```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

```
qvi_data = pd.read_csv('/content/QVI_data.csv')
qvi_data.head(10)
```

	LYLTY_CARD_NBR	DATE	STORE_NBR	TXN_ID	PROD_NBR	PROD_NAME	PROD_QTY	TOT_SALES	PACK_SIZE	BRAND	LIFES
0	1000	2018-10-17	1	1	5	Natural Chip Compny SeaSalt175g	2	6.0	175	NATURAL	YO SINGLES/COUF
1	1002	2018-09-16	1	2	58	Red Rock Deli Chikn&Garlic Aioli 150g	1	2.7	150	RRD	YO SINGLES/COUF
2	1003	2019-03-07	1	3	52	Grain Waves Sour Cream&Chives 210G	1	3.6	210	GRNWVES	YOUNG FAM
3	1003	2019-03-08	1	4	106	Natural ChipCo Hony Soy Chckn175g	1	3.0	175	NATURAL	YOUNG FAM
4	1004	2018-11-02	1	5	96	WW Original Stacked Chips 160g	1	1.9	160	WOOLWORTHS	OL SINGLES/COUF
5	1005	2018-12-28	1	6	86	Cheetos Puffs 165g	1	2.8	165	CHEETOS	MID SINGLES/COUF
6	1007	2018-12-04	1	7	49	Infuzions SourCream&Herbs Veg Strws 110g	1	3.8	110	INFUZIONS	YO SINGLES/COUF
7	1007	2018-12-05	1	8	10	RRD SR Slow Rst Pork Belly 150g	1	2.7	150	RRD	YO SINGLES/COUF
8	1009	2018-11-20	1	9	20	Doritos Cheese Supreme 330g	1	5.7	330	DORITOS	NEW FAM
9	1010	2018-09-09	1	10	51	Doritos Mexicana 170g	2	8.8	170	DORITOS	YO SINGLES/COUF

```
qvi_data.shape
```

```
(264834, 12)
```

```
qvi_data.describe()
```

	LYLTY_CARD_NBR	STORE_NBR	TXN_ID	PROD_NBR	PROD_QTY	TOT_SALES	PACK_SIZE
count	2.648340e+05	264834.000000	2.648340e+05	264834.000000	264834.000000	264834.000000	264834.000000
mean	1.355488e+05	135.079423	1.351576e+05	56.583554	1.905813	7.299346	182.425512
std	8.057990e+04	76.784063	7.813292e+04	32.826444	0.343436	2.527241	64.325148
min	1.000000e+03	1.000000	1.000000e+00	1.000000	1.000000	1.500000	70.000000
25%	7.002100e+04	70.000000	6.760050e+04	28.000000	2.000000	5.400000	150.000000
50%	1.303570e+05	130.000000	1.351365e+05	56.000000	2.000000	7.400000	170.000000
75%	2.030940e+05	203.000000	2.026998e+05	85.000000	2.000000	9.200000	175.000000
max	2.373711e+06	272.000000	2.415841e+06	114.000000	5.000000	29.500000	380.000000

```
qvi_data['DATE'] = pd.to_datetime(qvi_data['DATE'], format= '%Y-%m-%d')
qvi_data['MONTH_ID']  = qvi_data['DATE'].dt.strftime('%Y%m').astype('int')
qvi_data.head()
```

	LYLTY_CARD_NBR	DATE	STORE_NBR	TXN_ID	PROD_NBR	PROD_NAME	PROD_QTY	TOT_SALES	PACK_SIZE	BRAND	LIFESTAG
0	1000	2018-10-17	1	1	5	Natural Chip Compny SeaSalt175g	2	6.0	175	NATURAL	YOUN SINGLES/COUPLE
1	1002	2018-09-16	1	2	58	Red Rock Deli Chikn&Garlic Aioli 150g	1	2.7	150	RRD	YOUN SINGLES/COUPLE
2	1003	2019-03-07	1	3	52	Grain Waves Sour Cream&Chives 210G	1	3.6	210	GRNWVES	YOUNG FAMILIE
3	1003	2019-03-08	1	4	106	Natural ChipCo Hony Soy Chckn175g	1	3.0	175	NATURAL	YOUNG FAMILIE
4	1004	2018-11-02	1	5	96	WW Original Stacked Chips 160g	1	1.9	160	WOOLWORTHS	OLDE SINGLES/COUPLE

Creating metrices for each store and month calculate total sales, number of customers,transactions per customer, chips per customer and the average price per unit.

```
TOT_SALE_M = qvi_data.groupby(['STORE_NBR', 'MONTH_ID'])['TOT_SALES'].sum()
```

```
TOT_CUST_M = qvi_data.groupby(['STORE_NBR', 'MONTH_ID'])['LYLTY_CARD_NBR'].nunique()
```

```
TRAN_CUST_M = qvi_data.groupby(['STORE_NBR', 'MONTH_ID'])['TXN_ID'].nunique()
TRAN_CUST_M = TRAN_CUST_M / TOT_CUST_M
```

```
CHIP_CUST = qvi_data.groupby(['STORE_NBR', 'MONTH_ID'])['PROD_QTY'].sum()
CHIP_CUST = CHIP_CUST / TOT_CUST_M
```

```
TOT_PROD = qvi_data.groupby(['STORE_NBR','MONTH_ID'])['PROD_QTY'].sum()
AVG_PR_U = TOT_SALE_M / TOT_PROD
```

```
measureoverTime = pd.concat([TOT_SALE_M, TOT_CUST_M, TRAN_CUST_M, CHIP_CUST, AVG_PR_U],axis=1)
measureoverTime.columns = ["totSales", "nCustomers", "nTxnPerCust", "nChipsPerTxn", "avgPricePerUnit"]
measureoverTime = measureoverTime.reset_index()
measureoverTime.head(10)
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit
0	1	201807	206.9	49	1.061224	1.265306	3.337097
1	1	201808	176.1	42	1.023810	1.285714	3.261111
2	1	201809	278.8	59	1.050847	1.271186	3.717333
3	1	201810	188.1	44	1.022727	1.318182	3.243103
4	1	201811	192.6	46	1.021739	1.239130	3.378947
5	1	201812	189.6	42	1.119048	1.357143	3.326316
6	1	201901	154.8	35	1.028571	1.200000	3.685714
7	1	201902	225.4	52	1.057692	1.250000	3.467692
8	1	201903	192.9	45	1.088889	1.288889	3.325862
9	1	201904	192.9	42	1.023810	1.357143	3.384211

Filtering to the pre-trial period and stores with full observation periods.

```
observations = measureoverTime["STORE_NBR"].value_counts()
full_index = observations[observations == 12].index
storesWithFullObs = measureoverTime[measureoverTime['STORE_NBR'].isin(full_index)]
preTrialMeasures = storesWithFullObs[(storesWithFullObs['MONTH_ID'] < 201902)]
preTrialMeasures.reset_index(drop=True)
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit
0	1	201807	206.9	49	1.061224	1.265306	3.337097
1	1	201808	176.1	42	1.023810	1.285714	3.261111
2	1	201809	278.8	59	1.050847	1.271186	3.717333
3	1	201810	188.1	44	1.022727	1.318182	3.243103
4	1	201811	192.6	46	1.021739	1.239130	3.378947
...	...	...	...	...	...	...	...
1815	272	201809	304.7	32	1.125000	2.218750	4.291549
1816	272	201810	430.6	44	1.136364	2.250000	4.349495
1817	272	201811	376.2	41	1.097561	2.121951	4.324138
1818	272	201812	403.9	47	1.000000	1.893617	4.538202
1819	272	201901	423.0	46	1.086957	2.086957	4.406250

1820 rows × 7 columns

Creating a function to calculate correlation for a measure, looping through each control store.

```
def calculateCorrelation(inputTable, metricCol, storeComparison) :
  comp_stores = inputTable[~inputTable['STORE_NBR'].isin([77, 86, 88])]
  trial_stores = inputTable.loc[inputTable["STORE_NBR"] == storeComparison][metricCol].reset_index()
  calcCorrTable = pd.DataFrame(columns = ["Control_Store", "Trial_Store", "Corr"])

  for i in comp_stores["STORE_NBR"].unique():
        control = comp_stores[comp_stores["STORE_NBR"]==i][metricCol].reset_index()
        correlation = control.corrwith(trial_stores,axis=0)[1]
        calcCorrTable_i = pd.DataFrame({"Control_Store":i,"Trial_Store":storeComparison,"Corr":[correlation]})
        calcCorrTable = pd.concat([calcCorrTable, calcCorrTable_i])

  return calcCorrTable
```

Creating a function to calculate a standardised magnitude distance for a measure.

```
def calculateMagnitudeDistance(inputTable, metricCol, storeComparison):

    comp_stores = inputTable.loc[~inputTable["STORE_NBR"].isin([77,86,88])]
    trial_stores = inputTable.loc[inputTable["STORE_NBR"] == storeComparison].reset_index()[metricCol]
    calcDistTable = pd.DataFrame(columns=["Control_Store", "Trial_Store", "Magnitude"])

    for i in comp_stores["STORE_NBR"].unique():
        control = comp_stores[comp_stores["STORE_NBR"]==i].reset_index()[metricCol]
        diff = abs(trial_stores - control)
        s_diff = np.mean(1-((diff-min(diff))/(max(diff)-min(diff))))
        calcDistTable_i = pd.DataFrame({"Control_Store":i,"Trial_Store":[storeComparison],"Magnitude": s_diff})
        calcDistTable = pd.concat([calcDistTable, calcDistTable_i])
    return calcDistTable


corr_nSales_77 = calculateCorrelation(preTrialMeasures,"totSales",77)
magnitude_nSales_77 = calculateMagnitudeDistance(preTrialMeasures,"totSales",77)
corr_nCustomers_77 = calculateCorrelation(preTrialMeasures,"nCustomers",77)
magnitude_nCustomers_77 = calculateMagnitudeDistance(preTrialMeasures,"nCustomers",77)


nSales_77_merged = pd.concat([corr_nSales_77,magnitude_nSales_77],axis=1)
nSales_77_merged["score_nSales"] = 0.5 * nSales_77_merged["Corr"] + (1-0.5) * nSales_77_merged["Magnitude"]
nSales_77_merged.head(10)
```

	Control_Store	Trial_Store	Corr	Control_Store	Trial_Store	Magnitude	score_nSales
0	1	77	0.075218	1	77	0.408163	0.241691
0	2	77	-0.263079	2	77	0.590119	0.163520
0	3	77	0.806644	3	77	0.522914	0.664779
0	4	77	-0.263300	4	77	0.644934	0.190817
0	5	77	-0.110652	5	77	0.516320	0.202834
0	6	77	0.042490	6	77	0.622226	0.332358
0	7	77	-0.193886	7	77	0.423680	0.114897
0	8	77	-0.307360	8	77	0.621858	0.157249
0	9	77	-0.702976	9	77	0.414734	-0.144121
0	10	77	-0.040008	10	77	0.471165	0.215578

```
nCustomers_77_merged = pd.concat([corr_nCustomers_77,magnitude_nCustomers_77],axis=1)
nCustomers_77_merged["score_nCustomers"] = 0.5 * nCustomers_77_merged["Corr"] + (1-0.5) * nCustomers_77_merged["Magnitude"]
nCustomers_77_merged.head(10)
```

	Control_Store	Trial_Store	Corr	Control_Store	Trial_Store	Magnitude	score_nCustomers
0	1	77	0.322168	1	77	0.663866	0.493017
0	2	77	-0.572051	2	77	0.471429	-0.050311
0	3	77	0.834207	3	77	0.489796	0.662002
0	4	77	-0.295639	4	77	0.498258	0.101310
0	5	77	0.370659	5	77	0.512605	0.441632
0	6	77	0.136856	6	77	0.600000	0.368428
0	7	77	-0.310977	7	77	0.389610	0.039317
0	8	77	-0.410357	8	77	0.441558	0.015601
0	9	77	-0.785699	9	77	0.611429	-0.087135
0	10	77	0.112178	10	77	0.530612	0.321395

```
score_Control_77 = pd.concat([nSales_77_merged[["Control_Store", "Trial_Store", "score_nSales"]],nCustomers_77_merged["score_nCustomers'

score_Control_77["finalControlScore"] = 0.5 * score_Control_77["score_nSales"] + (1-0.5) * score_Control_77["score_nCustomers"]
score_Control_77
```

	Control_Store	Control_Store	Trial_Store	Trial_Store	score_nSales	score_nCustomers	finalControlScore
0	1	1	77	77	0.241691	0.493017	0.367354
0	2	2	77	77	0.163520	-0.050311	0.056604
0	3	3	77	77	0.664779	0.662002	0.663390
0	4	4	77	77	0.190817	0.101310	0.146064
0	5	5	77	77	0.202834	0.441632	0.322233
...	...	...	...	...	...	...	...
0	268	268	77	77	0.387272	0.470473	0.428872
0	269	269	77	77	0.121684	0.005090	0.063387
0	270	270	77	77	0.453489	0.202710	0.328100
0	271	271	77	77	0.348289	0.174100	0.261195
0	272	272	77	77	0.320626	0.384336	0.352481

257 rows × 7 columns

```
score_Control_77.sort_values(by='finalControlScore',ascending=False).head()
```

	Control_Store	Control_Store	Trial_Store	Trial_Store	score_nSales	score_nCustomers	finalControlScore
0	233	233	77	77	0.697290	0.816607	0.756949
0	71	71	77	77	0.789497	0.663123	0.726310
0	84	84	77	77	0.656972	0.715000	0.685986
0	119	119	77	77	0.636046	0.729729	0.682887
0	115	115	77	77	0.708347	0.645155	0.676751

```
measureoverTimeSales = measureoverTime

pastSales = measureoverTimeSales.assign(Store_type = lambda x: np.where(x['STORE_NBR'] == 77, 'Trial', np.where(x['STORE_NBR'] == 233,

pastSales.head(10)
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit	Store_type
0	1	201807	206.9	49	1.061224	1.265306	3.337097	Other Stores
1	1	201808	176.1	42	1.023810	1.285714	3.261111	Other Stores
2	1	201809	278.8	59	1.050847	1.271186	3.717333	Other Stores
3	1	201810	188.1	44	1.022727	1.318182	3.243103	Other Stores
4	1	201811	192.6	46	1.021739	1.239130	3.378947	Other Stores
5	1	201812	189.6	42	1.119048	1.357143	3.326316	Other Stores
6	1	201901	154.8	35	1.028571	1.200000	3.685714	Other Stores
7	1	201902	225.4	52	1.057692	1.250000	3.467692	Other Stores
8	1	201903	192.9	45	1.088889	1.288889	3.325862	Other Stores
9	1	201904	192.9	42	1.023810	1.357143	3.384211	Other Stores

```
pastSales['YearMonth'] = pd.to_datetime(pastSales['MONTH_ID'], format='%Y%m')
pastSales
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit	Store_type	YearMonth
0	1	201807	206.9	49	1.061224	1.265306	3.337097	Other Stores	2018-07-01
1	1	201808	176.1	42	1.023810	1.285714	3.261111	Other Stores	2018-08-01
2	1	201809	278.8	59	1.050847	1.271186	3.717333	Other Stores	2018-09-01
3	1	201810	188.1	44	1.022727	1.318182	3.243103	Other Stores	2018-10-01
4	1	201811	192.6	46	1.021739	1.239130	3.378947	Other Stores	2018-11-01
...	...	...	...	...	...	...	...	...	...
3164	272	201902	395.5	45	1.066667	2.022222	4.346154	Other Stores	2019-02-01
3165	272	201903	442.3	50	1.060000	2.020000	4.379208	Other Stores	2019-03-01
3166	272	201904	445.1	54	1.018519	1.944444	4.239048	Other Stores	2019-04-01
3167	272	201905	314.6	34	1.176471	2.088235	4.430986	Other Stores	2019-05-01
3168	272	201906	312.1	34	1.088235	2.058824	4.458571	Other Stores	2019-06-01

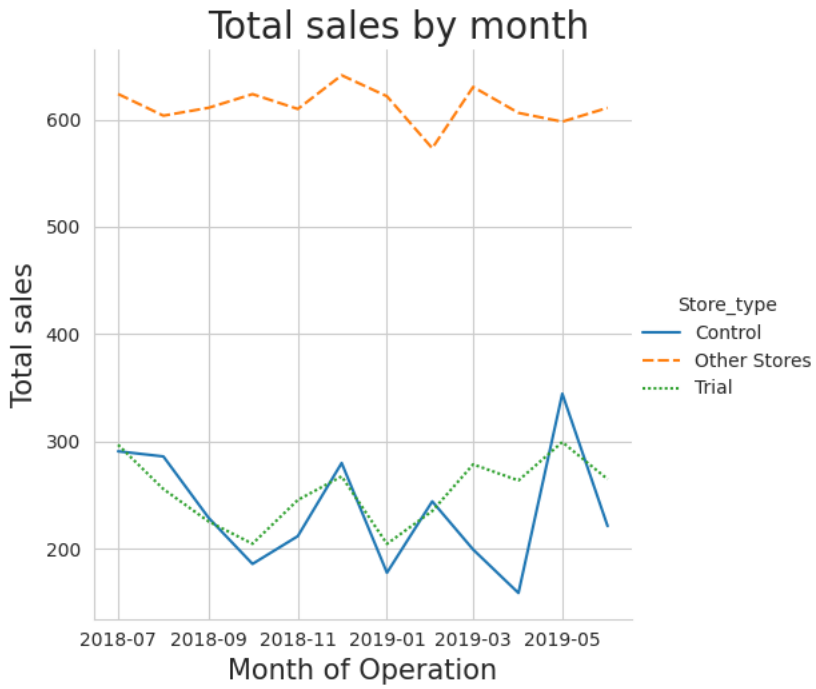
3169 rows × 9 columns

```
pastSales = pastSales.groupby(['YearMonth', 'Store_type']).agg(totSales = ('totSales', 'mean')).reset_index()
pastSales
```

	YearMonth	Store_type	totSales
0	2018-07-01	Control	290.700000
1	2018-07-01	Other Stores	623.817424
2	2018-07-01	Trial	296.800000
3	2018-08-01	Control	285.900000
4	2018-08-01	Other Stores	603.600192
5	2018-08-01	Trial	255.500000
6	2018-09-01	Control	228.600000
7	2018-09-01	Other Stores	610.947328
8	2018-09-01	Trial	225.200000
9	2018-10-01	Control	185.700000
10	2018-10-01	Other Stores	623.671103
11	2018-10-01	Trial	204.500000
12	2018-11-01	Control	211.600000
13	2018-11-01	Other Stores	609.835115
14	2018-11-01	Trial	245.300000
15	2018-12-01	Control	279.800000
16	2018-12-01	Other Stores	641.250192
17	2018-12-01	Trial	267.300000
18	2019-01-01	Control	177.500000
19	2019-01-01	Other Stores	621.687356
20	2019-01-01	Trial	204.400000
21	2019-02-01	Control	244.000000
22	2019-02-01	Other Stores	573.229008
23	2019-02-01	Trial	235.000000
24	2019-03-01	Control	199.100000
25	2019-03-01	Other Stores	630.371103
26	2019-03-01	Trial	278.500000
27	2019-04-01	Control	158.600000
28	2019-04-01	Other Stores	606.171103
29	2019-04-01	Trial	263.500000
30	2019-05-01	Control	344.400000
31	2019-05-01	Other Stores	597.984483
32	2019-05-01	Trial	299.300000
33	2019-06-01	Control	221.000000
34	2019-06-01	Other Stores	610.888931
35	2019-06-01	Trial	264.700000

```
plt.figure(figsize=(20,10))
fig1 = sns.relplot(kind='line', data=pastSales,x='YearMonth',y='totSales', hue = 'Store_type',style='Store_type',errorbar=None)
fig1.fig.suptitle("Total sales by month", y=1.03,fontsize=20)
plt.xlabel("Month of Operation",fontsize=15)
plt.ylabel("Total sales",fontsize=15)
```

```
Text(48.447177083333315, 0.5, 'Total sales')
<Figure size 2000x1000 with 0 Axes>
```




```
measureoverTimeCusts = measureoverTime
measureoverTimeCusts.head()
```

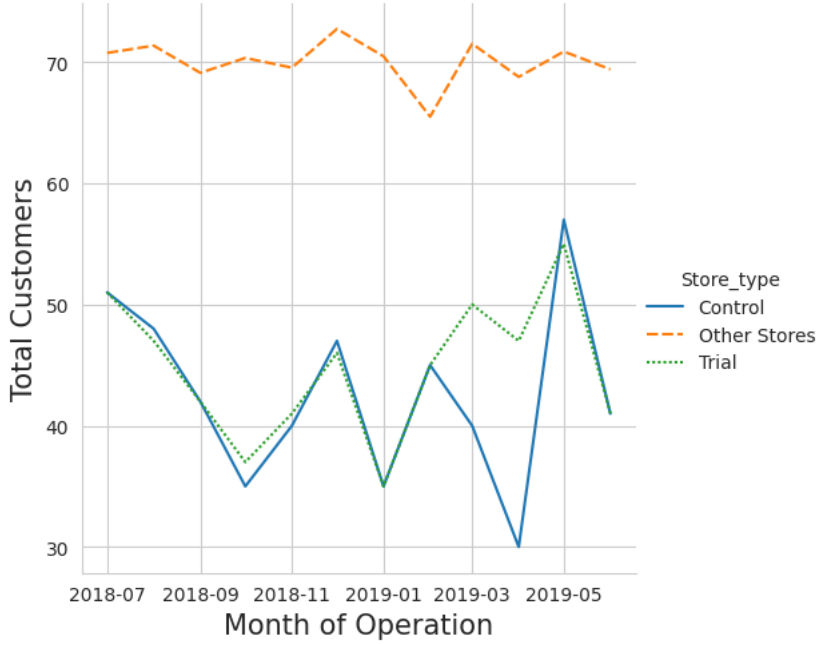
	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit
0	1	201807	206.9	49	1.061224	1.265306	3.337097
1	1	201808	176.1	42	1.023810	1.285714	3.261111
2	1	201809	278.8	59	1.050847	1.271186	3.717333
3	1	201810	188.1	44	1.022727	1.318182	3.243103
4	1	201811	192.6	46	1.021739	1.239130	3.378947

```
pastCustomers = measureoverTimeSales.assign(Store_type = lambda x: np.where(x['STORE_NBR'] == 77, 'Trial', np.where(x['STORE_NBR'] == 233
pastCustomers['YearMonth'] = pd.to_datetime(pastCustomers['MONTH_ID'], format='%Y%m')
pastCustomers = pastCustomers.groupby(['YearMonth', 'Store_type']).agg(nCustomers = ('nCustomers', 'mean')).reset_index()
pastCustomers.head(10)
```

	YearMonth	Store_type	nCustomers
0	2018-07-01	Control	51.000000
1	2018-07-01	Other Stores	70.750000
2	2018-07-01	Trial	51.000000
3	2018-08-01	Control	48.000000
4	2018-08-01	Other Stores	71.352490
5	2018-08-01	Trial	47.000000
6	2018-09-01	Control	42.000000
7	2018-09-01	Other Stores	69.110687
8	2018-09-01	Trial	42.000000
9	2018-10-01	Control	35.000000

```
sns.set_style('whitegrid')
plt.figure(figsize=(20,10))
fig2 = sns.relplot(kind='line', data=pastCustomers,x='YearMonth',y='nCustomers', hue = 'Store_type',style='Store_type')
fig1.fig.suptitle("Total Customers by month", y=1.03,fontsize=20)
plt.xlabel("Month of Operation",fontsize=15)
plt.ylabel("Total Customers",fontsize=15)
```

```
Text(46.038739583333324, 0.5, 'Total Customers')
<Figure size 2000x1000 with 0 Axes>
```



For Store 86

```
corr_nSales_86 = calculateCorrelation(preTrialMeasures,"totSales",86)

magnitude_nSales_86 = calculateMagnitudeDistance(preTrialMeasures,"totSales",86)

corr_nCustomers_86 = calculateCorrelation(preTrialMeasures,"nCustomers",86)

magnitude_nCustomers_86 = calculateMagnitudeDistance(preTrialMeasures,"nCustomers",86)


nSales_86_merged = pd.concat([corr_nSales_86,magnitude_nSales_86],axis=1)
nSales_86_merged["score_nSales"] = 0.5 * nSales_86_merged["Corr"] + (1-0.5) * nSales_86_merged["Magnitude"]
nSales_86_merged
```

	Control_Store	Trial_Store	Corr	Control_Store	Trial_Store	Magnitude	score_nSales
0	1	86	0.445632	1	86	0.488334	0.466983
0	2	86	-0.403835	2	86	0.321131	-0.041352
0	3	86	-0.261284	3	86	0.507515	0.123116
0	4	86	-0.039035	4	86	0.635654	0.298309
0	5	86	0.235159	5	86	0.579835	0.407497
...	...	...	...	...	...	...	...
0	268	86	-0.452182	268	86	0.291930	-0.080126
0	269	86	0.697055	269	86	0.480267	0.588661
0	270	86	-0.730679	270	86	0.517014	-0.106832
0	271	86	0.527637	271	86	0.565665	0.546651
0	272	86	0.004926	272	86	0.583840	0.294383

257 rows × 7 columns

```
nCustomers_86_merged = pd.concat([corr_nCustomers_86,magnitude_nCustomers_86],axis=1)
nCustomers_86_merged["score_nCustomers"] = 0.5 * nCustomers_86_merged["Corr"] + (1-0.5) * nCustomers_86_merged["Magnitude"]
nCustomers_86_merged
```

	Control_Store	Trial_Store	Corr	Control_Store	Trial_Store	Magnitude	score_nCustomers
0	1	86	0.485831	1	86	0.510204	0.498018
0	2	86	-0.086161	2	86	0.428571	0.171205
0	3	86	-0.353786	3	86	0.563025	0.104620
0	4	86	-0.169608	4	86	0.537815	0.184103
0	5	86	-0.253229	5	86	0.714286	0.230528
...	...	...	...	...	...	...	...
0	268	86	-0.034273	268	86	0.566327	0.266027
0	269	86	-0.098587	269	86	0.581633	0.241523
0	270	86	-0.767267	270	86	0.650794	-0.058237
0	271	86	0.267393	271	86	0.598214	0.432804
0	272	86	-0.353815	272	86	0.633540	0.139863

257 rows × 7 columns

```
score_Control_86 = pd.concat([nSales_86_merged[["Control_Store", "Trial_Store", "score_nSales"]],nCustomers_86_merged["score_nCustomers'

score_Control_86["finalControlScore"] = 0.5 * score_Control_86["score_nSales"] + (1-0.5) * score_Control_86["score_nCustomers"]
score_Control_86.sort_values(by='finalControlScore',ascending=False).head()
```

	Control_Store	Control_Store	Trial_Store	Trial_Store	score_nSales	score_nCustomers	finalControlScore
0	155	155	86	86	0.808106	0.733343	0.770724
0	109	109	86	86	0.697120	0.742532	0.719826
0	114	114	86	86	0.631393	0.663384	0.647389
0	225	225	86	86	0.601841	0.684356	0.643099
0	138	138	86	86	0.593296	0.660565	0.626930

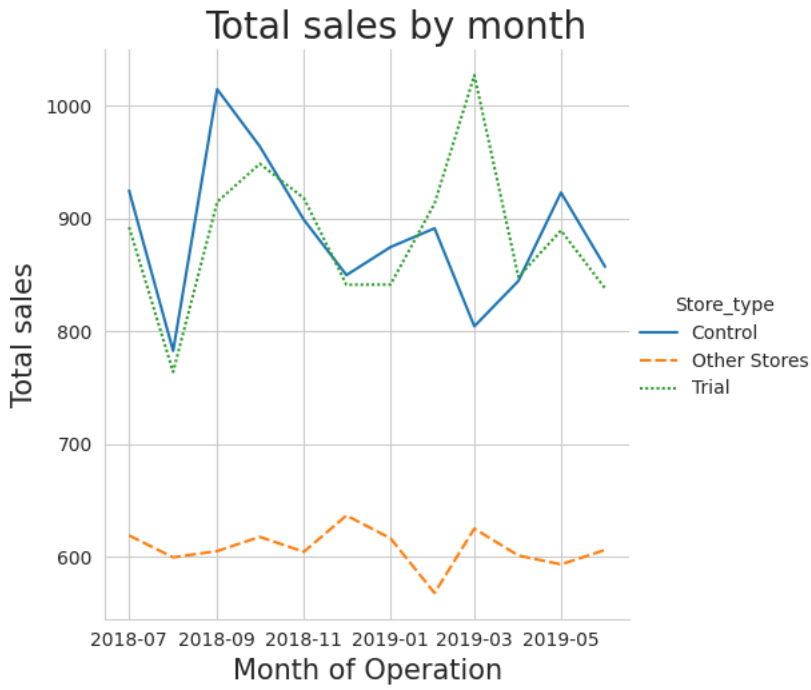
Now we have the Trial Store 86 and Control Store 155

```
measureoverTimeSales = measureoverTime

pastSales_86 = measureoverTimeSales.assign(Store_type = lambda x: np.where(x['STORE_NBR'] == 86, 'Trial', np.where(x['STORE_NBR'] == 15
pastSales_86['YearMonth'] = pd.to_datetime(pastSales_86['MONTH_ID'], format='%Y%m')
pastSales_86 = pastSales_86.groupby(['YearMonth', 'Store_type']).agg(totSales = ('totSales', 'mean')).reset_index()


sns.set_style('whitegrid')
plt.figure(figsize=(20,10))
fig3 = sns.relplot(kind='line', data=pastSales_86,x='YearMonth',y='totSales', hue = 'Store_type',style='Store_type')
fig3.fig.suptitle("Total sales by month", y=1.03,fontsize=20)
plt.xlabel("Month of Operation",fontsize=15)
plt.ylabel("Total sales",fontsize=15)
```

```
Text(50.855614583333335, 0.5, 'Total sales')
<Figure size 2000x1000 with 0 Axes>
```



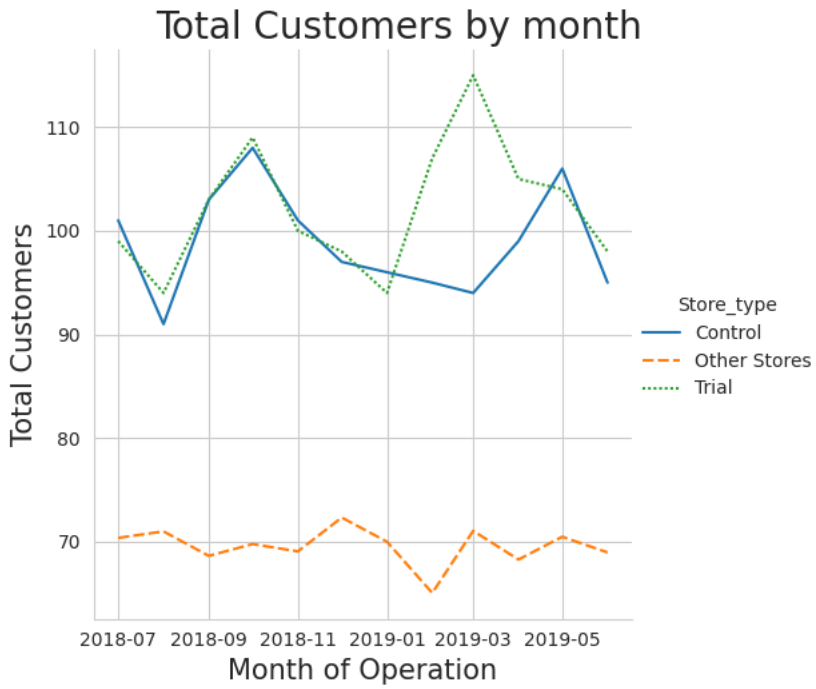

```
measureoverTimeCusts = measureoverTime


pastCustomers_86 = measureoverTimeSales.assign(Store_type = lambda x: np.where(x['STORE_NBR'] == 86, 'Trial', np.where(x['STORE_NBR'] ==
pastCustomers_86['YearMonth'] = pd.to_datetime(pastCustomers_86['MONTH_ID'], format='%Y%m')
pastCustomers_86 = pastCustomers_86.groupby(['YearMonth', 'Store_type']).agg(nCustomers = ('nCustomers', 'mean')).reset_index()
pastCustomers.head(10)
```

	YearMonth	Store_type	nCustomers
0	2018-07-01	Control	51.000000
1	2018-07-01	Other Stores	70.750000
2	2018-07-01	Trial	51.000000
3	2018-08-01	Control	48.000000
4	2018-08-01	Other Stores	71.352490
5	2018-08-01	Trial	47.000000
6	2018-09-01	Control	42.000000
7	2018-09-01	Other Stores	69.110687
8	2018-09-01	Trial	42.000000
9	2018-10-01	Control	35.000000

```
sns.set_style('whitegrid')
plt.figure(figsize=(20,10))
fig4 = sns.relplot(kind='line', data=pastCustomers_86,x='YearMonth',y='nCustomers', hue = 'Store_type',style='Store_type')
fig4.fig.suptitle("Total Customers by month", y=1.03,fontsize=20)
plt.xlabel("Month of Operation",fontsize=15)
plt.ylabel("Total Customers",fontsize=15)
```

```
Text(48.48158333333332, 0.5, 'Total Customers')
<Figure size 2000x1000 with 0 Axes>
```



For Store 88

```
corr_nSales_88 = calculateCorrelation(preTrialMeasures,"totSales",88)
magnitude_nSales_88 = calculateMagnitudeDistance(preTrialMeasures,"totSales",88)
corr_nCustomers_88 = calculateCorrelation(preTrialMeasures,"nCustomers",88)
magnitude_nCustomers_88 = calculateMagnitudeDistance(preTrialMeasures,"nCustomers",88)
```

```
nSales_88_merged = pd.concat([corr_nSales_88,magnitude_nSales_88['Magnitude']],axis=1)
nSales_88_merged["score_nSales"] = 0.5 * nSales_88_merged["Corr"] + 0.5 * nSales_88_merged["Magnitude"]
nSales_88_merged
```

	Control_Store	Trial_Store	Corr	Magnitude	score_nSales
0	1	88	0.813636	0.548959	0.681297
0	2	88	-0.067927	0.541212	0.236643
0	3	88	-0.507847	0.458109	-0.024869
0	4	88	-0.745566	0.484447	-0.130559
0	5	88	0.190330	0.496409	0.343370
...	...	...	...	...	...
0	268	88	-0.021429	0.522847	0.250709
0	269	88	-0.172578	0.564856	0.196139
0	270	88	-0.723272	0.513329	-0.104971
0	271	88	-0.103037	0.429220	0.163091
0	272	88	-0.772772	0.617809	-0.077482

257 rows × 5 columns

```
nCustomers_88_merged = pd.concat([corr_nCustomers_88,magnitude_nCustomers_88['Magnitude']],axis=1)
nCustomers_88_merged["score_nCustomers"] = 0.5 * nCustomers_88_merged["Corr"] + 0.5 * nCustomers_88_merged["Magnitude"]
nCustomers_88_merged
```

	Control_Store	Trial_Store	Corr	Magnitude	score_nCustomers
0	1	88	0.305334	0.357143	0.331238
0	2	88	-0.452379	0.285714	-0.083332
0	3	88	0.522884	0.683673	0.603279
0	4	88	-0.361503	0.577922	0.108210
0	5	88	-0.025320	0.558442	0.266561
...	...	...	...	...	...
0	268	88	0.672672	0.630252	0.651462
0	269	88	-0.274781	0.360902	0.043061
0	270	88	-0.103032	0.367965	0.132467
0	271	88	-0.018831	0.655844	0.318507
0	272	88	0.026909	0.448980	0.237944

257 rows × 5 columns

```
score_Control_88 = pd.concat([nSales_88_merged[["Control_Store", "Trial_Store", "score_nSales"]],nCustomers_88_merged["score_nCustomers'

score_Control_88["finalControlScore"] = 0.5 * score_Control_88["score_nSales"] + 0.5 * score_Control_88["score_nCustomers"]


score_Control_88.sort_values(by='finalControlScore',ascending=False)
```

	Control_Store	Trial_Store	score_nSales	score_nCustomers	finalControlScore
0	178	88	0.650803	0.707828	0.679316
0	14	88	0.646064	0.685774	0.665919
0	134	88	0.775084	0.540154	0.657619
0	237	88	0.451974	0.777235	0.614604
0	187	88	0.616752	0.594560	0.605656
...	...	...	...	...	...
0	141	88	-0.111265	-0.057033	-0.084149
0	48	88	-0.174440	-0.050650	-0.112545
0	239	88	-0.109933	-0.123703	-0.116818
0	133	88	-0.119811	-0.175477	-0.147644
0	19	88	-0.081841	-0.247593	-0.164717

257 rows × 5 columns

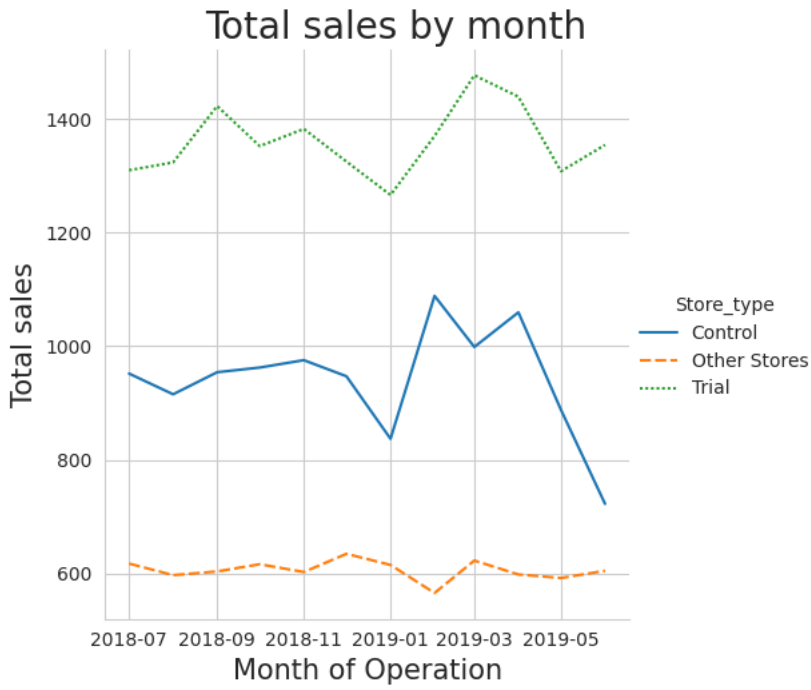
We have Trial Store 88 and Control Store 178

```
measureoverTimeSales = measureoverTime


pastSales_88 = measureoverTimeSales.assign(Store_type = lambda x: np.where(x['STORE_NBR'] == 88, 'Trial', np.where(x['STORE_NBR'] == 17
pastSales_88['YearMonth'] = pd.to_datetime(pastSales_88['MONTH_ID'], format='%Y%m')
pastSales_88 = pastSales_88.groupby(['YearMonth', 'Store_type']).agg(totSales = ('totSales', 'mean')).reset_index()


sns.set_style('whitegrid')
plt.figure(figsize=(20,10))
fig5 = sns.relplot(kind='line', data=pastSales_88,x='YearMonth',y='totSales', hue = 'Store_type',style='Store_type')
fig5.fig.suptitle("Total sales by month", y=1.03,fontsize=20)
plt.xlabel("Month of Operation",fontsize=15)
plt.ylabel("Total sales",fontsize=15)
```

```
Text(50.855614583333335, 0.5, 'Total sales')
<Figure size 2000x1000 with 0 Axes>
```



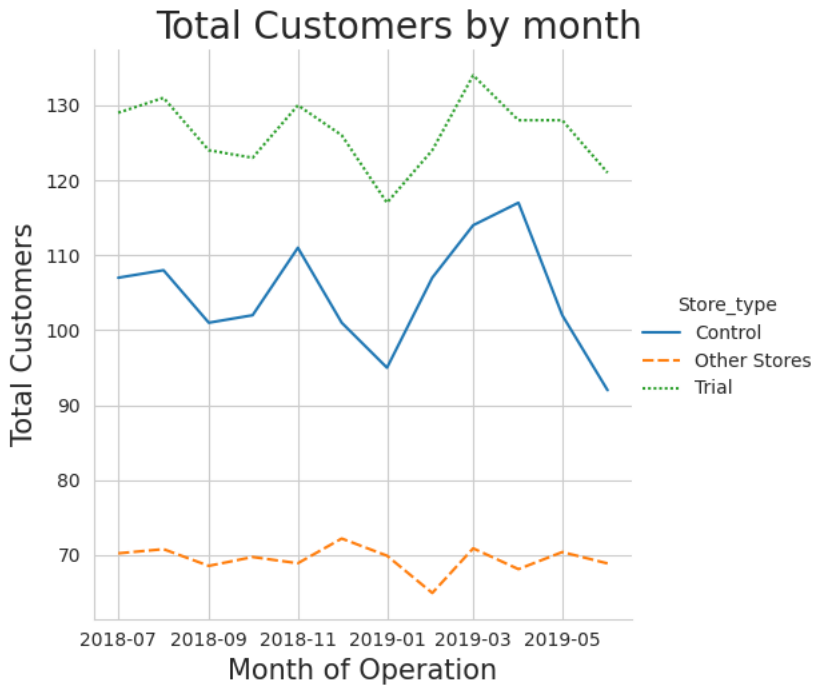

```
measureoverTimeCusts = measureoverTime


pastCustomers_88 = measureoverTimeSales.assign(Store_type = lambda x: np.where(x['STORE_NBR'] == 88, 'Trial', np.where(x['STORE_NBR'] ==
pastCustomers_88['YearMonth'] = pd.to_datetime(pastCustomers_88['MONTH_ID'], format='%Y%m')
pastCustomers_88 = pastCustomers_88.groupby(['YearMonth', 'Store_type']).agg(nCustomers = ('nCustomers', 'mean')).reset_index()
pastCustomers.head(10)
```

	YearMonth	Store_type	nCustomers
0	2018-07-01	Control	51.000000
1	2018-07-01	Other Stores	70.750000
2	2018-07-01	Trial	51.000000
3	2018-08-01	Control	48.000000
4	2018-08-01	Other Stores	71.352490
5	2018-08-01	Trial	47.000000
6	2018-09-01	Control	42.000000
7	2018-09-01	Other Stores	69.110687
8	2018-09-01	Trial	42.000000
9	2018-10-01	Control	35.000000

```
sns.set_style('whitegrid')
plt.figure(figsize=(20,10))
fig6 = sns.relplot(kind='line', data=pastCustomers_88,x='YearMonth',y='nCustomers', hue = 'Store_type',style='Store_type')
fig6.fig.suptitle("Total Customers by month", y=1.03,fontsize=20)
plt.xlabel("Month of Operation",fontsize=15)
plt.ylabel("Total Customers",fontsize=15)
```

```
Text(48.48158333333332, 0.5, 'Total Customers')
<Figure size 2000x1000 with 0 Axes>
```



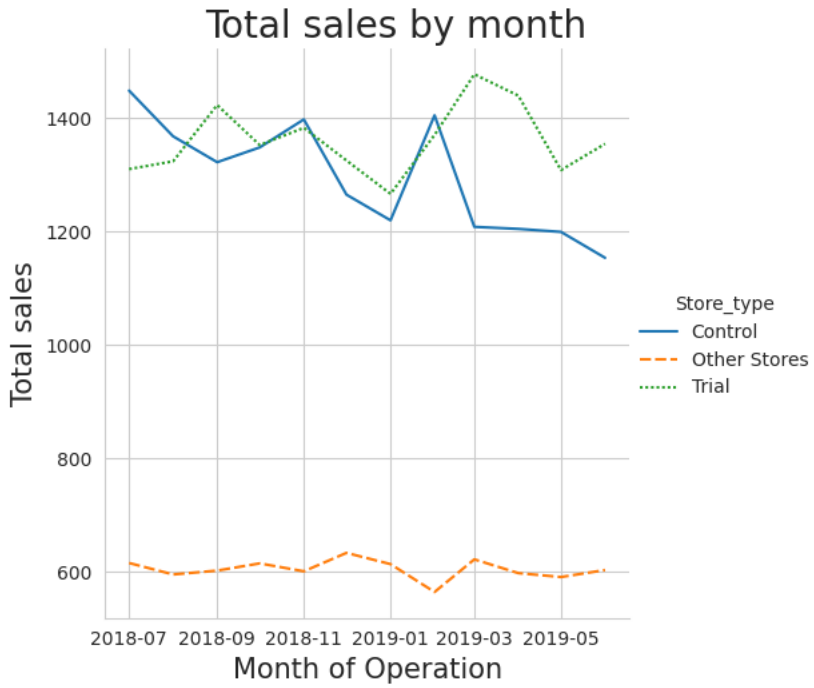
The Visualization shows that Control Store 178 is not a good store for Trial Store 88

Let's try Store 237 as the Control Store.

```
pastSales_88 = measureoverTimeSales.assign(Store_type = lambda x: np.where(x['STORE_NBR'] == 88, 'Trial', np.where(x['STORE_NBR'] == 237
pastSales_88['YearMonth'] = pd.to_datetime(pastSales_88['MONTH_ID'], format='%Y%m')
pastSales_88 = pastSales_88.groupby(['YearMonth', 'Store_type']).agg(totSales = ('totSales', 'mean')).reset_index()
```

```
sns.set_style('whitegrid')
plt.figure(figsize=(20,10))
fig5 = sns.relplot(kind='line', data=pastSales_88,x='YearMonth',y='totSales', hue = 'Store_type',style='Store_type')
fig5.fig.suptitle("Total sales by month", y=1.03,fontsize=20)
plt.xlabel("Month of Operation",fontsize=15)
plt.ylabel("Total sales",fontsize=15)
```

```
Text(50.855614583333335, 0.5, 'Total sales')
<Figure size 2000x1000 with 0 Axes>
```



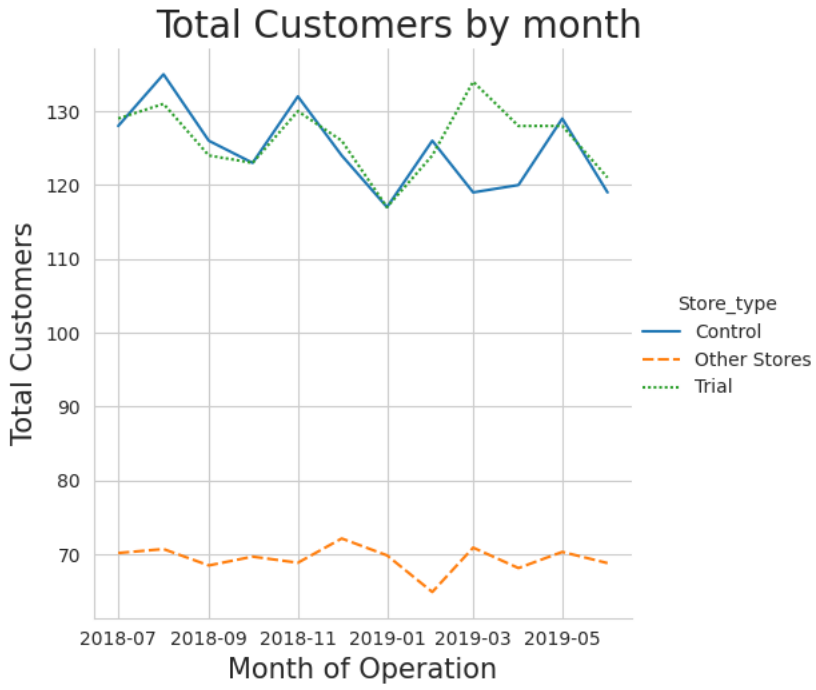
```
measureoverTimeCusts = measureoverTime


pastCustomers_88 = measureoverTimeSales.assign(Store_type = lambda x: np.where(x['STORE_NBR'] == 88, 'Trial', np.where(x['STORE_NBR'] ==
pastCustomers_88['YearMonth'] = pd.to_datetime(pastCustomers_88['MONTH_ID'], format='%Y%m')
pastCustomers_88 = pastCustomers_88.groupby(['YearMonth', 'Store_type']).agg(nCustomers = ('nCustomers', 'mean')).reset_index()
pastCustomers.head(10)
```

	YearMonth	Store_type	nCustomers
0	2018-07-01	Control	51.000000
1	2018-07-01	Other Stores	70.750000
2	2018-07-01	Trial	51.000000
3	2018-08-01	Control	48.000000
4	2018-08-01	Other Stores	71.352490
5	2018-08-01	Trial	47.000000
6	2018-09-01	Control	42.000000
7	2018-09-01	Other Stores	69.110687
8	2018-09-01	Trial	42.000000
9	2018-10-01	Control	35.000000

```
sns.set_style('whitegrid')
plt.figure(figsize=(20,10))
fig6 = sns.relplot(kind='line', data=pastCustomers_88,x='YearMonth',y='nCustomers', hue = 'Store_type',style='Store_type')
fig6.fig.suptitle("Total Customers by month", y=1.03,fontsize=20)
plt.xlabel("Month of Operation",fontsize=15)
plt.ylabel("Total Customers",fontsize=15)
```

```
Text(48.48158333333332, 0.5, 'Total Customers')
<Figure size 2000x1000 with 0 Axes>
```



Store 237 gives good output as Control Store for Trial Store 88.

Assessment of trial

```
preTrialMeasures
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit
0	1	201807	206.9	49	1.061224	1.265306	3.337097
1	1	201808	176.1	42	1.023810	1.285714	3.261111
2	1	201809	278.8	59	1.050847	1.271186	3.717333
3	1	201810	188.1	44	1.022727	1.318182	3.243103
4	1	201811	192.6	46	1.021739	1.239130	3.378947
...	...	...	...	...	...	...	...
3159	272	201809	304.7	32	1.125000	2.218750	4.291549
3160	272	201810	430.6	44	1.136364	2.250000	4.349495
3161	272	201811	376.2	41	1.097561	2.121951	4.324138
3162	272	201812	403.9	47	1.000000	1.893617	4.538202
3163	272	201901	423.0	46	1.086957	2.086957	4.406250

1820 rows × 7 columns

```
scalingFactorForControlSales_77 = (preTrialMeasures[preTrialMeasures['STORE_NBR'] == 77]['totSales'].sum()) / (preTrialMeasures[preTria
scalingFactorForControlSales_77
```

```
1.023617303289553
```

```
scaledControlSales_77 = preTrialMeasures.loc[(preTrialMeasures['STORE_NBR'] == 233)]
scaledControlSales_77
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit
2699	233	201807	290.7	51	1.058824	1.725490	3.303409
2700	233	201808	285.9	48	1.041667	1.666667	3.573750
2701	233	201809	228.6	42	1.071429	1.666667	3.265714
2702	233	201810	185.7	35	1.028571	1.600000	3.316071
2703	233	201811	211.6	40	1.025000	1.550000	3.412903
2704	233	201812	279.8	47	1.063830	1.595745	3.730667
2705	233	201901	177.5	35	1.000000	1.342857	3.776596

```
scaledControlSales_77["controlSales"] = scaledControlSales_77["totSales"] * scalingFactorForControlSales_77
scaledControlSales_77
```

```
<ipython-input-239-9e43c7d7223b>: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
  scaledControlSales_77["controlSales"] = scaledControlSales_77["totSales"] * scalingFactorForControlSales_77
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit	controlSales
2699	233	201807	290.7	51	1.058824	1.725490	3.303409	297.565550
2700	233	201808	285.9	48	1.041667	1.666667	3.573750	292.652187
2701	233	201809	228.6	42	1.071429	1.666667	3.265714	233.998916
2702	233	201810	185.7	35	1.028571	1.600000	3.316071	190.085733
2703	233	201811	211.6	40	1.025000	1.550000	3.412903	216.597421
2704	233	201812	279.8	47	1.063830	1.595745	3.730667	286.408121
2705	233	201901	177.5	35	1.000000	1.342857	3.776596	181.692071

```
scaledControlSales_77.reset_index(drop=True)
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit	controlSales
0	233	201807	290.7	51	1.058824	1.725490	3.303409	297.565550
1	233	201808	285.9	48	1.041667	1.666667	3.573750	292.652187
2	233	201809	228.6	42	1.071429	1.666667	3.265714	233.998916
3	233	201810	185.7	35	1.028571	1.600000	3.316071	190.085733
4	233	201811	211.6	40	1.025000	1.550000	3.412903	216.597421
5	233	201812	279.8	47	1.063830	1.595745	3.730667	286.408121
6	233	201901	177.5	35	1.000000	1.342857	3.776596	181.692071

```
trialSales_77 = measureoverTime[measureoverTime['STORE_NBR'] == 77].reset_index(drop=True)
scaledControlSales_77 = scaledControlSales_77.reset_index(drop=True)
percentDiffS_77 = pd.concat([trialSales_77["MONTH_ID"],trialSales_77["totSales"],scaledControlSales_77["controlSales"]],axis=1)
percentDiffS_77.columns=["MONTH_ID","trialSales","controlSales"]
percentDiffS_77["percentDiffS"]= (abs(percentDiffS_77["trialSales"]-percentDiffS_77["controlSales"]))/percentDiffS_77["controlSales"]
percentDiffS_77
```

	MONTH_ID	trialSales	controlSales	percentDiffS
0	201807	296.8	297.565550	0.002573
1	201808	255.5	292.652187	0.126950
2	201809	225.2	233.998916	0.037602
3	201810	204.5	190.085733	0.075830
4	201811	245.3	216.597421	0.132516
5	201812	267.3	286.408121	0.066716
6	201901	204.4	181.692071	0.124980
7	201902	235.0	NaN	NaN
8	201903	278.5	NaN	NaN
9	201904	263.5	NaN	NaN
10	201905	299.3	NaN	NaN
11	201906	264.7	NaN	NaN

```
stdS_77 = percentDiffS_77[percentDiffS_77["MONTH_ID"]<201902]["percentDiffS"].std()
stdS_77
```

```
0.04994076264142537
```

Note that there are 8 months in the pre-trial period

hence 8 - 1 = 7 degrees of freedom

```
dof = 7
```

We will test with a null hypothesis of there being 0 difference between trial and control stores.

The test statistic here is (x - u)/standard deviation

```
percentDiffS_77['tValue'] = (percentDiffS_77['percentDiffS'] - 0) / stdS_77
percentDiffS_77
```

	MONTH_ID	trialSales	controlSales	percentDiffS	tValue
0	201807	296.8	297.565550	0.002573	0.051515
1	201808	255.5	292.652187	0.126950	2.542011
2	201809	225.2	233.998916	0.037602	0.752940
3	201810	204.5	190.085733	0.075830	1.518406
4	201811	245.3	216.597421	0.132516	2.653459
5	201812	267.3	286.408121	0.066716	1.335911
6	201901	204.4	181.692071	0.124980	2.502571
7	201902	235.0	NaN	NaN	NaN
8	201903	278.5	NaN	NaN	NaN
9	201904	263.5	NaN	NaN	NaN
10	201905	299.3	NaN	NaN	NaN
11	201906	264.7	NaN	NaN	NaN

```
from scipy.stats import t


t.ppf(0.975,df = dof)
```

```
2.3646242510102993
```

We can observe that the t-value is much larger than the 95th percentile value of the t-distribution for March and April - i.e. the increase in sales in the trial store in March and April is statistically greater than in the control store.

Let's create a more visual version of this by plotting the sales of the control store, the sales of the trial stores and the 95th percentile value of sales of the control store.

```
measureoverTimeSales_77 = measureoverTime
pastSales_77 = measureoverTimeSales_77

trial_store = 77
control_store = 233
store_type = []
for i in pastSales_77["STORE_NBR"]:
    if i == trial_store:
        store_type.append("Trial")
    elif i == control_store:
        store_type.append("Control")
    else:
        store_type.append("Other Stores")
pastSales_77["Store_type"] = store_type


pastSales_77
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit	Store_type
0	1	201807	206.9	49	1.061224	1.265306	3.337097	Other Stores
1	1	201808	176.1	42	1.023810	1.285714	3.261111	Other Stores
2	1	201809	278.8	59	1.050847	1.271186	3.717333	Other Stores
3	1	201810	188.1	44	1.022727	1.318182	3.243103	Other Stores
4	1	201811	192.6	46	1.021739	1.239130	3.378947	Other Stores
...	...	...	...	...	...	...	...	...
3164	272	201902	395.5	45	1.066667	2.022222	4.346154	Other Stores
3165	272	201903	442.3	50	1.060000	2.020000	4.379208	Other Stores
3166	272	201904	445.1	54	1.018519	1.944444	4.239048	Other Stores
3167	272	201905	314.6	34	1.176471	2.088235	4.430986	Other Stores
3168	272	201906	312.1	34	1.088235	2.058824	4.458571	Other Stores

3169 rows × 8 columns

```
pastSales_77['TransactionMonth'] = pd.to_datetime(pastSales_77['MONTH_ID'], format='%Y%m')
```

```
pastSales_77 = pastSales_77.loc[pastSales_77['Store_type'].isin(['Control','Trial'])]
pastSales_77 = pastSales_77.loc[:,['TransactionMonth','totSales','Store_type']]
pastSales_77
```

	TransactionMonth	totSales	Store_type
880	2018-07-01	296.8	Trial
881	2018-08-01	255.5	Trial
882	2018-09-01	225.2	Trial
883	2018-10-01	204.5	Trial
884	2018-11-01	245.3	Trial
885	2018-12-01	267.3	Trial
886	2019-01-01	204.4	Trial
887	2019-02-01	235.0	Trial
888	2019-03-01	278.5	Trial
889	2019-04-01	263.5	Trial
890	2019-05-01	299.3	Trial
891	2019-06-01	264.7	Trial
2699	2018-07-01	290.7	Control
2700	2018-08-01	285.9	Control
2701	2018-09-01	228.6	Control
2702	2018-10-01	185.7	Control
2703	2018-11-01	211.6	Control
2704	2018-12-01	279.8	Control
2705	2019-01-01	177.5	Control
2706	2019-02-01	244.0	Control
2707	2019-03-01	199.1	Control
2708	2019-04-01	158.6	Control
2709	2019-05-01	344.4	Control
2710	2019-06-01	221.0	Control

```
pastSales_Controls95 = pastSales_77[pastSales_77['Store_type'] == "Control"]
pastSales_Controls95['totSales'] = pastSales_Controls95['totSales'] * (1 + (stdS_77 * 2))
pastSales_Controls95['Store_type'] = "Control 95th % confidence interval"
pastSales_Controls95.head(10)
```

```
<ipython-input-251-60de99702a6e>:2: 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
  pastSales_Controls95['totSales'] = pastSales_Controls95['totSales'] * (1 + (stdS_77 * 2))
<ipython-input-251-60de99702a6e>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus
  pastSales_Controls95['Store_type'] = "Control 95th % confidence interval"
```

	TransactionMonth	totSales	Store_type
2699	2018-07-01	319.735559	Control 95th % confidence interval
2700	2018-08-01	314.456128	Control 95th % confidence interval
2701	2018-09-01	251.432917	Control 95th % confidence interval
2702	2018-10-01	204.247999	Control 95th % confidence interval
2703	2018-11-01	232.734931	Control 95th % confidence interval
2704	2018-12-01	307.746851	Control 95th % confidence interval
2705	2019-01-01	195.228971	Control 95th % confidence interval
2706	2019-02-01	268.371092	Control 95th % confidence interval
2707	2019-03-01	218.986412	Control 95th % confidence interval
2708	2019-04-01	174.441210	Control 95th % confidence interval

```
pastSales_Controls5 = pastSales_77[pastSales_77['Store_type'] == "Control"]
pastSales_Controls5['totSales'] = pastSales_Controls5['totSales'] * (1 - (stdS_77 * 2))
pastSales_Controls5['Store_type'] = "Control 5th % confidence interval"
pastSales_Controls5.head(10)
```

```
<ipython-input-252-5710a30ee2cb>:2: 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
  pastSales_Controls5['totSales'] = pastSales_Controls5['totSales'] * (1 - (stdS_77 * 2))
<ipython-input-252-5710a30ee2cb>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus
  pastSales_Controls5['Store_type'] = "Control 5th % confidence interval"
```

	TransactionMonth	totSales	Store_type
2699	2018-07-01	261.664441	Control 5th % confidence interval
2700	2018-08-01	257.343872	Control 5th % confidence interval
2701	2018-09-01	205.767083	Control 5th % confidence interval
2702	2018-10-01	167.152001	Control 5th % confidence interval
2703	2018-11-01	190.465069	Control 5th % confidence interval
2704	2018-12-01	251.853149	Control 5th % confidence interval
2705	2019-01-01	159.771029	Control 5th % confidence interval
2706	2019-02-01	219.628908	Control 5th % confidence interval
2707	2019-03-01	179.213588	Control 5th % confidence interval
2708	2019-04-01	142.758790	Control 5th % confidence interval

```
trialAstS_77 = pd.concat([pastSales_77,pastSales_Controls95,pastSales_Controls5])
trialAstS_77
```

	TransactionMonth	totSales	Store_type
880	2018-07-01	296.800000	Trial
881	2018-08-01	255.500000	Trial
882	2018-09-01	225.200000	Trial
883	2018-10-01	204.500000	Trial
884	2018-11-01	245.300000	Trial
885	2018-12-01	267.300000	Trial
886	2019-01-01	204.400000	Trial
887	2019-02-01	235.000000	Trial
888	2019-03-01	278.500000	Trial
889	2019-04-01	263.500000	Trial
890	2019-05-01	299.300000	Trial
891	2019-06-01	264.700000	Trial
2699	2018-07-01	290.700000	Control
2700	2018-08-01	285.900000	Control
2701	2018-09-01	228.600000	Control
2702	2018-10-01	185.700000	Control
2703	2018-11-01	211.600000	Control
2704	2018-12-01	279.800000	Control
2705	2019-01-01	177.500000	Control
2706	2019-02-01	244.000000	Control
2707	2019-03-01	199.100000	Control
2708	2019-04-01	158.600000	Control
2709	2019-05-01	344.400000	Control
2710	2019-06-01	221.000000	Control
2699	2018-07-01	319.735559	Control 95th % confidence interval
2700	2018-08-01	314.456128	Control 95th % confidence interval
2701	2018-09-01	251.432917	Control 95th % confidence interval
2702	2018-10-01	204.247999	Control 95th % confidence interval
2703	2018-11-01	232.734931	Control 95th % confidence interval
2704	2018-12-01	307.746851	Control 95th % confidence interval
2705	2019-01-01	195.228971	Control 95th % confidence interval
2706	2019-02-01	268.371092	Control 95th % confidence interval
2707	2019-03-01	218.986412	Control 95th % confidence interval
2708	2019-04-01	174.441210	Control 95th % confidence interval
2709	2019-05-01	378.799197	Control 95th % confidence interval
2710	2019-06-01	243.073817	Control 95th % confidence interval
2699	2018-07-01	261.664441	Control 5th % confidence interval
2700	2018-08-01	257.343872	Control 5th % confidence interval
2701	2018-09-01	205.767083	Control 5th % confidence interval
2702	2018-10-01	167.152001	Control 5th % confidence interval
2703	2018-11-01	190.465069	Control 5th % confidence interval
2704	2018-12-01	251.853149	Control 5th % confidence interval
2705	2019-01-01	159.771029	Control 5th % confidence interval
2706	2019-02-01	219.628908	Control 5th % confidence interval
2707	2019-03-01	179.213588	Control 5th % confidence interval
2708	2019-04-01	142.758790	Control 5th % confidence interval
2709	2019-05-01	310.000803	Control 5th % confidence interval
2710	2019-06-01	198.926183	Control 5th % confidence interval

```
trialAstS_77['TransactionMonth'] = pd.to_datetime(trialAstS_77['TransactionMonth'],format='%Y-%m')


bardata =trialAstS_77
bardata['TransactionMonth'] = bardata['TransactionMonth'].dt.strftime('%Y-%m').astype('str')
bardata = bardata.set_index('TransactionMonth')
bardata = bardata.loc[(bardata['Store_type'] == 'Trial') | (bardata['Store_type'] == 'Control')]
bardata
```

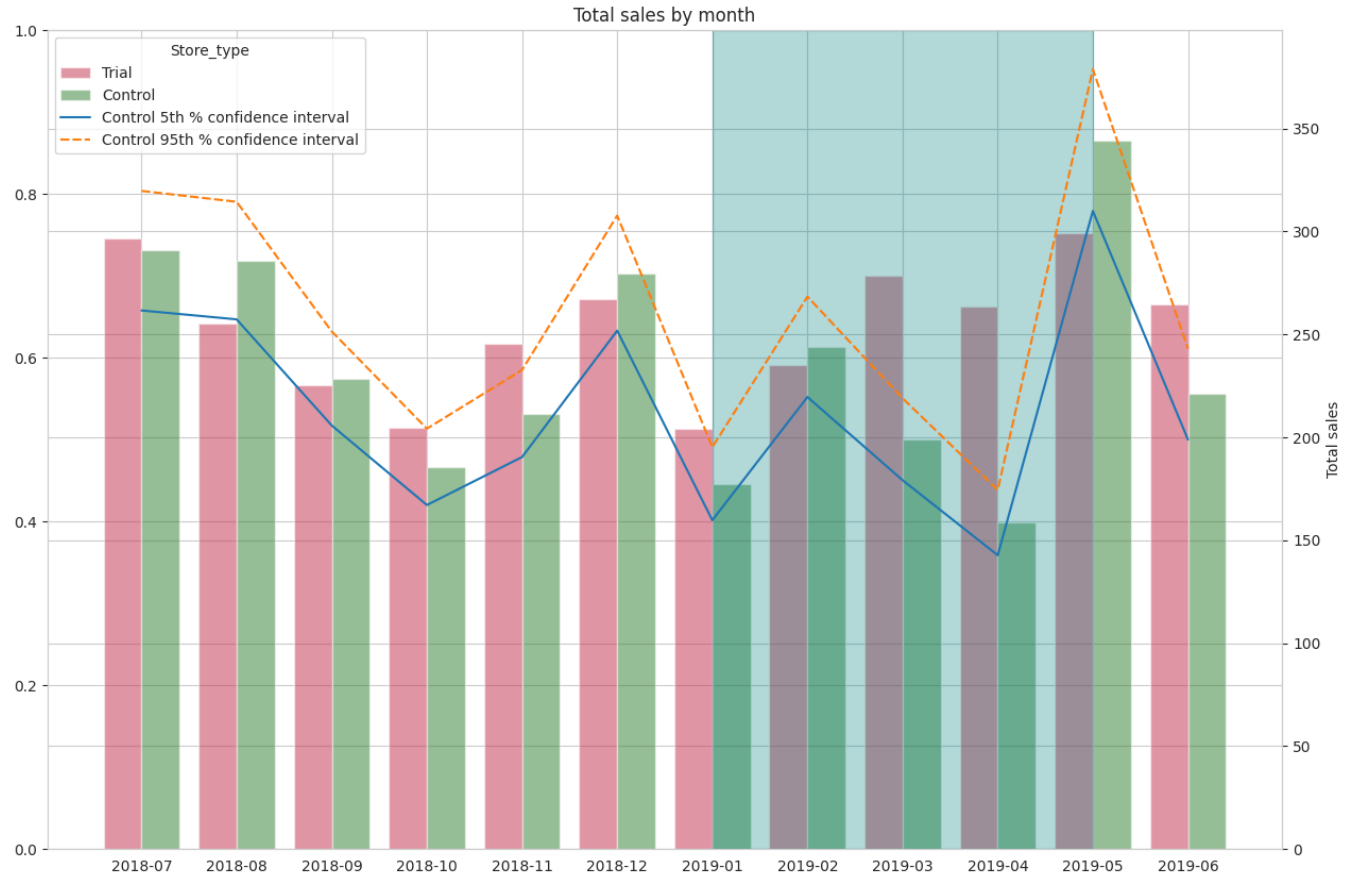
TransactionMonth	totSales	Store_type
2018-07	296.8	Trial
2018-08	255.5	Trial
2018-09	225.2	Trial
2018-10	204.5	Trial
2018-11	245.3	Trial
2018-12	267.3	Trial
2019-01	204.4	Trial
2019-02	235.0	Trial
2019-03	278.5	Trial
2019-04	263.5	Trial
2019-05	299.3	Trial
2019-06	264.7	Trial
2018-07	290.7	Control
2018-08	285.9	Control
2018-09	228.6	Control
2018-10	185.7	Control
2018-11	211.6	Control
2018-12	279.8	Control
2019-01	177.5	Control
2019-02	244.0	Control
2019-03	199.1	Control
2019-04	158.6	Control
2019-05	344.4	Control
2019-06	221.0	Control

```
linedata = trialAstS_77
linedata = linedata.set_index(['TransactionMonth','Store_type'])['totSales'].unstack()
linedata = linedata.iloc[:,[1,2]]
linedata
```

TransactionMonth	Store_type	Control 5th % confidence interval	Control 95th % confidence interval
2018-07		261.664441	319.735559
2018-08		257.343872	314.456128
2018-09		205.767083	251.432917
2018-10		167.152001	204.247999
2018-11		190.465069	232.734931
2018-12		251.853149	307.746851
2019-01		159.771029	195.228971
2019-02		219.628908	268.371092
2019-03		179.213588	218.986412
2019-04		142.758790	174.441210
2019-05		310.000803	378.799197
2019-06		198.926183	243.073817

```
fig, ax1 = plt.subplots(figsize=(15,10))
ax2 = ax1.twinx()
ax1 = sns.barplot(data=bardata,x=bardata.index,y=bardata['totSales'],hue=bardata['Store_type'],palette=['crimson','forestgreen'],alpha=0.
ax2 = sns.lineplot(data=linedata)
ax1.axvspan(xmin='2019-01', xmax='2019-05',  color="teal", alpha=0.3)
plt.xlabel("Month of Operation", fontsize=20)
plt.ylabel('Total sales')
plt.title('Total sales by month')
```

```
Text(0.5, 1.0, 'Total sales by month')
```



Store 86

```
scalingFactorForControlSales_86 = (preTrialMeasures[preTrialMeasures['STORE_NBR'] == 86]['totSales'].sum()) / (preTrialMeasures[preTria
scalingFactorForControlSales_86
```

```
0.9700651481287743
```

```
scaledControlSales_86 = preTrialMeasures.loc[(preTrialMeasures['STORE_NBR'] == 155)]
scaledControlSales_86
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit
1793	155	201807	924.6	101	1.217822	2.475248	3.698400
1794	155	201808	782.7	91	1.307692	2.516484	3.417904
1795	155	201809	1014.4	103	1.398058	2.815534	3.497931
1796	155	201810	963.8	108	1.259259	2.518519	3.543382
1797	155	201811	898.8	101	1.316832	2.673267	3.328889
1798	155	201812	849.8	97	1.237113	2.494845	3.511570
1799	155	201901	874.6	96	1.302083	2.625000	3.470635

```
scaledControlSales_86["controlSales"] = scaledControlSales_86["totSales"] * scalingFactorForControlSales_86
scaledControlSales_86
```

```
<ipython-input-260-17f521da5b20>: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
  scaledControlSales_86["controlSales"] = scaledControlSales_86["totSales"] * scalingFactorForControlSales_86
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit	controlSales
1793	155	201807	924.6	101	1.217822	2.475248	3.698400	896.922236
1794	155	201808	782.7	91	1.307692	2.516484	3.417904	759.269991
1795	155	201809	1014.4	103	1.398058	2.815534	3.497931	984.034086
1796	155	201810	963.8	108	1.259259	2.518519	3.543382	934.948790
1797	155	201811	898.8	101	1.316832	2.673267	3.328889	871.894555
1798	155	201812	849.8	97	1.237113	2.494845	3.511570	824.361363
1799	155	201901	874.6	96	1.302083	2.625000	3.470635	848.418979

```
trialSales_86 = measureoverTime[measureoverTime['STORE_NBR'] == 86].reset_index(drop=True)
scaledControlSales_86 = scaledControlSales_86.reset_index(drop=True)
percentDiffS_86 = pd.concat([trialSales_86["MONTH_ID"],trialSales_86["totSales"],scaledControlSales_86["controlSales"]],axis=1)
percentDiffS_86.columns=["MONTH_ID","trialSales","controlSales"]
percentDiffS_86["percentDiffS"]= (abs(percentDiffS_86["trialSales"]-percentDiffS_86["controlSales"]))/percentDiffS_86["controlSales"]
percentDiffS_86
```

	MONTH_ID	trialSales	controlSales	percentDiffS
0	201807	892.20	896.922236	0.005265
1	201808	764.05	759.269991	0.006296
2	201809	914.60	984.034086	0.070561
3	201810	948.40	934.948790	0.014387
4	201811	918.00	871.894555	0.052880
5	201812	841.20	824.361363	0.020426
6	201901	841.40	848.418979	0.008273
7	201902	913.20	NaN	NaN
8	201903	1026.80	NaN	NaN
9	201904	848.20	NaN	NaN
10	201905	889.30	NaN	NaN
11	201906	838.00	NaN	NaN

```
stdS_86 = percentDiffS_86[percentDiffS_86["MONTH_ID"]<201902]["percentDiffS"].std()
stdS_86
```

```
0.025833952854772368
```

```
dof = 7
percentDiffS_86['tValue'] = (percentDiffS_86['percentDiffS'] - 0) / stdS_86
percentDiffS_86
```

	MONTH_ID	trialSales	controlSales	percentDiffS	tValue
0	201807	892.20	896.922236	0.005265	0.203799
1	201808	764.05	759.269991	0.006296	0.243692
2	201809	914.60	984.034086	0.070561	2.731315
3	201810	948.40	934.948790	0.014387	0.556907
4	201811	918.00	871.894555	0.052880	2.046904
5	201812	841.20	824.361363	0.020426	0.790676
6	201901	841.40	848.418979	0.008273	0.320238
7	201902	913.20	NaN	NaN	NaN
8	201903	1026.80	NaN	NaN	NaN
9	201904	848.20	NaN	NaN	NaN
10	201905	889.30	NaN	NaN	NaN
11	201906	838.00	NaN	NaN	NaN

```
measureoverTimeSales_86 = measureoverTime
pastSales_86 = measureoverTimeSales_86

trial_store = 86
control_store = 155
store_type = []
for i in pastSales_86["STORE_NBR"]:
    if i == trial_store:
        store_type.append("Trial")
    elif i == control_store:
        store_type.append("Control")
    else:
        store_type.append("Other Stores")
pastSales_86["Store_type"] = store_type


pastSales_86['TransactionMonth'] = pd.to_datetime(pastSales_86['MONTH_ID'], format='%Y%m')
pastSales_86 = pastSales_86.loc[pastSales_86['Store_type'].isin(['Control','Trial'])]
pastSales_86 = pastSales_86.loc[:,['TransactionMonth','totSales','Store_type']]
pastSales_86
```

	TransactionMonth	totSales	Store_type
977	2018-07-01	892.20	Trial
978	2018-08-01	764.05	Trial
979	2018-09-01	914.60	Trial
980	2018-10-01	948.40	Trial
981	2018-11-01	918.00	Trial
982	2018-12-01	841.20	Trial
983	2019-01-01	841.40	Trial
984	2019-02-01	913.20	Trial
985	2019-03-01	1026.80	Trial
986	2019-04-01	848.20	Trial
987	2019-05-01	889.30	Trial
988	2019-06-01	838.00	Trial
1793	2018-07-01	924.60	Control
1794	2018-08-01	782.70	Control
1795	2018-09-01	1014.40	Control
1796	2018-10-01	963.80	Control
1797	2018-11-01	898.80	Control
1798	2018-12-01	849.80	Control
1799	2019-01-01	874.60	Control
1800	2019-02-01	891.20	Control
1801	2019-03-01	804.40	Control
1802	2019-04-01	844.60	Control
1803	2019-05-01	922.85	Control
1804	2019-06-01	857.20	Control

```
pastSales_Controls95_86 = pastSales_86[pastSales_86['Store_type'] == "Control"]
pastSales_Controls95_86['totSales'] = pastSales_Controls95_86['totSales'] * (1 + (stdS_86 * 2))
pastSales_Controls95_86['Store_type'] = "Control 95th % confidence interval"
pastSales_Controls95_86.head(10)
```

```
<ipython-input-266-e8536291fd57>:2: 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
  pastSales_Controls95_86['totSales'] = pastSales_Controls95_86['totSales'] * (1 + (stdS_86 * 2))
<ipython-input-266-e8536291fd57>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus
  pastSales_Controls95_86['Store_type'] = "Control 95th % confidence interval"
```

	TransactionMonth	totSales	Store_type
1793	2018-07-01	972.372146	Control 95th % confidence interval
1794	2018-08-01	823.140470	Control 95th % confidence interval
1795	2018-09-01	1066.811924	Control 95th % confidence interval
1796	2018-10-01	1013.597528	Control 95th % confidence interval
1797	2018-11-01	945.239114	Control 95th % confidence interval
1798	2018-12-01	893.707386	Control 95th % confidence interval
1799	2019-01-01	919.788750	Control 95th % confidence interval
1800	2019-02-01	937.246438	Control 95th % confidence interval
1801	2019-03-01	845.961663	Control 95th % confidence interval
1802	2019-04-01	888.238713	Control 95th % confidence interval

```
pastSales_Controls5_86 = pastSales_86[pastSales_86['Store_type'] == "Control"]
pastSales_Controls5_86['totSales'] = pastSales_Controls5_86['totSales'] * (1 - (stdS_86 * 2))
pastSales_Controls5_86['Store_type'] = "Control 5th % confidence interval"
pastSales_Controls5_86.head(10)
```

```
pastSales_Controls5_86.head(10)
```

```
<ipython-input-267-64add9222da8>:2: 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
  pastSales_Controls5_86['totSales'] = pastSales_Controls5_86['totSales'] * (1 - (stdS_86 * 2))
<ipython-input-267-64add9222da8>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus
  pastSales_Controls5_86['Store_type'] = "Control 5th % confidence interval"
```

	TransactionMonth	totSales	Store_type
1793	2018-07-01	876.827854	Control 5th % confidence interval
1794	2018-08-01	742.259530	Control 5th % confidence interval
1795	2018-09-01	961.988076	Control 5th % confidence interval
1796	2018-10-01	914.002472	Control 5th % confidence interval
1797	2018-11-01	852.360886	Control 5th % confidence interval
1798	2018-12-01	805.892614	Control 5th % confidence interval
1799	2019-01-01	829.411250	Control 5th % confidence interval
1800	2019-02-01	845.153562	Control 5th % confidence interval
1801	2019-03-01	762.838337	Control 5th % confidence interval
1802	2019-04-01	800.961287	Control 5th % confidence interval

```
trialAstS_86 = pd.concat([pastSales_86,pastSales_Controls95_86,pastSales_Controls5_86])
trialAstS_86
```

	TransactionMonth	totSales	Store_type
977	2018-07-01	892.200000	Trial
978	2018-08-01	764.050000	Trial
979	2018-09-01	914.600000	Trial
980	2018-10-01	948.400000	Trial
981	2018-11-01	918.000000	Trial
982	2018-12-01	841.200000	Trial
983	2019-01-01	841.400000	Trial
984	2019-02-01	913.200000	Trial
985	2019-03-01	1026.800000	Trial
986	2019-04-01	848.200000	Trial
987	2019-05-01	889.300000	Trial
988	2019-06-01	838.000000	Trial
1793	2018-07-01	924.600000	Control
1794	2018-08-01	782.700000	Control
1795	2018-09-01	1014.400000	Control
1796	2018-10-01	963.800000	Control
1797	2018-11-01	898.800000	Control
1798	2018-12-01	849.800000	Control
1799	2019-01-01	874.600000	Control
1800	2019-02-01	891.200000	Control
1801	2019-03-01	804.400000	Control
1802	2019-04-01	844.600000	Control
1803	2019-05-01	922.850000	Control
1804	2019-06-01	857.200000	Control
1793	2018-07-01	972.372146	Control 95th % confidence interval
1794	2018-08-01	823.140470	Control 95th % confidence interval
1795	2018-09-01	1066.811924	Control 95th % confidence interval
1796	2018-10-01	1013.597528	Control 95th % confidence interval
1797	2018-11-01	945.239114	Control 95th % confidence interval
1798	2018-12-01	893.707386	Control 95th % confidence interval
1799	2019-01-01	919.788750	Control 95th % confidence interval
1800	2019-02-01	937.246438	Control 95th % confidence interval
1801	2019-03-01	845.961663	Control 95th % confidence interval
1802	2019-04-01	888.238713	Control 95th % confidence interval
1803	2019-05-01	970.531727	Control 95th % confidence interval
1804	2019-06-01	901.489729	Control 95th % confidence interval
1793	2018-07-01	876.827854	Control 5th % confidence interval
1794	2018-08-01	742.259530	Control 5th % confidence interval
1795	2018-09-01	961.988076	Control 5th % confidence interval
1796	2018-10-01	914.002472	Control 5th % confidence interval
1797	2018-11-01	852.360886	Control 5th % confidence interval
1798	2018-12-01	805.892614	Control 5th % confidence interval
1799	2019-01-01	829.411250	Control 5th % confidence interval
1800	2019-02-01	845.153562	Control 5th % confidence interval
1801	2019-03-01	762.838337	Control 5th % confidence interval
1802	2019-04-01	800.961287	Control 5th % confidence interval
1803	2019-05-01	875.168273	Control 5th % confidence interval
1804	2019-06-01	812.910271	Control 5th % confidence interval

```
bardata_86 =trialAstS_86
bardata_86['TransactionMonth'] = bardata_86['TransactionMonth'].dt.strftime('%Y-%m').astype('str')
bardata_86 = bardata_86.set_index('TransactionMonth')
bardata_86 = bardata_86.loc[(bardata_86['Store_type'] == 'Trial') | (bardata_86['Store_type'] == 'Control')]
bardata_86
```

TransactionMonth	totSales	Store_type
2018-07	892.20	Trial
2018-08	764.05	Trial
2018-09	914.60	Trial
2018-10	948.40	Trial
2018-11	918.00	Trial
2018-12	841.20	Trial
2019-01	841.40	Trial
2019-02	913.20	Trial
2019-03	1026.80	Trial
2019-04	848.20	Trial
2019-05	889.30	Trial
2019-06	838.00	Trial
2018-07	924.60	Control
2018-08	782.70	Control
2018-09	1014.40	Control
2018-10	963.80	Control
2018-11	898.80	Control
2018-12	849.80	Control
2019-01	874.60	Control
2019-02	891.20	Control
2019-03	804.40	Control
2019-04	844.60	Control
2019-05	922.85	Control
2019-06	857.20	Control

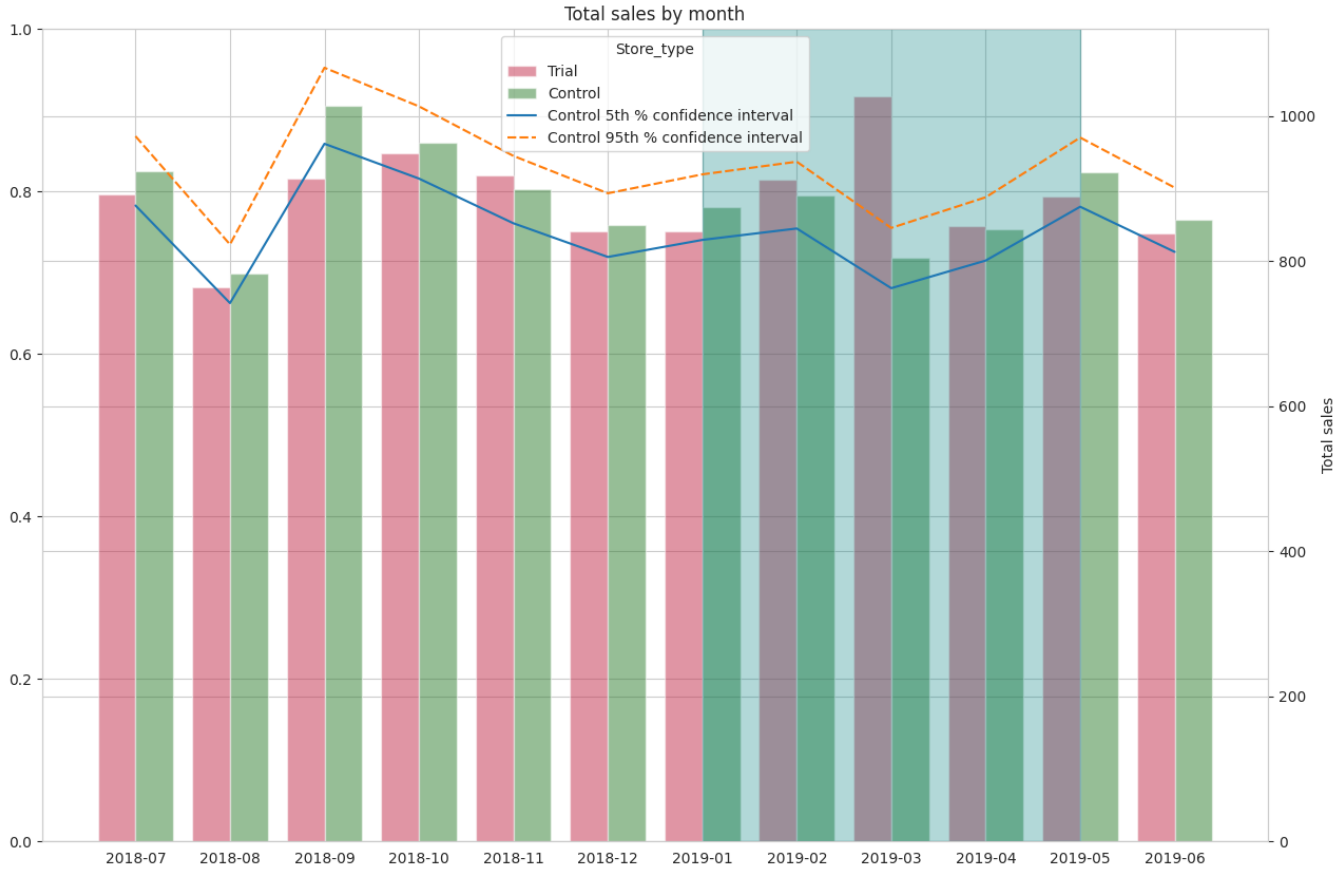
```
linedata_86 = trialAstS_86
linedata_86 = linedata_86.set_index(['TransactionMonth','Store_type'])['totSales'].unstack()
linedata_86 = linedata_86.iloc[:,[1,2]]
linedata_86
```

TransactionMonth	Store_type	Control 5th % confidence interval	Control 95th % confidence interval
2018-07		876.827854	972.372146
2018-08		742.259530	823.140470
2018-09		961.988076	1066.811924
2018-10		914.002472	1013.597528
2018-11		852.360886	945.239114
2018-12		805.892614	893.707386
2019-01		829.411250	919.788750
2019-02		845.153562	937.246438
2019-03		762.838337	845.961663
2019-04		800.961287	888.238713
2019-05		875.168273	970.531727
2019-06		812.910271	901.489729

```
fig, ax1 = plt.subplots(figsize=(15,10))
ax2 = ax1.twinx()
```

```
ax1 = sns.barplot(data=bardata_86,x=bardata_86.index,y=bardata_86['totSales'],hue=bardata_86['Store_type'],palette=['crimson','forestgree
ax2 = sns.lineplot(data=linedata_86)
ax1.axvspan(xmin='2019-01', xmax='2019-05',  color="teal", alpha=0.3)
plt.xlabel("Month of Operation", fontsize=20)
plt.ylabel('Total sales')
plt.title('Total sales by month')
```

```
Text(0.5, 1.0, 'Total sales by month')
```



For Store 88

```
scalingFactorForControlSales_88 = (preTrialMeasures[preTrialMeasures['STORE_NBR'] == 88]['totSales'].sum()) / (preTrialMeasures[preTria
scalingFactorForControlSales_88
```

```
1.001558330664959
```

```
scaledControlSales_88 = preTrialMeasures.loc[(preTrialMeasures['STORE_NBR'] == 237)]
scaledControlSales_88
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit
2747	237	201807	1448.4	128	1.265625	2.531250	4.470370
2748	237	201808	1367.8	135	1.222222	2.318519	4.369968
2749	237	201809	1322.2	126	1.182540	2.373016	4.422074
2750	237	201810	1348.3	123	1.195122	2.430894	4.509365
2751	237	201811	1397.6	132	1.219697	2.424242	4.367500
2752	237	201812	1265.0	124	1.161290	2.330645	4.377163
2753	237	201901	1219.7	117	1.188034	2.367521	4.403249

```
scaledControlSales_88["controlSales"] = scaledControlSales_88["totSales"] * scalingFactorForControlSales_88
scaledControlSales_88
```

```
<ipython-input-274-ad6d6b2a455d>: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
  scaledControlSales_88["controlSales"] = scaledControlSales_88["totSales"] * scalingFactorForControlSales_88
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit	controlSales
2747	237	201807	1448.4	128	1.265625	2.531250	4.470370	1450.657086
2748	237	201808	1367.8	135	1.222222	2.318519	4.369968	1369.931485
2749	237	201809	1322.2	126	1.182540	2.373016	4.422074	1324.260425
2750	237	201810	1348.3	123	1.195122	2.430894	4.509365	1350.401097
2751	237	201811	1397.6	132	1.219697	2.424242	4.367500	1399.777923
2752	237	201812	1265.0	124	1.161290	2.330645	4.377163	1266.971288
2753	237	201901	1219.7	117	1.188034	2.367521	4.403249	1221.600696

```
trialSales_88 = measureoverTime[measureoverTime['STORE_NBR'] == 88].reset_index(drop=True)
scaledControlSales_88 = scaledControlSales_88.reset_index(drop=True)
percentDiffS_88 = pd.concat([trialSales_88["MONTH_ID"],trialSales_88["totSales"],scaledControlSales_88["controlSales"]],axis=1)
percentDiffS_88.columns=["MONTH_ID","trialSales","controlSales"]
percentDiffS_88["percentDiffS"]= (abs(percentDiffS_88["trialSales"]-percentDiffS_88["controlSales"]))/percentDiffS_88["controlSales"]
percentDiffS_88
```

	MONTH_ID	trialSales	controlSales	percentDiffS
0	201807	1310.00	1450.657086	0.096961
1	201808	1323.80	1369.931485	0.033674
2	201809	1423.00	1324.260425	0.074562
3	201810	1352.40	1350.401097	0.001480
4	201811	1382.80	1399.777923	0.012129
5	201812	1325.20	1266.971288	0.045959
6	201901	1266.40	1221.600696	0.036673
7	201902	1370.20	NaN	NaN
8	201903	1477.20	NaN	NaN
9	201904	1439.40	NaN	NaN
10	201905	1308.25	NaN	NaN
11	201906	1354.60	NaN	NaN

```
stdS_88 = percentDiffS_88[percentDiffS_88["MONTH_ID"]<201902]["percentDiffS"].std()
stdS_88
```

```
0.0334678673030788
```

```
dof = 7
percentDiffS_88['tValue'] = (percentDiffS_88['percentDiffS'] - 0) / stdS_88
percentDiffS_88
```

	MONTH_ID	trialSales	controlSales	percentDiffS	tValue
0	201807	1310.00	1450.657086	0.096961	2.897136
1	201808	1323.80	1369.931485	0.033674	1.006168
2	201809	1423.00	1324.260425	0.074562	2.227870
3	201810	1352.40	1350.401097	0.001480	0.044228
4	201811	1382.80	1399.777923	0.012129	0.362408
5	201812	1325.20	1266.971288	0.045959	1.373227
6	201901	1266.40	1221.600696	0.036673	1.095756
7	201902	1370.20	NaN	NaN	NaN
8	201903	1477.20	NaN	NaN	NaN
9	201904	1439.40	NaN	NaN	NaN
10	201905	1308.25	NaN	NaN	NaN
11	201906	1354.60	NaN	NaN	NaN

```
measureoverTimeSales_88 = measureoverTime
pastSales_88 = measureoverTimeSales_88

trial_store = 88
control_store = 237
store_type = []
for i in pastSales_88["STORE_NBR"]:
    if i == trial_store:
        store_type.append("Trial")
    elif i == control_store:
        store_type.append("Control")
    else:
        store_type.append("Other Stores")
pastSales_88["Store_type"] = store_type


pastSales_88['TransactionMonth'] = pd.to_datetime(pastSales_88['MONTH_ID'], format='%Y%m')
pastSales_88 = pastSales_88.loc[pastSales_88['Store_type'].isin(['Control','Trial'])]
pastSales_88 = pastSales_88.loc[:,['TransactionMonth','totSales','Store_type']]
pastSales_88
```

	TransactionMonth	totSales	Store_type
1001	2018-07-01	1310.00	Trial
1002	2018-08-01	1323.80	Trial
1003	2018-09-01	1423.00	Trial
1004	2018-10-01	1352.40	Trial
1005	2018-11-01	1382.80	Trial
1006	2018-12-01	1325.20	Trial
1007	2019-01-01	1266.40	Trial
1008	2019-02-01	1370.20	Trial
1009	2019-03-01	1477.20	Trial
1010	2019-04-01	1439.40	Trial
1011	2019-05-01	1308.25	Trial
1012	2019-06-01	1354.60	Trial
2747	2018-07-01	1448.40	Control
2748	2018-08-01	1367.80	Control
2749	2018-09-01	1322.20	Control
2750	2018-10-01	1348.30	Control
2751	2018-11-01	1397.60	Control
2752	2018-12-01	1265.00	Control
2753	2019-01-01	1219.70	Control
2754	2019-02-01	1404.80	Control
2755	2019-03-01	1208.20	Control
2756	2019-04-01	1204.60	Control
2757	2019-05-01	1199.30	Control
2758	2019-06-01	1153.60	Control

```
pastSales_Controls95_88 = pastSales_88[pastSales_88['Store_type'] == "Control"]
pastSales_Controls95_88['totSales'] = pastSales_Controls95_88['totSales'] * (1 + (stdS_88 * 2))
pastSales_Controls95_88['Store_type'] = "Control 95th % confidence interval"
pastSales_Controls95_88.head(10)
```

```
<ipython-input-280-292191e0cf24>:2: 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
  pastSales_Controls95_88['totSales'] = pastSales_Controls95_88['totSales'] * (1 + (stdS_88 * 2))
<ipython-input-280-292191e0cf24>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus
  pastSales_Controls95_88['Store_type'] = "Control 95th % confidence interval"
```

	TransactionMonth	totSales	Store_type
2747	2018-07-01	1545.349718	Control 95th % confidence interval
2748	2018-08-01	1459.354698	Control 95th % confidence interval
2749	2018-09-01	1410.702428	Control 95th % confidence interval
2750	2018-10-01	1438.549451	Control 95th % confidence interval
2751	2018-11-01	1491.149383	Control 95th % confidence interval
2752	2018-12-01	1349.673704	Control 95th % confidence interval
2753	2019-01-01	1301.341515	Control 95th % confidence interval
2754	2019-02-01	1498.831320	Control 95th % confidence interval
2755	2019-03-01	1289.071755	Control 95th % confidence interval
2756	2019-04-01	1285.230786	Control 95th % confidence interval

```
pastSales_Controls5_88 = pastSales_88[pastSales_88['Store_type'] == "Control"]
pastSales_Controls5_88['totSales'] = pastSales_Controls5_88['totSales'] * (1 - (stdS_88 * 2))
pastSales_Controls5_88['Store_type'] = "Control 5th % confidence interval"
pastSales_Controls5_88.head(10)
```

```
pastSales_Controls5_88.head(10)
```

```
<ipython-input-281-f439159c2133>:2: 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
  pastSales_Controls5_88['totSales'] = pastSales_Controls5_88['totSales'] * (1 - (stdS_88 * 2))
<ipython-input-281-f439159c2133>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus
  pastSales_Controls5_88['Store_type'] = "Control 5th % confidence interval"
```

	TransactionMonth	totSales	Store_type
2747	2018-07-01	1351.450282	Control 5th % confidence interval
2748	2018-08-01	1276.245302	Control 5th % confidence interval
2749	2018-09-01	1233.697572	Control 5th % confidence interval
2750	2018-10-01	1258.050549	Control 5th % confidence interval
2751	2018-11-01	1304.050617	Control 5th % confidence interval
2752	2018-12-01	1180.326296	Control 5th % confidence interval
2753	2019-01-01	1138.058485	Control 5th % confidence interval
2754	2019-02-01	1310.768680	Control 5th % confidence interval
2755	2019-03-01	1127.328245	Control 5th % confidence interval
2756	2019-04-01	1123.969214	Control 5th % confidence interval

```
trialAstS_88 = pd.concat([pastSales_88,pastSales_Controls95_88,pastSales_Controls5_88])
trialAstS_88
```

	TransactionMonth	totSales	Store_type
1001	2018-07-01	1310.000000	Trial
1002	2018-08-01	1323.800000	Trial
1003	2018-09-01	1423.000000	Trial
1004	2018-10-01	1352.400000	Trial
1005	2018-11-01	1382.800000	Trial
1006	2018-12-01	1325.200000	Trial
1007	2019-01-01	1266.400000	Trial
1008	2019-02-01	1370.200000	Trial
1009	2019-03-01	1477.200000	Trial
1010	2019-04-01	1439.400000	Trial
1011	2019-05-01	1308.250000	Trial
1012	2019-06-01	1354.600000	Trial
2747	2018-07-01	1448.400000	Control
2748	2018-08-01	1367.800000	Control
2749	2018-09-01	1322.200000	Control
2750	2018-10-01	1348.300000	Control
2751	2018-11-01	1397.600000	Control
2752	2018-12-01	1265.000000	Control
2753	2019-01-01	1219.700000	Control
2754	2019-02-01	1404.800000	Control
2755	2019-03-01	1208.200000	Control
2756	2019-04-01	1204.600000	Control
2757	2019-05-01	1199.300000	Control
2758	2019-06-01	1153.600000	Control
2747	2018-07-01	1545.349718	Control 95th % confidence interval
2748	2018-08-01	1459.354698	Control 95th % confidence interval
2749	2018-09-01	1410.702428	Control 95th % confidence interval
2750	2018-10-01	1438.549451	Control 95th % confidence interval
2751	2018-11-01	1491.149383	Control 95th % confidence interval
2752	2018-12-01	1349.673704	Control 95th % confidence interval
2753	2019-01-01	1301.341515	Control 95th % confidence interval
2754	2019-02-01	1498.831320	Control 95th % confidence interval
2755	2019-03-01	1289.071755	Control 95th % confidence interval
2756	2019-04-01	1285.230786	Control 95th % confidence interval
2757	2019-05-01	1279.576027	Control 95th % confidence interval
2758	2019-06-01	1230.817063	Control 95th % confidence interval
2747	2018-07-01	1351.450282	Control 5th % confidence interval
2748	2018-08-01	1276.245302	Control 5th % confidence interval
2749	2018-09-01	1233.697572	Control 5th % confidence interval
2750	2018-10-01	1258.050549	Control 5th % confidence interval
2751	2018-11-01	1304.050617	Control 5th % confidence interval
2752	2018-12-01	1180.326296	Control 5th % confidence interval
2753	2019-01-01	1138.058485	Control 5th % confidence interval
2754	2019-02-01	1310.768680	Control 5th % confidence interval
2755	2019-03-01	1127.328245	Control 5th % confidence interval
2756	2019-04-01	1123.969214	Control 5th % confidence interval
2757	2019-05-01	1119.023973	Control 5th % confidence interval
2758	2019-06-01	1076.382937	Control 5th % confidence interval

```
bardata_88 =trialAstS_88
bardata_88['TransactionMonth'] = bardata_88['TransactionMonth'].dt.strftime('%Y-%m').astype('str')
bardata_88 = bardata_88.set_index('TransactionMonth')
bardata_88 = bardata_88.loc[(bardata_88['Store_type'] == 'Trial') | (bardata_88['Store_type'] == 'Control')]
bardata_88
```

TransactionMonth	totSales	Store_type
2018-07	1310.00	Trial
2018-08	1323.80	Trial
2018-09	1423.00	Trial
2018-10	1352.40	Trial
2018-11	1382.80	Trial
2018-12	1325.20	Trial
2019-01	1266.40	Trial
2019-02	1370.20	Trial
2019-03	1477.20	Trial
2019-04	1439.40	Trial
2019-05	1308.25	Trial
2019-06	1354.60	Trial
2018-07	1448.40	Control
2018-08	1367.80	Control
2018-09	1322.20	Control
2018-10	1348.30	Control
2018-11	1397.60	Control
2018-12	1265.00	Control
2019-01	1219.70	Control
2019-02	1404.80	Control
2019-03	1208.20	Control
2019-04	1204.60	Control
2019-05	1199.30	Control
2019-06	1153.60	Control

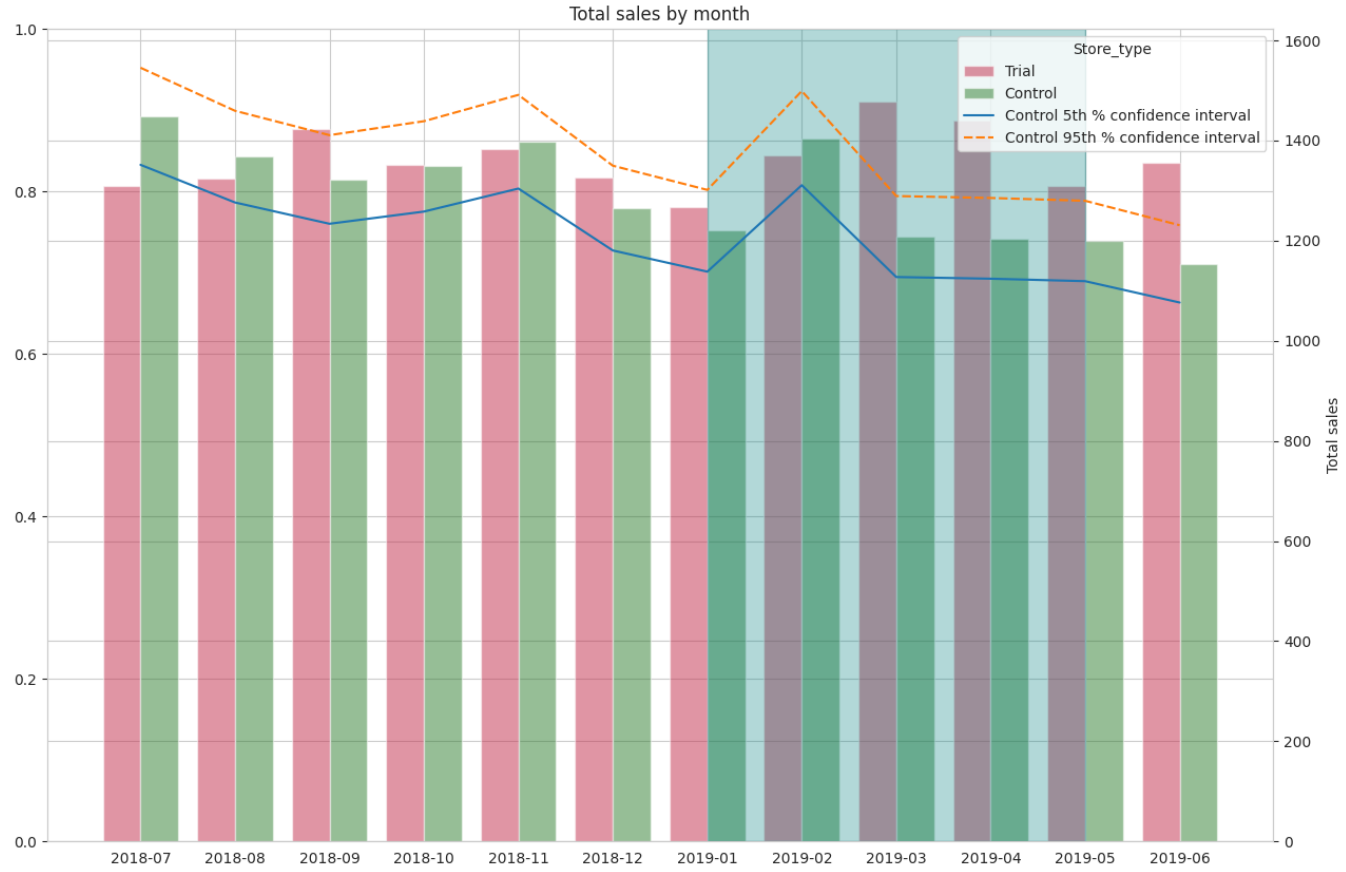
```
linedata_88 = trialAstS_88
linedata_88 = linedata_88.set_index(['TransactionMonth','Store_type'])['totSales'].unstack()
linedata_88 = linedata_88.iloc[:,[1,2]]
linedata_88
```

TransactionMonth	Control 5th % confidence interval	Control 95th % confidence interval
2018-07	1351.450282	1545.349718
2018-08	1276.245302	1459.354698
2018-09	1233.697572	1410.702428
2018-10	1258.050549	1438.549451
2018-11	1304.050617	1491.149383
2018-12	1180.326296	1349.673704
2019-01	1138.058485	1301.341515
2019-02	1310.768680	1498.831320
2019-03	1127.328245	1289.071755
2019-04	1123.969214	1285.230786
2019-05	1119.023973	1279.576027
2019-06	1076.382937	1230.817063

```
fig, ax1 = plt.subplots(figsize=(15,10))
ax2 = ax1.twinx()
```

```
ax1 = sns.barplot(data=bardata_88,x=bardata_88.index,y=bardata_88['totSales'],hue=bardata_88['Store_type'],palette=['crimson','forestgree
ax2 = sns.lineplot(data=linedata_88)
ax1.axvspan(xmin='2019-01', xmax='2019-05',  color="teal", alpha=0.3)
plt.xlabel("Month of Operation", fontsize=20)
plt.ylabel('Total sales')
plt.title('Total sales by month')
```

```
Text(0.5, 1.0, 'Total sales by month')
```



Let's have a look at assessing this for number of customers as well.

For Store 77

```
scalingFactorForControlCust_77 = (preTrialMeasures[preTrialMeasures['STORE_NBR'] == 77]['nCustomers'].sum()) / (preTrialMeasures[preTri
scalingFactorForControlCust_77
```

```
1.0033557046979866
```

```
scaledControlCust_77 = preTrialMeasures.loc[(preTrialMeasures['STORE_NBR'] == 233)]
scaledControlCust_77
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit
2699	233	201807	290.7	51	1.058824	1.725490	3.303409
2700	233	201808	285.9	48	1.041667	1.666667	3.573750
2701	233	201809	228.6	42	1.071429	1.666667	3.265714
2702	233	201810	185.7	35	1.028571	1.600000	3.316071
2703	233	201811	211.6	40	1.025000	1.550000	3.412903
2704	233	201812	279.8	47	1.063830	1.595745	3.730667
2705	233	201901	177.5	35	1.000000	1.342857	3.776596

```
scaledControlCust_77["controlCust"] = scaledControlCust_77["nCustomers"] * scalingFactorForControlCust_77
scaledControlCust_77
```

```
<ipython-input-288-331be9b8bca6>: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
  scaledControlCust_77["controlCust"] = scaledControlCust_77["nCustomers"] * scalingFactorForControlCust_77
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit	controlCust
2699	233	201807	290.7	51	1.058824	1.725490	3.303409	51.171141
2700	233	201808	285.9	48	1.041667	1.666667	3.573750	48.161074
2701	233	201809	228.6	42	1.071429	1.666667	3.265714	42.140940
2702	233	201810	185.7	35	1.028571	1.600000	3.316071	35.117450
2703	233	201811	211.6	40	1.025000	1.550000	3.412903	40.134228
2704	233	201812	279.8	47	1.063830	1.595745	3.730667	47.157718
2705	233	201901	177.5	35	1.000000	1.342857	3.776596	35.117450

```
trialCust_77 = measureoverTime[measureoverTime['STORE_NBR'] == 77].reset_index(drop=True)
scaledControlCust_77 = scaledControlCust_77.reset_index(drop=True)
percentDiffCust_77 = pd.concat([trialCust_77["MONTH_ID"],trialCust_77["nCustomers"],scaledControlCust_77["controlCust"]],axis=1)
percentDiffCust_77.columns=["MONTH_ID","trialCust","controlCust"]
percentDiffCust_77["percentDiffCust"]= (abs(percentDiffCust_77["trialCust"]-percentDiffCust_77["controlCust"]))/percentDiffCust_77["contr
percentDiffCust_77
```

	MONTH_ID	trialCust	controlCust	percentDiffCust
0	201807	51	51.171141	0.003344
1	201808	47	48.161074	0.024108
2	201809	42	42.140940	0.003344
3	201810	37	35.117450	0.053607
4	201811	41	40.134228	0.021572
5	201812	46	47.157718	0.024550
6	201901	35	35.117450	0.003344
7	201902	45	NaN	NaN
8	201903	50	NaN	NaN
9	201904	47	NaN	NaN
10	201905	55	NaN	NaN
11	201906	41	NaN	NaN

```
stdCust_77 = percentDiffCust_77[percentDiffCust_77["MONTH_ID"]<201902]["percentDiffCust"].std()
stdCust_77
```

```
0.01824074855824395
```

```
dof = 7
percentDiffCust_77['tValue'] = (percentDiffCust_77['percentDiffCust'] - 0) / stdCust_77
percentDiffCust_77
```

	MONTH_ID	trialCust	controlCust	percentDiffCust	tValue
0	201807	51	51.171141	0.003344	0.183352
1	201808	47	48.161074	0.024108	1.321664
2	201809	42	42.140940	0.003344	0.183352
3	201810	37	35.117450	0.053607	2.938874
4	201811	41	40.134228	0.021572	1.182622
5	201812	46	47.157718	0.024550	1.345883
6	201901	35	35.117450	0.003344	0.183352
7	201902	45	NaN	NaN	NaN
8	201903	50	NaN	NaN	NaN
9	201904	47	NaN	NaN	NaN
10	201905	55	NaN	NaN	NaN
11	201906	41	NaN	NaN	NaN

```
measureoverTimeCust_77 = measureoverTime
pastCust_77 = measureoverTimeCust_77
trial_store = 77
control_store = 233
store_type = []
for i in pastCust_77["STORE_NBR"]:
    if i == trial_store:
        store_type.append("Trial")
    elif i == control_store:
        store_type.append("Control")
    else:
        store_type.append("Other Stores")
pastCust_77["Store_type"] = store_type
```

```
pastCust_77['TransactionMonth'] = pd.to_datetime(pastCust_77['MONTH_ID'], format='%Y%m')
pastCust_77= pastCust_77.loc[pastCust_77['Store_type'].isin(['Control','Trial'])]
pastCust_77 = pastCust_77.loc[:,['TransactionMonth','nCustomers','Store_type']]
pastCust_77
```

	TransactionMonth	nCustomers	Store_type
880	2018-07-01	51	Trial
881	2018-08-01	47	Trial
882	2018-09-01	42	Trial
883	2018-10-01	37	Trial
884	2018-11-01	41	Trial
885	2018-12-01	46	Trial
886	2019-01-01	35	Trial
887	2019-02-01	45	Trial
888	2019-03-01	50	Trial
889	2019-04-01	47	Trial
890	2019-05-01	55	Trial
891	2019-06-01	41	Trial
2699	2018-07-01	51	Control
2700	2018-08-01	48	Control
2701	2018-09-01	42	Control
2702	2018-10-01	35	Control
2703	2018-11-01	40	Control
2704	2018-12-01	47	Control
2705	2019-01-01	35	Control
2706	2019-02-01	45	Control
2707	2019-03-01	40	Control
2708	2019-04-01	30	Control
2709	2019-05-01	57	Control
2710	2019-06-01	41	Control

```
pastCust_Ctrlc95_77 = pastCust_77[pastCust_77['Store_type'] == "Control"]
pastCust_Ctrlc95_77['nCustomers'] = pastCust_Ctrlc95_77['nCustomers'] * (1 + (stdCust_77 * 2))
pastCust_Ctrlc95_77['Store_type'] = "Control 95th % confidence interval"
pastCust_Ctrlc95_77.head(10)
```

```
<ipython-input-294-11ad646cc247>:2: 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
  pastCust_Ctrlc95_77['nCustomers'] = pastCust_Ctrlc95_77['nCustomers'] * (1 + (stdCust_77 * 2))
<ipython-input-294-11ad646cc247>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus
  pastCust_Ctrlc95_77['Store_type'] = "Control 95th % confidence interval"
```

	TransactionMonth	nCustomers	Store_type
2699	2018-07-01	52.860556	Control 95th % confidence interval
2700	2018-08-01	49.751112	Control 95th % confidence interval
2701	2018-09-01	43.532223	Control 95th % confidence interval
2702	2018-10-01	36.276852	Control 95th % confidence interval
2703	2018-11-01	41.459260	Control 95th % confidence interval
2704	2018-12-01	48.714630	Control 95th % confidence interval
2705	2019-01-01	36.276852	Control 95th % confidence interval
2706	2019-02-01	46.641667	Control 95th % confidence interval
2707	2019-03-01	41.459260	Control 95th % confidence interval
2708	2019-04-01	31.094445	Control 95th % confidence interval

```
pastCust_Ctrlc5_77 = pastCust_77[pastCust_77['Store_type'] == "Control"]
pastCust_Ctrlc5_77['nCustomers'] = pastCust_Ctrlc5_77['nCustomers'] * (1 - (stdCust_77 * 2))
pastCust_Ctrlc5_77['Store_type'] = "Control 5th % confidence interval"
pastCust_Ctrlc5_77.head(10)
```

```
pastCust_Ctrlc5_77.head(10)
```

```
<ipython-input-295-68400d35ea2d>:2: 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
  pastCust_Ctrlc5_77['nCustomers'] = pastCust_Ctrlc5_77['nCustomers'] * (1 - (stdCust_77 * 2))
<ipython-input-295-68400d35ea2d>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus
  pastCust_Ctrlc5_77['Store_type'] = "Control 5th % confidence interval"
```

	TransactionMonth	nCustomers	Store_type
2699	2018-07-01	49.139444	Control 5th % confidence interval
2700	2018-08-01	46.248888	Control 5th % confidence interval
2701	2018-09-01	40.467777	Control 5th % confidence interval
2702	2018-10-01	33.723148	Control 5th % confidence interval
2703	2018-11-01	38.540740	Control 5th % confidence interval
2704	2018-12-01	45.285370	Control 5th % confidence interval
2705	2019-01-01	33.723148	Control 5th % confidence interval
2706	2019-02-01	43.358333	Control 5th % confidence interval
2707	2019-03-01	38.540740	Control 5th % confidence interval
2708	2019-04-01	28.905555	Control 5th % confidence interval

```
trialAstCust_77 = pd.concat([pastCust_77,pastCust_Ctrlc95_77,pastCust_Ctrlc5_77])
trialAstCust_77
```

	TransactionMonth	nCustomers	Store_type
880	2018-07-01	51.000000	Trial
881	2018-08-01	47.000000	Trial
882	2018-09-01	42.000000	Trial
883	2018-10-01	37.000000	Trial
884	2018-11-01	41.000000	Trial
885	2018-12-01	46.000000	Trial
886	2019-01-01	35.000000	Trial
887	2019-02-01	45.000000	Trial
888	2019-03-01	50.000000	Trial
889	2019-04-01	47.000000	Trial
890	2019-05-01	55.000000	Trial
891	2019-06-01	41.000000	Trial
2699	2018-07-01	51.000000	Control
2700	2018-08-01	48.000000	Control
2701	2018-09-01	42.000000	Control
2702	2018-10-01	35.000000	Control
2703	2018-11-01	40.000000	Control
2704	2018-12-01	47.000000	Control
2705	2019-01-01	35.000000	Control
2706	2019-02-01	45.000000	Control
2707	2019-03-01	40.000000	Control
2708	2019-04-01	30.000000	Control
2709	2019-05-01	57.000000	Control
2710	2019-06-01	41.000000	Control
2699	2018-07-01	52.860556	Control 95th % confidence interval
2700	2018-08-01	49.751112	Control 95th % confidence interval
2701	2018-09-01	43.532223	Control 95th % confidence interval
2702	2018-10-01	36.276852	Control 95th % confidence interval
2703	2018-11-01	41.459260	Control 95th % confidence interval
2704	2018-12-01	48.714630	Control 95th % confidence interval
2705	2019-01-01	36.276852	Control 95th % confidence interval
2706	2019-02-01	46.641667	Control 95th % confidence interval
2707	2019-03-01	41.459260	Control 95th % confidence interval
2708	2019-04-01	31.094445	Control 95th % confidence interval
2709	2019-05-01	59.079445	Control 95th % confidence interval
2710	2019-06-01	42.495741	Control 95th % confidence interval
2699	2018-07-01	49.139444	Control 5th % confidence interval
2700	2018-08-01	46.248888	Control 5th % confidence interval
2701	2018-09-01	40.467777	Control 5th % confidence interval
2702	2018-10-01	33.723148	Control 5th % confidence interval
2703	2018-11-01	38.540740	Control 5th % confidence interval
2704	2018-12-01	45.285370	Control 5th % confidence interval
2705	2019-01-01	33.723148	Control 5th % confidence interval
2706	2019-02-01	43.358333	Control 5th % confidence interval
2707	2019-03-01	38.540740	Control 5th % confidence interval
2708	2019-04-01	28.905555	Control 5th % confidence interval
2709	2019-05-01	54.920555	Control 5th % confidence interval
2710	2019-06-01	39.504259	Control 5th % confidence interval

```
bardatac_77 =trialAstCust_77
bardatac_77['TransactionMonth'] = bardatac_77['TransactionMonth'].dt.strftime('%Y-%m').astype('str')
bardatac_77 = bardatac_77.set_index('TransactionMonth')
bardatac_77 = bardatac_77.loc[(bardatac_77['Store_type'] == 'Trial') | (bardatac_77['Store_type'] == 'Control')]
bardatac_77
```

TransactionMonth	nCustomers	Store_type
2018-07	51.0	Trial
2018-08	47.0	Trial
2018-09	42.0	Trial
2018-10	37.0	Trial
2018-11	41.0	Trial
2018-12	46.0	Trial
2019-01	35.0	Trial
2019-02	45.0	Trial
2019-03	50.0	Trial
2019-04	47.0	Trial
2019-05	55.0	Trial
2019-06	41.0	Trial
2018-07	51.0	Control
2018-08	48.0	Control
2018-09	42.0	Control
2018-10	35.0	Control
2018-11	40.0	Control
2018-12	47.0	Control
2019-01	35.0	Control
2019-02	45.0	Control
2019-03	40.0	Control
2019-04	30.0	Control
2019-05	57.0	Control
2019-06	41.0	Control

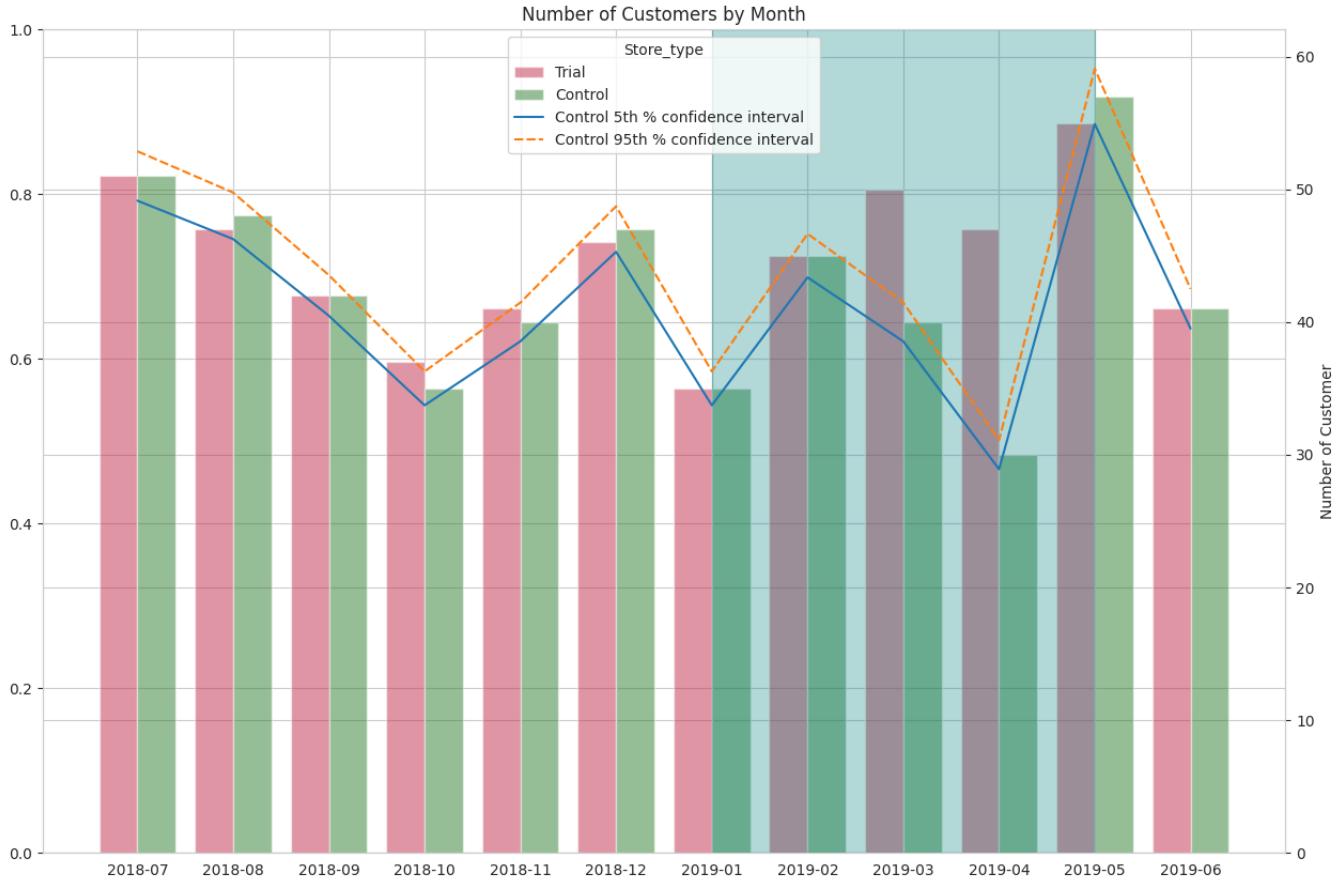
```
linedatac_77 = trialAstCust_77
linedatac_77 = linedatac_77.set_index(['TransactionMonth','Store_type'])['nCustomers'].unstack()
linedatac_77 = linedatac_77.iloc[:,[1,2]]
linedatac_77
```

TransactionMonth	Control 5th % confidence interval	Control 95th % confidence interval
2018-07	49.139444	52.860556
2018-08	46.248888	49.751112
2018-09	40.467777	43.532223
2018-10	33.723148	36.276852
2018-11	38.540740	41.459260
2018-12	45.285370	48.714630
2019-01	33.723148	36.276852
2019-02	43.358333	46.641667
2019-03	38.540740	41.459260
2019-04	28.905555	31.094445
2019-05	54.920555	59.079445
2019-06	39.504259	42.495741

```
fig, ax1 = plt.subplots(figsize=(15,10))
ax2 = ax1.twinx()
```

```
ax1 = sns.barplot(data=bardatac_77,x=bardatac_77.index,y=bardatac_77['nCustomers'],hue=bardatac_77['Store_type'],palette=['crimson','fore
ax2 = sns.lineplot(data=linedatac_77)
ax1.axvspan(xmin='2019-01', xmax='2019-05',  color="teal", alpha=0.3)
plt.xlabel("Month of Operation", fontsize=20)
plt.ylabel('Number of Customer')
plt.title('Number of Customers by Month')
```

```
Text(0.5, 1.0, 'Number of Customers by Month')
```



For Store 88

```
scalingFactorForControlCust_86 = (preTrialMeasures[preTrialMeasures['STORE_NBR'] == 86]['nCustomers'].sum()) / (preTrialMeasures[preTria
scalingFactorForControlCust_86
```

```
1.0
```

```
scaledControlCust_86 = preTrialMeasures.loc[(preTrialMeasures['STORE_NBR'] == 155)]
scaledControlCust_86
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit
1793	155	201807	924.6	101	1.217822	2.475248	3.698400
1794	155	201808	782.7	91	1.307692	2.516484	3.417904
1795	155	201809	1014.4	103	1.398058	2.815534	3.497931
1796	155	201810	963.8	108	1.259259	2.518519	3.543382
1797	155	201811	898.8	101	1.316832	2.673267	3.328889
1798	155	201812	849.8	97	1.237113	2.494845	3.511570
1799	155	201901	874.6	96	1.302083	2.625000	3.470635

```
scaledControlCust_86["controlCust"] = scaledControlCust_86["nCustomers"] * scalingFactorForControlCust_86
scaledControlCust 86
```

```
<ipython-input-302-3e6238ab2db0>: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
  scaledControlCust_86["controlCust"] = scaledControlCust_86["nCustomers"] * scalingFactorForControlCust_86
```

	STORE_NBR	MONTH_ID	totSales	nCustomers	nTxnPerCust	nChipsPerTxn	avgPricePerUnit	controlCust
1793	155	201807	924.6	101	1.217822	2.475248	3.698400	101.0
1794	155	201808	782.7	91	1.307692	2.516484	3.417904	91.0
1795	155	201809	1014.4	103	1.398058	2.815534	3.497931	103.0
1796	155	201810	963.8	108	1.259259	2.518519	3.543382	108.0
1797	155	201811	898.8	101	1.316832	2.673267	3.328889	101.0
1798	155	201812	849.8	97	1.237113	2.494845	3.511570	97.0
1799	155	201901	874.6	96	1.302083	2.625000	3.470635	96.0

```
trialCust_86 = measureoverTime[measureoverTime['STORE_NBR'] == 86].reset_index(drop=True)
scaledControlCust_86 = scaledControlCust_86.reset_index(drop=True)
percentDiffCust_86 = pd.concat([trialCust_86["MONTH_ID"],trialCust_86["nCustomers"],scaledControlCust_86["controlCust"]],axis=1)
percentDiffCust_86.columns=["MONTH_ID","trialCust","controlCust"]
percentDiffCust_86["percentDiffCust"]= (abs(percentDiffCust_86["trialCust"]-percentDiffCust_86["controlCust"]))/percentDiffCust_86["contr
percentDiffCust_86
```

	MONTH_ID	trialCust	controlCust	percentDiffCust
0	201807	99	101.0	0.019802
1	201808	94	91.0	0.032967
2	201809	103	103.0	0.000000
3	201810	109	108.0	0.009259
4	201811	100	101.0	0.009901
5	201812	98	97.0	0.010309
6	201901	94	96.0	0.020833
7	201902	107	NaN	NaN
8	201903	115	NaN	NaN
9	201904	105	NaN	NaN
10	201905	104	NaN	NaN
11	201906	98	NaN	NaN

```
stdCust_86 = percentDiffCust_86[percentDiffCust_86["MONTH_ID"]<201902]["percentDiffCust"].std()
stdCust_86
```

```
0.010687444701395238
```

```
dof = 7
percentDiffCust_86['tValue'] = (percentDiffCust_86['percentDiffCust'] - 0) / stdCust_86
percentDiffCust_86
```

	MONTH_ID	trialCust	controlCust	percentDiffCust	tValue
0	201807	99	101.0	0.019802	1.852826
1	201808	94	91.0	0.032967	3.084651
2	201809	103	103.0	0.000000	0.000000
3	201810	109	108.0	0.009259	0.866368
4	201811	100	101.0	0.009901	0.926413
5	201812	98	97.0	0.010309	0.964616
6	201901	94	96.0	0.020833	1.949328
7	201902	107	NaN	NaN	NaN
8	201903	115	NaN	NaN	NaN
9	201904	105	NaN	NaN	NaN
10	201905	104	NaN	NaN	NaN
11	201906	98	NaN	NaN	NaN

```
measureoverTimeCust_86 = measureoverTime
pastCust_86 = measureoverTimeCust_86
trial_store = 86
control_store = 155
store_type = []
for i in pastCust_86["STORE_NBR"]:
    if i == trial_store:
        store_type.append("Trial")
    elif i == control_store:
        store_type.append("Control")
    else:
        store_type.append("Other Stores")
pastCust_86["Store_type"] = store_type
```

```
pastCust_86['TransactionMonth'] = pd.to_datetime(pastCust_86['MONTH_ID'], format='%Y%m')
pastCust_86= pastCust_86.loc[pastCust_86['Store_type'].isin(['Control','Trial'])]
pastCust_86 = pastCust_86.loc[:,['TransactionMonth','nCustomers','Store_type']]
pastCust_86
```

	TransactionMonth	nCustomers	Store_type
977	2018-07-01	99	Trial
978	2018-08-01	94	Trial
979	2018-09-01	103	Trial
980	2018-10-01	109	Trial
981	2018-11-01	100	Trial
982	2018-12-01	98	Trial
983	2019-01-01	94	Trial
984	2019-02-01	107	Trial
985	2019-03-01	115	Trial
986	2019-04-01	105	Trial
987	2019-05-01	104	Trial
988	2019-06-01	98	Trial
1793	2018-07-01	101	Control
1794	2018-08-01	91	Control
1795	2018-09-01	103	Control
1796	2018-10-01	108	Control
1797	2018-11-01	101	Control
1798	2018-12-01	97	Control
1799	2019-01-01	96	Control
1800	2019-02-01	95	Control
1801	2019-03-01	94	Control
1802	2019-04-01	99	Control
1803	2019-05-01	106	Control
1804	2019-06-01	95	Control

```
pastCust_Ctrlc95_86 = pastCust_86[pastCust_86['Store_type'] == "Control"]
pastCust_Ctrlc95_86['nCustomers'] = pastCust_Ctrlc95_86['nCustomers'] * (1 + (stdCust_86  * 2))
pastCust_Ctrlc95_86['Store_type'] = "Control 95th % confidence interval"
pastCust_Ctrlc95_86.head(10)
```

```
<ipython-input-308-1ef085b1af89>:2: 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
  pastCust_Ctrlc95_86['nCustomers'] = pastCust_Ctrlc95_86['nCustomers'] * (1 + (stdCust_86  * 2))
<ipython-input-308-1ef085b1af89>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus
  pastCust_Ctrlc95_86['Store_type'] = "Control 95th % confidence interval"
```

	TransactionMonth	nCustomers	Store_type
1793	2018-07-01	103.158864	Control 95th % confidence interval
1794	2018-08-01	92.945115	Control 95th % confidence interval
1795	2018-09-01	105.201614	Control 95th % confidence interval
1796	2018-10-01	110.308488	Control 95th % confidence interval
1797	2018-11-01	103.158864	Control 95th % confidence interval
1798	2018-12-01	99.073364	Control 95th % confidence interval
1799	2019-01-01	98.051989	Control 95th % confidence interval
1800	2019-02-01	97.030614	Control 95th % confidence interval
1801	2019-03-01	96.009240	Control 95th % confidence interval
1802	2019-04-01	101.116114	Control 95th % confidence interval

```
pastCust_Ctrlc5_86 = pastCust_86[pastCust_86['Store_type'] == "Control"]
pastCust_Ctrlc5_86['nCustomers'] = pastCust_Ctrlc5_86['nCustomers'] * (1 - (stdCust_86 * 2))
pastCust_Ctrlc5_86['Store_type'] = "Control 5th % confidence interval"
pastCust_Ctrlc5_86.head(10)
```

```
pastCust_Ctrlc95_86.head(10)
```

```
<ipython-input-309-f7029bd4be2b>:2: 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
  pastCust_Ctrlc5_86['nCustomers'] = pastCust_Ctrlc5_86['nCustomers'] * (1 - (stdCust_86 * 2))
<ipython-input-309-f7029bd4be2b>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus
  pastCust_Ctrlc5_86['Store_type'] = "Control 5th % confidence interval"
```

	TransactionMonth	nCustomers	Store_type
1793	2018-07-01	98.841136	Control 5th % confidence interval
1794	2018-08-01	89.054885	Control 5th % confidence interval
1795	2018-09-01	100.798386	Control 5th % confidence interval
1796	2018-10-01	105.691512	Control 5th % confidence interval
1797	2018-11-01	98.841136	Control 5th % confidence interval
1798	2018-12-01	94.926636	Control 5th % confidence interval
1799	2019-01-01	93.948011	Control 5th % confidence interval
1800	2019-02-01	92.969386	Control 5th % confidence interval
1801	2019-03-01	91.990760	Control 5th % confidence interval
1802	2019-04-01	96.883886	Control 5th % confidence interval

```
trialAstCust_86 = pd.concat([pastCust_86,pastCust_Ctrlc95_86,pastCust_Ctrlc5_86])
trialAstCust_86
```

	TransactionMonth	nCustomers	Store_type
977	2018-07-01	99.000000	Trial
978	2018-08-01	94.000000	Trial
979	2018-09-01	103.000000	Trial
980	2018-10-01	109.000000	Trial
981	2018-11-01	100.000000	Trial
982	2018-12-01	98.000000	Trial
983	2019-01-01	94.000000	Trial
984	2019-02-01	107.000000	Trial
985	2019-03-01	115.000000	Trial
986	2019-04-01	105.000000	Trial
987	2019-05-01	104.000000	Trial
988	2019-06-01	98.000000	Trial
1793	2018-07-01	101.000000	Control
1794	2018-08-01	91.000000	Control
1795	2018-09-01	103.000000	Control
1796	2018-10-01	108.000000	Control
1797	2018-11-01	101.000000	Control
1798	2018-12-01	97.000000	Control
1799	2019-01-01	96.000000	Control
1800	2019-02-01	95.000000	Control

```
bardatac_86 =trialAstCust_86
bardatac_86['TransactionMonth'] = bardatac_86['TransactionMonth'].dt.strftime('%Y-%m').astype('str')
bardatac_86 = bardatac_86.set_index('TransactionMonth')
bardatac_86 = bardatac_86.loc[(bardatac_86['Store_type'] == 'Trial') | (bardatac_86['Store_type'] == 'Control')]
bardatac_86
```

	nCustomers	Store_type
TransactionMonth		
2018-07	99.0	Trial
2018-08	94.0	Trial
2018-09	103.0	Trial