08-01	292.652187	263.421640
2018-09-01	233.998916	210.626747
2018-10-01	190.085733	171.099680
2018-11-01	216.597421	194.963341
2018-12-01	286.408121	257.801241
2019-01-01	181.692071	163.544390
2019-02-01	249.762622	224.815950
2019-03-01	203.802205	183.446130
2019-04-01	162.345704	146.130368
2019-05-01	352.533799	317.322186
2019-06-01	226.219424	203.624283

	Control 95% Confidence Interval	Trial Sales
TransactionMonth		
2018-07-01	327.286851	296.8
2018-08-01	321.882734	255.5

2018-09-01	257.371084	225.2
2018-10-01	209.071786	204.5
2018-11-01	238.231502	245.3
2018-12-01	315.015001	267.3
2019-01-01	199.839753	204.4
2019-02-01	274.709294	235.0
2019-03-01	224.158280	278.5
2019-04-01	178.561041	263.5
2019-05-01	387.745413	299.3
2019-06-01	248.814565	264.7

```
[77]: plt.plot(combineSales);
```



```
[78]: # Make it bigger
plt.figure(figsize = (12, 8))
plt.plot(combineSales)

# Set graph title and axis title
plt.title('Total Sales by Month')
plt.xlabel('Month of Operation')
plt.ylabel('Total Sales')
```

```

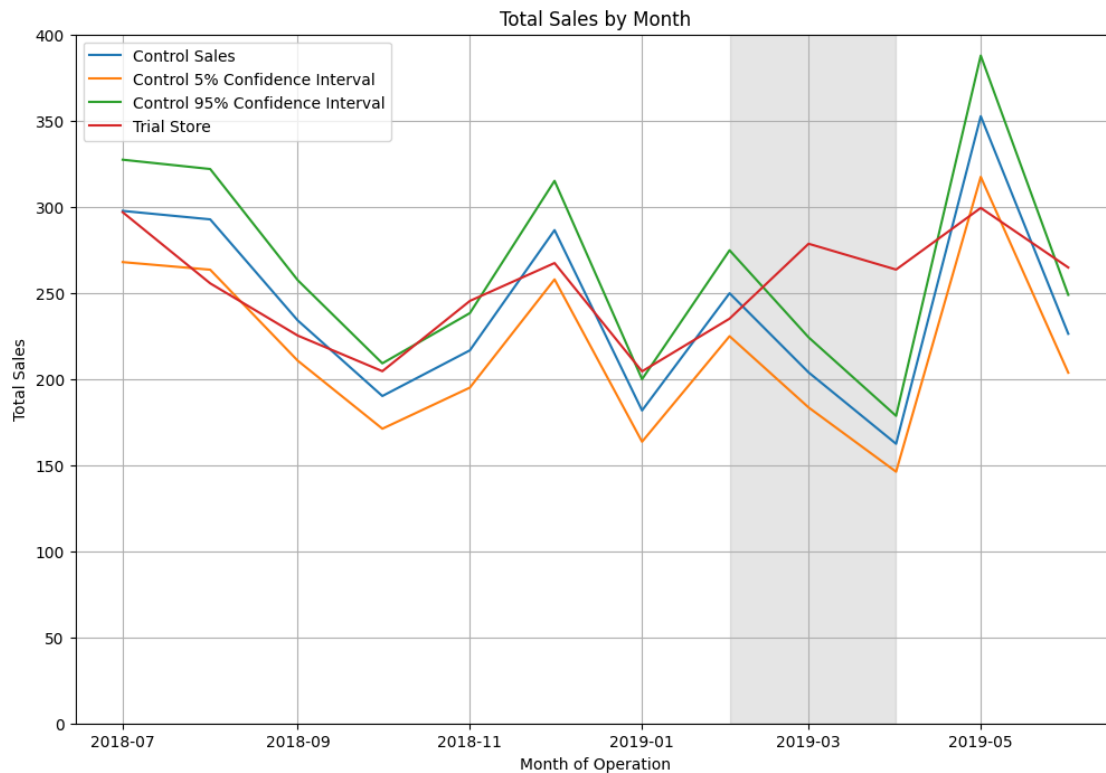
# Set legend
plt.legend(['Control Sales', 'Control 5% Confidence Interval', 'Control 95%_
↳Confidence Interval', 'Trial Store'], loc = 2)

# Set new y-axis limit
plt.ylim((0, 400))

# Highlight trial period
plt.axvspan(*mdates.datestr2num(['2019-02-01', '2019-04-01']), color = 'grey',_
↳alpha = 0.2)

# Set grid
plt.grid()
plt.show()

```



```

[79]: trial_customers = preTrialMeasures.loc[preTrialMeasures['store_type'] == 'Trial_
↳Store', 'nCustomers'].sum()
control_customers = preTrialMeasures.loc[preTrialMeasures['store_type'] ==_
↳'Control Store', 'nCustomers'].sum()
scalingFactorCustomers = trial_customers / control_customers
scalingFactorCustomers

```

```
[79]: 1.0033557046979866
```

```
[80]: scaledControlCustomers = over_time_measure.loc[over_time_measure['STORE_NBR']_
      ↪== control_store]
      scaledControlCustomers.head()
```

```
[80]:
```

	STORE_NBR	YEARMONTH	totSales	nCustomers	nChipsPerCust	nChipsPerTxn	\
2699	233	201807	290.7	51	1.058824	1.629630	
2700	233	201808	285.9	48	1.041667	1.600000	
2701	233	201809	228.6	42	1.071429	1.555556	
2702	233	201810	185.7	35	1.028571	1.555556	
2703	233	201811	211.6	40	1.025000	1.512195	

	avgPricePerUnit	TransactionMonth
2699	3.303409	2018-07-01
2700	3.573750	2018-08-01
2701	3.265714	2018-09-01
2702	3.316071	2018-10-01
2703	3.412903	2018-11-01

```
[81]: scaledControlCustomers['controlCustomers'] =_
      ↪scaledControlCustomers['nCustomers'] * scalingFactorCustomers
      scaledControlCustomers.head()
```

<ipython-input-81-9ca1945d05a5>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

```
scaledControlCustomers['controlCustomers'] =
scaledControlCustomers['nCustomers'] * scalingFactorCustomers
```

```
[81]:
```

	STORE_NBR	YEARMONTH	totSales	nCustomers	nChipsPerCust	nChipsPerTxn	\
2699	233	201807	290.7	51	1.058824	1.629630	
2700	233	201808	285.9	48	1.041667	1.600000	
2701	233	201809	228.6	42	1.071429	1.555556	
2702	233	201810	185.7	35	1.028571	1.555556	
2703	233	201811	211.6	40	1.025000	1.512195	

	avgPricePerUnit	TransactionMonth	controlCustomers
2699	3.303409	2018-07-01	51.171141
2700	3.573750	2018-08-01	48.161074
2701	3.265714	2018-09-01	42.140940
2702	3.316071	2018-10-01	35.117450
2703	3.412903	2018-11-01	40.134228

```
[82]: percentageDiff = scaledControlCustomers[['YEARMONTH', 'controlCustomers']]
percentageDiff.reset_index(drop = True, inplace = True)

trialCustomers = over_time_measure.loc[over_time_measure['STORE_NBR'] ==
↳ trial_store, 'nCustomers']
trialCustomers.reset_index(drop = True, inplace = True)
percentageDiff = pd.concat([percentageDiff, trialCustomers], axis = 1)
percentageDiff.rename(columns = {'nCustomers': 'trialCustomers'}, inplace =
↳ True)

percentageDiff
```

```
[82]:
```

	YEARMONTH	controlCustomers	trialCustomers
0	201807	51.171141	51
1	201808	48.161074	47
2	201809	42.140940	42
3	201810	35.117450	37
4	201811	40.134228	41
5	201812	47.157718	46
6	201901	35.117450	35
7	201902	45.151007	45
8	201903	40.134228	50
9	201904	30.100671	47
10	201905	57.191275	55
11	201906	41.137584	41

```
[83]: percentageDiff['percentageDiff'] = abs(percentDiff.controlCustomers -
↳ percentDiff.trialCustomers) / percentDiff.controlCustomers

percentageDiff
```

```
[83]:
```

	YEARMONTH	controlCustomers	trialCustomers	percentageDiff
0	201807	51.171141	51	0.003344
1	201808	48.161074	47	0.024108
2	201809	42.140940	42	0.003344
3	201810	35.117450	37	0.053607
4	201811	40.134228	41	0.021572
5	201812	47.157718	46	0.024550
6	201901	35.117450	35	0.003344
7	201902	45.151007	45	0.003344
8	201903	40.134228	50	0.245819
9	201904	30.100671	47	0.561427
10	201905	57.191275	55	0.038315
11	201906	41.137584	41	0.003344

```
[85]: import statistics
stdDev = statistics.stdev(percentDiff.loc[percentDiff['YEARMONTH'] <
↳ 201902, 'percentageDiff'])
```

```
stdDev
```

```
[85]: 0.018240748558243945
```

```
[86]: percentageDiff['tValue'] = (percentageDiff['percentageDiff'] - 0) / stdDev
percentageDiff.loc[(percentageDiff['YEARMONTH'] > 201901) &
↳(percentageDiff['YEARMONTH'] < 201905), 'tValue']
```

```
[86]: 7      0.183352
      8      13.476388
      9      30.778725
      Name: tValue, dtype: float64
```

```
[87]: controlCustomers = scaledControlCustomers.loc[:, ['TransactionMonth',
↳'controlCustomers']]
controlCustomers.set_index('TransactionMonth', inplace = True)
controlCustomers.rename(columns = {'controlCustomers': 'Control Customers'},
↳inplace = True)
controlCustomers
```

```
[87]:
```

Control Customers	
TransactionMonth	
2018-07-01	51.171141
2018-08-01	48.161074
2018-09-01	42.140940
2018-10-01	35.117450
2018-11-01	40.134228
2018-12-01	47.157718
2019-01-01	35.117450
2019-02-01	45.151007
2019-03-01	40.134228
2019-04-01	30.100671
2019-05-01	57.191275
2019-06-01	41.137584

```
[88]: trialCustomers = over_time_measure.loc[over_time_measure['STORE_NBR'] ==
↳trial_store, ['TransactionMonth', 'nCustomers']]
trialCustomers.set_index('TransactionMonth', inplace = True)
trialCustomers.rename(columns = {'nCustomers': 'Trial Customers'}, inplace =
↳True)
trialCustomers
```

```
[88]:
```

Trial Customers	
TransactionMonth	
2018-07-01	51
2018-08-01	47
2018-09-01	42

2018-10-01	37
2018-11-01	41
2018-12-01	46
2019-01-01	35
2019-02-01	45
2019-03-01	50
2019-04-01	47
2019-05-01	55
2019-06-01	41

```
[89]: controlCustomers['Control 5% Confidence Interval'] = controlCustomers['Control_
↳Customers'] * (1 - stdDev*2)
controlCustomers['Control 95% Confidence Interval'] = controlCustomers['Control_
↳Customers'] * (1 + stdDev*2)
controlCustomers
```

```
[89]:
```

TransactionMonth	Control Customers	Control 5% Confidence Interval \
2018-07-01	51.171141	49.304341
2018-08-01	48.161074	46.404086
2018-09-01	42.140940	40.603575
2018-10-01	35.117450	33.836313
2018-11-01	40.134228	38.670071
2018-12-01	47.157718	45.437334
2019-01-01	35.117450	33.836313
2019-02-01	45.151007	43.503830
2019-03-01	40.134228	38.670071
2019-04-01	30.100671	29.002554
2019-05-01	57.191275	55.104852
2019-06-01	41.137584	39.636823

TransactionMonth	Control 95% Confidence Interval
2018-07-01	53.037941
2018-08-01	49.918062
2018-09-01	43.678304
2018-10-01	36.398587
2018-11-01	41.598385
2018-12-01	48.878102
2019-01-01	36.398587
2019-02-01	46.798183
2019-03-01	41.598385
2019-04-01	31.198789
2019-05-01	59.277699
2019-06-01	42.638345

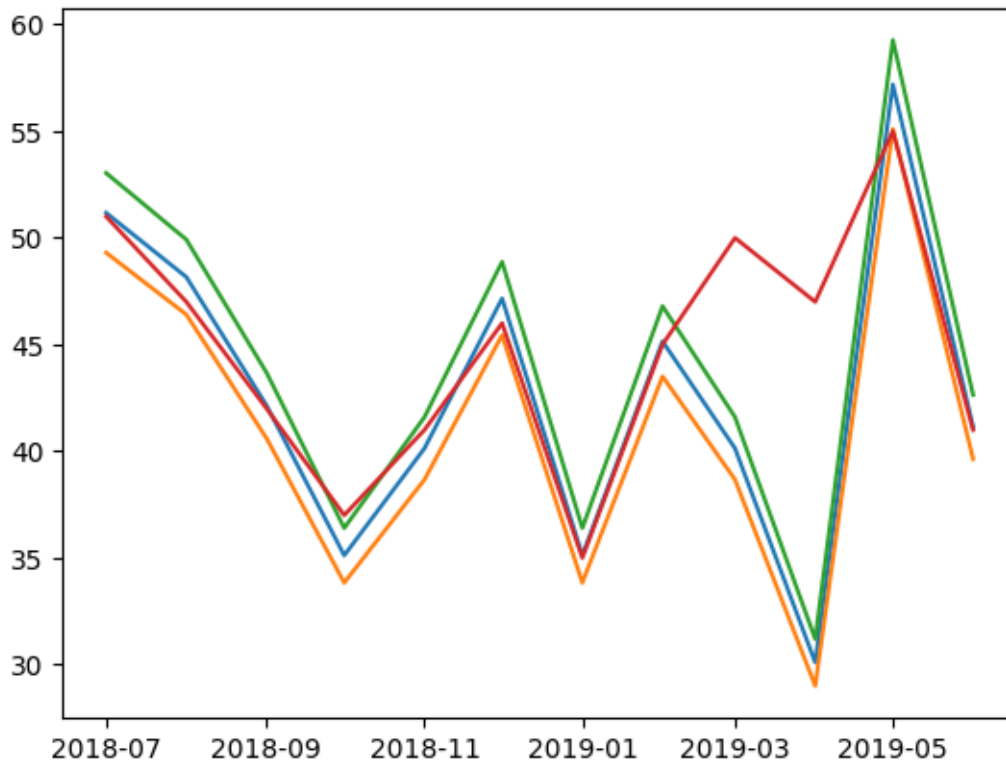
```
[90]: combineCustomers = pd.merge(controlCustomers, trialCustomers, left_index =  
    ↪ True, right_index = True)  
combineCustomers
```

```
[90]:
```

TransactionMonth	Control Customers	Control 5% Confidence Interval \
2018-07-01	51.171141	49.304341
2018-08-01	48.161074	46.404086
2018-09-01	42.140940	40.603575
2018-10-01	35.117450	33.836313
2018-11-01	40.134228	38.670071
2018-12-01	47.157718	45.437334
2019-01-01	35.117450	33.836313
2019-02-01	45.151007	43.503830
2019-03-01	40.134228	38.670071
2019-04-01	30.100671	29.002554
2019-05-01	57.191275	55.104852
2019-06-01	41.137584	39.636823

TransactionMonth	Control 95% Confidence Interval	Trial Customers
2018-07-01	53.037941	51
2018-08-01	49.918062	47
2018-09-01	43.678304	42
2018-10-01	36.398587	37
2018-11-01	41.598385	41
2018-12-01	48.878102	46
2019-01-01	36.398587	35
2019-02-01	46.798183	45
2019-03-01	41.598385	50
2019-04-01	31.198789	47
2019-05-01	59.277699	55
2019-06-01	42.638345	41

```
[92]: plt.plot(combineCustomers);
```

```
[93]: plt.figure(figsize = (12, 8))
plt.plot(combineCustomers)

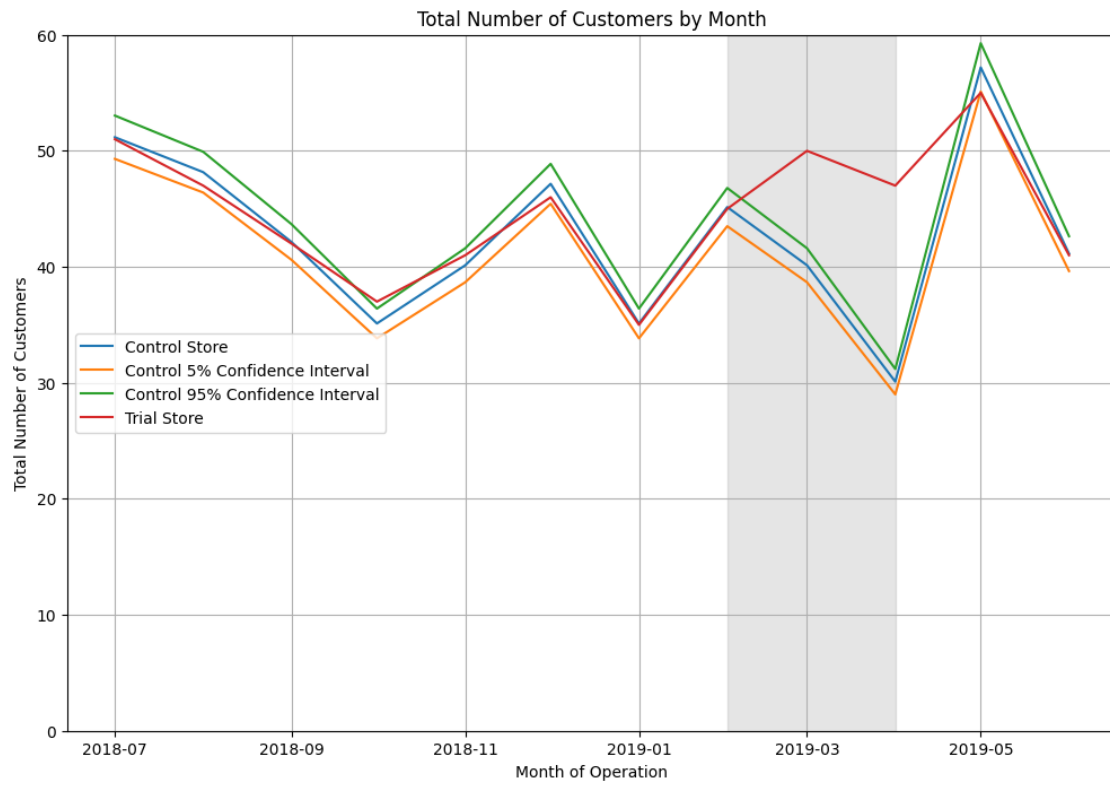
plt.title('Total Number of Customers by Month')
plt.xlabel('Month of Operation')
plt.ylabel('Total Number of Customers')

plt.legend(['Control Store', 'Control 5% Confidence Interval', 'Control 95% Confidence Interval', 'Trial Store'], loc = 6)

plt.ylim((0, 60))

plt.axvspan(*mdates.datestr2num(['2019-02-01', '2019-04-01']), color = 'grey', alpha = 0.2)

plt.grid()
plt.show()
```



[]: