```
Start coding or generate with AI.
```

Import libraries

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

from sklearn.preprocessing import LabelEncoder
from sklearn.cluster import KMeans
from sklearn.model_selection import train_test_split

pd.set_option('display.max_columns', None)
sns.set(style='whitegrid')
plt.rcParams['figure.figsize'] = (10, 6)
```

Load Data

```
df = pd.read_csv("/content/QVI_data.csv")
```

Data exploration

```
df
```

	LYLTY_CARD_NBR	DATE	STORE_NBR	TXN_ID	PROD_NBR	PROD_NAME	PROD_QTY	TOT_SALES	PACK_SIZE	BRAND	L
0	1000	2018-10-17	1	1	5	Natural Chip Compny SeaSalt175g	2	6.0	175	NATURAL	SINGLES/C
1	1002	2018-09-16	1	2	58	Red Rock Deli Chikn&Garlic Aioli 150g	1	2.7	150	RRD	SINGLES/C
2	1003	2019-03-07	1	3	52	Grain Waves Sour Cream&Chives 210G	1	3.6	210	GRNWVES	YOUNG I
3	1003	2019-03-08	1	4	106	Natural ChipCo Hony Soy Chckn175g	1	3.0	175	NATURAL	YOUNG I
4	1004	2018-11-02	1	5	96	WW Original Stacked Chips 160g	1	1.9	160	WOOLWORTHS	SINGLES/C
...	...	...	...	...	...	...	...	...	...	...	
264829	2370701	2018-12-08	88	240378	24	Grain Waves Sweet Chilli 210g	2	7.2	210	GRNWVES	YOUNG I
264830	2370751	2018-10-01	88	240394	60	Kettle Tortilla ChpsFeta&Garlic 150g	2	9.2	150	KETTLE	YOUNG I
264831	2370961	2018-10-24	88	240480	70	Tyrrells Crisps Lightly Salted 165g	2	8.4	165	TYRRELLS	OLDER I
264832	2370961	2018-10-27	88	240481	65	Old El Paso Salsa Dip Chnky Tom Ht300g	2	10.2	300	OLD	OLDER I
264833	2373711	2018-12-14	88	241815	16	Smiths Crinkle Chips Salt & Vinegar 330g	2	11.4	330	SMITHS	SINGLES/C

264834 rows × 12 columns

```
1 df.sample(5)
```

	LYLTY_CARD_NBR	DATE	STORE_NBR	TXN_ID	PROD_NBR	PROD_NAME	PROD_QTY	TOT_SALES	PACK_SIZE	BRAND	LIFEST
66044	69253	2018-10-16	69	67430	104	Infuzions Thai SweetChili PotatoMix 110g	2	7.6	110	INFUZIONS	YOU SINGLES/COUP
152048	155039	2018-07-16	155	155251	46	Kettle Original 175g	2	10.8	175	KETTLE	YOUNG FAMIL
74940	78183	2018-09-10	78	76522	46	Kettle Original 175g	2	10.8	175	KETTLE	OLI SINGLES/COUP
199978	205037	2019-01-15	205	204096	46	Kettle Original 175g	2	10.8	175	KETTLE	YOU SINGLES/COUP
204195	209164	2018-08-05	209	208405	105	Woolworths Cheese Rings 190g	2	3.6	190	WOOLWORTHS	YOU SINGLES/COUP

```
1 df.columns
```

```
Index(['LYLTY_CARD_NBR', 'DATE', 'STORE_NBR', 'TXN_ID', 'PROD_NBR',
       'PROD_NAME', 'PROD_QTY', 'TOT_SALES', 'PACK_SIZE', 'BRAND', 'LIFESTAGE',
       'PREMIUM_CUSTOMER'],
      dtype='object')
```

```
1 df.info()
```

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

```
1 df.isnull().sum()
```

	0
LYLTY_CARD_NBR	0
DATE	0
STORE_NBR	0
TXN_ID	0
PROD_NBR	0
PROD_NAME	0
PROD_QTY	0
TOT_SALES	0
PACK_SIZE	0
BRAND	0
LIFESTAGE	0
PREMIUM_CUSTOMER	0

```
df.duplicated().sum()
```

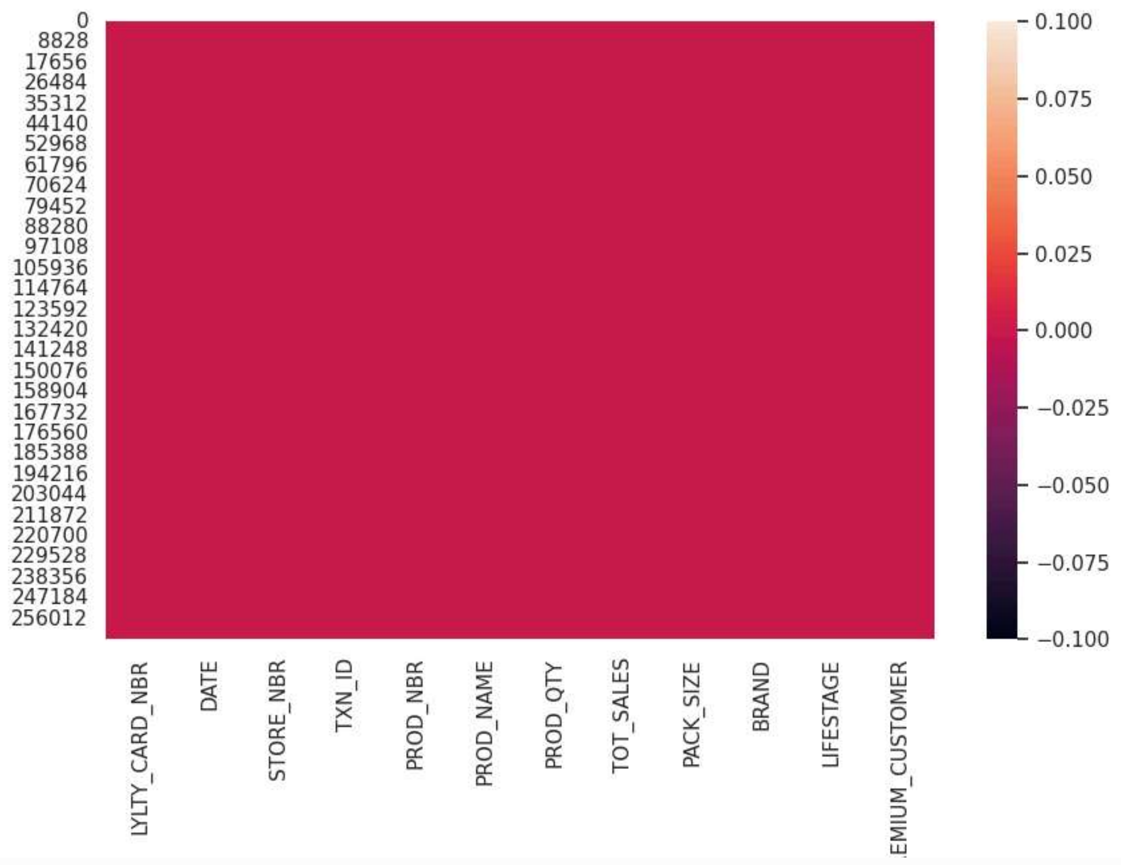
```
np.int64(1)
```

Data processing

```
df = df.dropna()
```

```
sns.heatmap(df.isnull())
```

```
<Axes: >
```

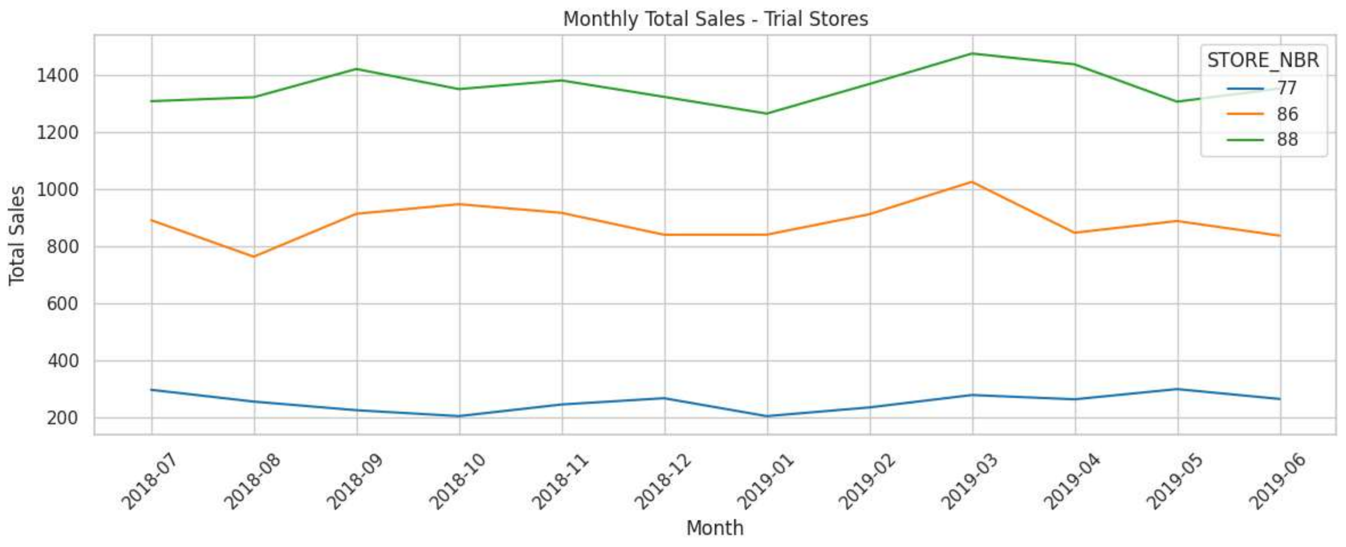


```
df['DATE'] = pd.to_datetime(df['DATE'])
df['MONTH'] = df['DATE'].dt.to_period('M')

monthly_summary = df.groupby(['STORE_NBR', 'MONTH']).agg(
    total_sales=('TOT_SALES', 'sum'),
    total_customers=('LYLTY_CARD_NBR', pd.Series.nunique),
    total_transactions=('TXN_ID', pd.Series.nunique)
).reset_index()

monthly_summary['avg_txn_per_customer'] = (
    monthly_summary['total_transactions'] / monthly_summary['total_customers']
)

```

```
trial_stores = [77, 86, 88]

trial_data = monthly_summary[monthly_summary['STORE_NBR'].isin(trial_stores)].copy()

trial_data['MONTH_STR'] = trial_data['MONTH'].astype(str)

```

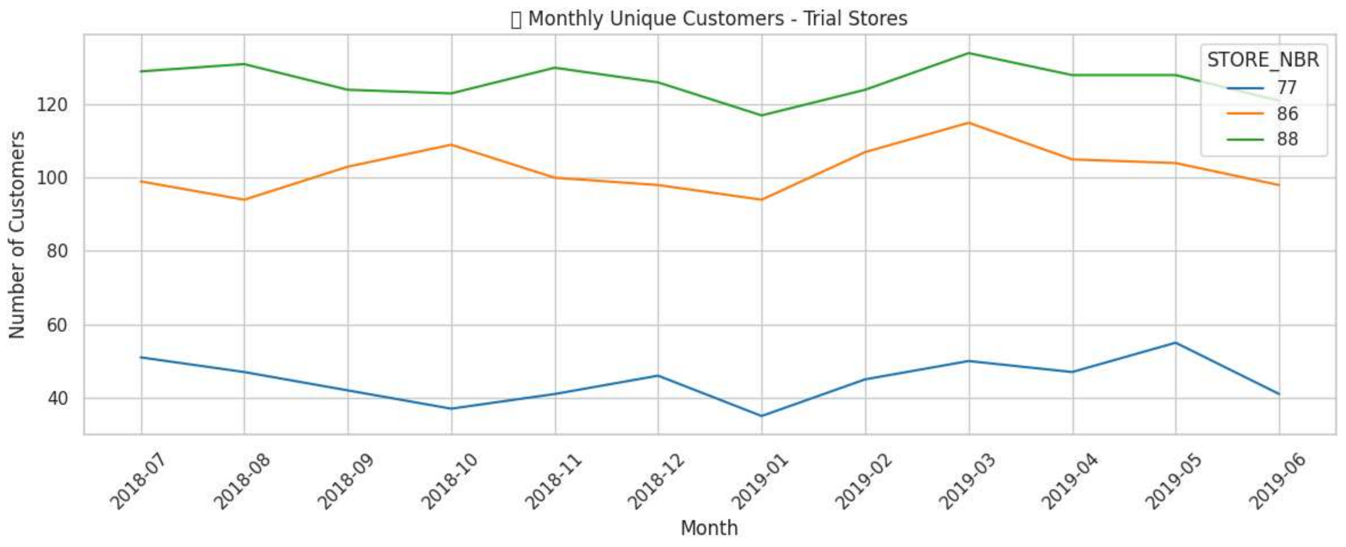
Data analysis

```python
sns.set(style="whitegrid")
palette = sns.color_palette("tab10", len(trial_stores))

plt.figure(figsize=(12, 5))
sns.lineplot(data=trial_data, x='MONTH_STR', y='total_sales', hue='STORE_NBR', palette=palette)
plt.title('Monthly Total Sales - Trial Stores')
plt.xlabel('Month')
plt.ylabel('Total Sales')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()

```



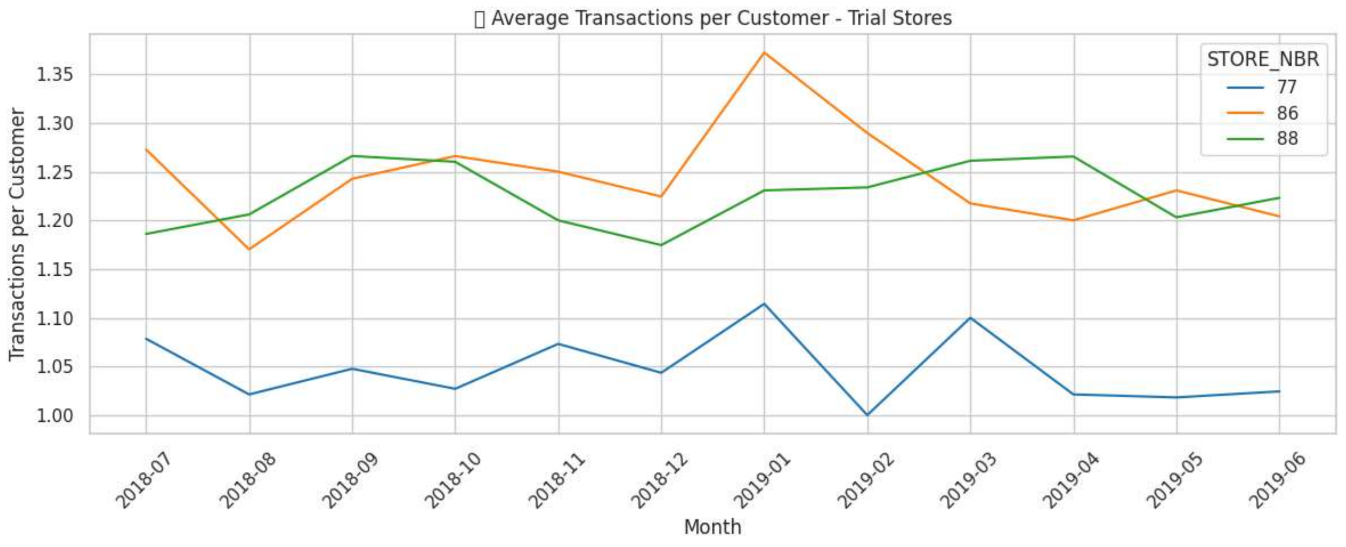
```python
plt.figure(figsize=(12, 5))
sns.lineplot(data=trial_data, x='MONTH_STR', y='total_customers', hue='STORE_NBR', palette=palette)
plt.title('👥 Monthly Unique Customers - Trial Stores')
plt.xlabel('Month')
plt.ylabel('Number of Customers')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()

```

```
<ipython-input-14-b099232d3fdc>:7: UserWarning: Glyph 128101 (\N{BUSTS IN SILHOUETTE}) missing from font(s) DejaVu Sans.
  plt.tight_layout()
/usr/local/lib/python3.11/dist-packages/IPython/core/pylabtools.py:151: UserWarning: Glyph 128101 (\N{BUSTS IN SILHOUETTE}) missing
  fig.canvas.print_figure(bytes_io, **kw)
```



```
plt.figure(figsize=(12, 5))
sns.lineplot(data=trial_data, x='MONTH_STR', y='avg_txn_per_customer', hue='STORE_NBR', palette=palet
plt.title('💳 Average Transactions per Customer - Trial Stores')
plt.xlabel('Month')
plt.ylabel('Transactions per Customer')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```

```
<ipython-input-15-790517cf1ffb>:7: UserWarning: Glyph 128179 (\N{CREDIT CARD}) missing from font(s) DejaVu Sans.
  plt.tight_layout()
/usr/local/lib/python3.11/dist-packages/IPython/core/pylabtools.py:151: UserWarning: Glyph 128179 (\N{CREDIT CARD}) missing from fo
  fig.canvas.print_figure(bytes_io, **kw)
```



```
def check_data_ready(df):
    print("Checking for missing columns:")
    print(df.isnull().sum())

    print("\nData types:")
    print(df.dtypes)

    print("\nData samples:")
    print(df.head())

    print("\nChecking for illogical values:")
    if (df['TOT_SALES'] < 0).any():
        print("There are negative sales.")
    if (df['PROD_QTY'] < 0).any():
        print("There are negative quantities.")

    if df.duplicated().any():
        print("There are duplicate rows.")
    else:
        print("No duplicate rows.")

check_data_ready(df)
```

```
Checking for missing columns:
LYLTY_CARD_NBR      0
DATE                0
STORE_NBR           0
TXN_ID              0
PROD_NBR            0
PROD_NAME           0
PROD_QTY            0
TOT_SALES           0
PACK_SIZE           0
BRAND               0
LIFESTAGE           0
PREMIUM_CUSTOMER    0
```

```
MONTH              0
dtype: int64

Data types:
LYLTY_CARD_NBR               int64
DATE                datetime64[ns]
STORE_NBR                    int64
TXN_ID                       int64
PROD_NBR                     int64
PROD_NAME                   object
PROD_QTY                     int64
TOT_SALES                  float64
PACK_SIZE                    int64
BRAND                       object
LIFESTAGE                   object
PREMIUM_CUSTOMER            object
MONTH                    period[M]
dtype: object

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

                               PROD_NAME  PROD_QTY  TOT_SALES  PACK_SIZE  \
0  Natural Chip        Compny SeaSalt175g         2        6.0        175   
1   Red Rock Deli Chikn&Garlic Aioli 150g         1        2.7        150   
2   Grain Waves Sour    Cream&Chives 210G         1        3.6        210   
3  Natural ChipCo      Hony Soy Chckn175g         1        3.0        175   
4          WW Original Stacked Chips 160g         1        1.9        160   

        BRAND              LIFESTAGE PREMIUM_CUSTOMER    MONTH  
0     NATURAL  YOUNG SINGLES/COUPLES          Premium  2018-10  
1         RRD  YOUNG SINGLES/COUPLES       Mainstream  2018-09  
2     GRNWVES         YOUNG FAMILIES           Budget  2019-03  
3     NATURAL         YOUNG FAMILIES           Budget  2019-03  
4  WOOLWORTHS  OLDER SINGLES/COUPLES       Mainstream  2018-11  

Checking for illogical values:
There are duplicate rows.
```

```python
print("Number of rows before deletion:", len(df))

df = df.drop_duplicates()

print("Number of rows after deletion:", len(df))
```

```
Number of rows before deletion: 264834
Number of rows after deletion: 264833
```

```python
from scipy.stats import pearsonr
import numpy as np

def get_control_store(trial_store, metric='TOT_SALES'):

    pre_trial_df = df[df['MONTH'] < '2019-02']
    grouped = pre_trial_df.groupby(['MONTH', 'STORE_NBR'])[[metric]].sum().reset_index()

    trial_data = grouped[grouped['STORE_NBR'] == trial_store].reset_index(drop=True)
    other_stores = grouped['STORE_NBR'].unique()
    other_stores = [store for store in other_stores if store != trial_store]

    results = []
    for store in other_stores:
        control_data = grouped[grouped['STORE_NBR'] == store].reset_index(drop=True)

        if len(control_data) == len(trial_data):
            corr, _ = pearsonr(trial_data[metric], control_data[metric])

            dist = np.abs(trial_data[metric] - control_data[metric]).sum()
            results.append((store, corr, dist))

    results_df = pd.DataFrame(results, columns=['STORE_NBR', 'Correlation', 'MagnitudeDistance'])
    results_df['NormalizedDistance'] = 1 - (results_df['MagnitudeDistance'] - results_df['MagnitudeDi

    results_df['Score'] = (results_df['Correlation'] + results_df['NormalizedDistance']) / 2
    return results_df.sort_values(by='Score', ascending=False).head()

```

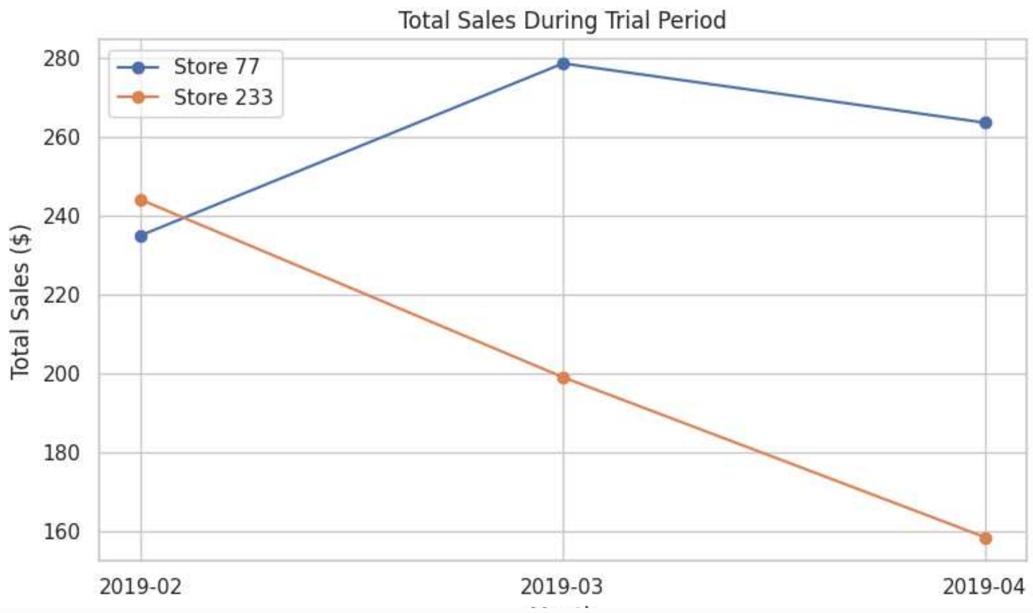
```
get_control_store(trial_store=77, metric='TOT_SALES')

```

	STORE_NBR	Correlation	MagnitudeDistance	NormalizedDistance	Score
220	233	0.903774	131.8	1.000000	0.951887
38	41	0.783232	317.4	0.977927	0.880579
46	50	0.763866	243.0	0.986775	0.875320
15	17	0.842668	1089.3	0.886125	0.864397

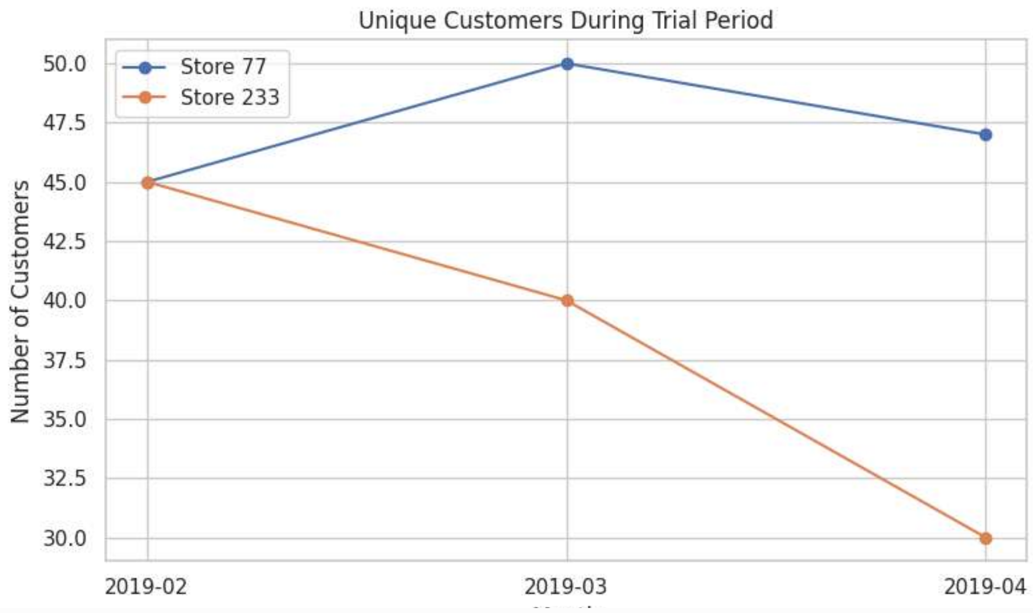
```
def compare_trial_vs_control(trial_store, control_store, start='2019-02', end='2019-04'):
    trial_period = df[(df['STORE_NBR'].isin([trial_store, control_store])) &
                      (df['MONTH'] >= start) & (df['MONTH'] <= end)]

    summary = trial_period.groupby(['STORE_NBR', 'MONTH']).agg(
        total_sales=('TOT_SALES', 'sum'),
        total_customers=('LYLTY_CARD_NBR', 'nunique'),
        avg_txn_per_customer=('TXN_ID', 'count')
    ).reset_index()

    print(summary)

compare_trial_vs_control(trial_store=77, control_store=233)

```

```
   STORE_NBR    MONTH  total_sales  total_customers  avg_txn_per_customer
0         77  2019-02        235.0               45                    45
1         77  2019-03        278.5               50                    55
2         77  2019-04        263.5               47                    48
3        233  2019-02        244.0               45                    47
4        233  2019-03        199.1               40                    41
5        233  2019-04        158.6               30                    33
```

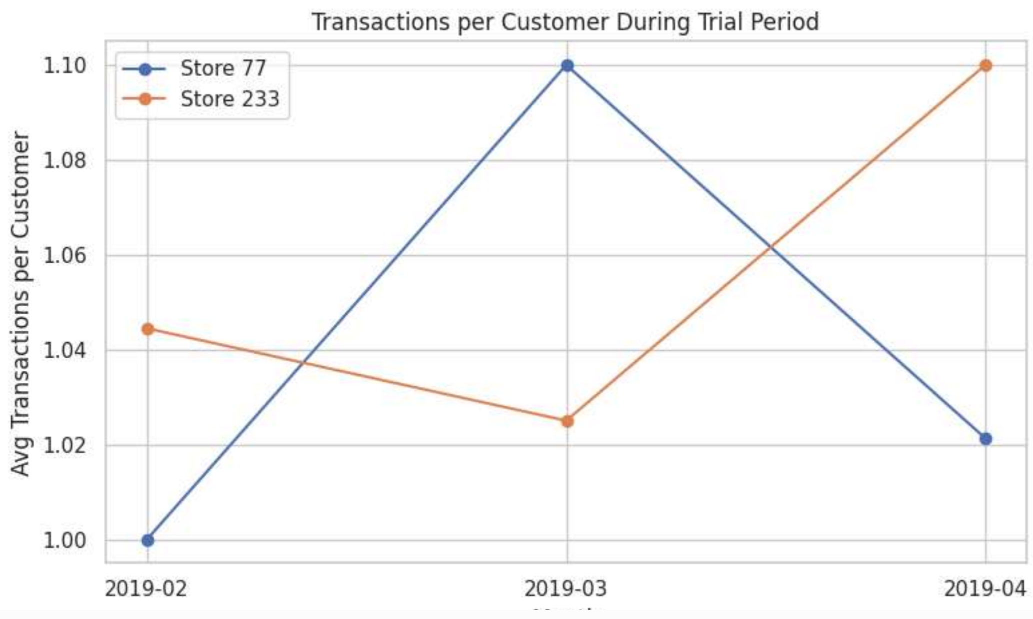
```
def plot_total_sales(trial_store, control_store, start='2019-02', end='2019-04'):
    trial_period = df[(df['STORE_NBR'].isin([trial_store, control_store])) &
                      (df['MONTH'] >= start) & (df['MONTH'] <= end)]

    summary = trial_period.groupby(['STORE_NBR', 'MONTH'])['TOT_SALES'].sum().reset_index()
    summary['MONTH'] = summary['MONTH'].astype(str)

    plt.figure(figsize=(8,5))
    for store in [trial_store, control_store]:
        store_data = summary[summary['STORE_NBR'] == store]
        plt.plot(store_data['MONTH'], store_data['TOT_SALES'], marker='o', label=f'Store {store}')

    plt.title('Total Sales During Trial Period')
    plt.xlabel('Month')
    plt.ylabel('Total Sales ($)')
    plt.legend()
    plt.grid(True)
    plt.tight_layout()
    plt.show()

plot_total_sales(trial_store=77, control_store=233)

```



```python
def plot_total_customers(trial_store, control_store, start='2019-02', end='2019-04'):
    trial_period = df[(df['STORE_NBR'].isin([trial_store, control_store])) &
                      (df['MONTH'] >= start) & (df['MONTH'] <= end)]

    customers = trial_period.groupby(['STORE_NBR', 'MONTH'])['LYLTY_CARD_NBR'].nunique().reset_index(
    customers['MONTH'] = customers['MONTH'].astype(str)

    plt.figure(figsize=(8,5))
    for store in [trial_store, control_store]:
        store_data = customers[customers['STORE_NBR'] == store]
        plt.plot(store_data['MONTH'], store_data['LYLTY_CARD_NBR'], marker='o', label=f'Store {store}

    plt.title('Unique Customers During Trial Period')
    plt.xlabel('Month')
    plt.ylabel('Number of Customers')
    plt.legend()
    plt.grid(True)
    plt.tight_layout()
    plt.show()

plot_total_customers(trial_store=77, control_store=233)
```



```python
def plot_txn_per_customer(trial_store, control_store, start='2019-02', end='2019-04'):
    trial_period = df[(df['STORE_NBR'].isin([trial_store, control_store])) &
                      (df['MONTH'] >= start) & (df['MONTH'] <= end)]

    summary = trial_period.groupby(['STORE_NBR', 'MONTH']).agg(
        total_txn=('TXN_ID', 'count'),
        unique_customers=('LYLTY_CARD_NBR', 'nunique')
    ).reset_index()
    summary['txn_per_customer'] = summary['total_txn'] / summary['unique_customers']
    summary['MONTH'] = summary['MONTH'].astype(str)

    plt.figure(figsize=(8,5))
    for store in [trial_store, control_store]:
        store_data = summary[summary['STORE_NBR'] == store]
        plt.plot(store_data['MONTH'], store_data['txn_per_customer'], marker='o', label=f'Store {stor

    plt.title('Transactions per Customer During Trial Period')
    plt.xlabel('Month')
    plt.ylabel('Avg Transactions per Customer')
    plt.legend()
    plt.grid(True)
    plt.tight_layout()
    plt.show()

plot_txn_per_customer(trial_store=77, control_store=233)

```



Project completed!