A/B Testing using Python

The dataset I have used here contains two data files about two marketing campaigns: Control Campaign and Test Campaign

In [1]:
```
import pandas as pd
import datetime
from datetime import date, timedelta
import plotly.graph_objects as go
import plotly.express as px
import plotly.io as pio
pio.templates.default = "plotly_white"
import warnings
warnings.filterwarnings('ignore')
```

Data Extration

In [2]:
```
control_data = pd.read_csv("control_group.csv", sep = ";")
test_data = pd.read_csv("test_group.csv", sep = ";")
```

In [3]:
```
print(control_data.head())
```

```
      Campaign Name       Date  Spend [USD]  # of Impressions     Reach  \
0  Control Campaign  1.08.2019         2280           82702.0   56930.0
1  Control Campaign  2.08.2019         1757          121040.0  102513.0
2  Control Campaign  3.08.2019         2343          131711.0  110862.0
3  Control Campaign  4.08.2019         1940           72878.0   61235.0
4  Control Campaign  5.08.2019         1835               NaN       NaN

   # of Website Clicks  # of Searches  # of View Content  # of Add to Cart  \
0               7016.0         2290.0             2159.0            1819.0
1               8110.0         2033.0             1841.0            1219.0
2               6508.0         1737.0             1549.0            1134.0
3               3065.0         1042.0              982.0            1183.0
4                  NaN            NaN                NaN               NaN

   # of Purchase
0         618.0
1         511.0
2         372.0
3         340.0
4           NaN
```

In [4]:
```
print(test_data.head())
```

```
   Campaign Name       Date  Spend [USD]  # of Impressions  Reach  \
0  Test Campaign  1.08.2019         3008             39550  35820
1  Test Campaign  2.08.2019         2542            100719  91236
2  Test Campaign  3.08.2019         2365             70263  45198
3  Test Campaign  4.08.2019         2710             78451  25937
4  Test Campaign  5.08.2019         2297            114295  95138

   # of Website Clicks  # of Searches  # of View Content  # of Add to Cart  \
0                3038           1946              1069               894
1                4657           2359              1548               879
2                7885           2572              2367              1268
3                4216           2216              1437               566
4                5863           2106               858               956
```

```
   # of Purchase
0             255
1             677
2             578
3             340
4             768
```

Data Preparation

In [5]:
```
control_data.columns = ["Campaign Name", "Date", "Amount Spent", "Number of Impressions"
                        "Searches Received", "Content Viewed", "Added to Cart", "Purchas

test_data.columns = ["Campaign Name", "Date", "Amount Spent", "Number of Impressions", "
                     "Searches Received", "Content Viewed", "Added to Cart", "Purchases"
```

In [6]:
```
print(control_data.isnull().sum())
```

```
Campaign Name             0
Date                      0
Amount Spent              0
Number of Impressions     1
Reach                     1
Website Clicks            1
Searches Received         1
Content Viewed            1
Added to Cart             1
Purchases                 1
dtype: int64
```

In [7]:
```
print(test_data.isnull().sum())
```

```
Campaign Name             0
Date                      0
Amount Spent              0
Number of Impressions     0
Reach                     0
Website Clicks            0
Searches Received         0
Content Viewed            0
Added to Cart             0
Purchases                 0
dtype: int64
```

In [8]:
```
###filled missing values of control campaign dataset
control_data["Number of Impressions"].fillna(value=control_data["Number of Impressions"]
control_data["Reach"].fillna(value=control_data["Reach"].mean(), inplace=True)
control_data["Website Clicks"].fillna(value=control_data["Website Clicks"].mean(), inpla
control_data["Searches Received"].fillna(value=control_data["Searches Received"].mean(),
control_data["Content Viewed"].fillna(value=control_data["Content Viewed"].mean(), inpla
control_data["Added to Cart"].fillna(value=control_data["Added to Cart"].mean(), inplace
control_data["Purchases"].fillna(value=control_data["Purchases"].mean(), inplace=True)
print(control_data.isnull().sum())
```

```
Campaign Name             0
Date                      0
Amount Spent              0
Number of Impressions     0
Reach                     0
Website Clicks            0
Searches Received         0
Content Viewed            0
Added to Cart             0
Purchases                 0
dtype: int64
```

In [9]:
```
ab_data = control_data.merge(test_data, how="outer").sort_values(["Date"])
ab_data = ab_data.reset_index(drop=True)
print(ab_data.head())

###outer join
```

```
      Campaign Name         Date  Amount Spent  Number of Impressions    Reach  \
0  Control Campaign    1.08.2019          2280                82702.0  56930.0
1     Test Campaign    1.08.2019          3008                39550.0  35820.0
2     Test Campaign   10.08.2019          2790                95054.0  79632.0
3  Control Campaign   10.08.2019          2149               117624.0  91257.0
4     Test Campaign   11.08.2019          2420                83633.0  71286.0

   Website Clicks  Searches Received  Content Viewed  Added to Cart  Purchases
0          7016.0             2290.0          2159.0         1819.0      618.0
1          3038.0             1946.0          1069.0          894.0      255.0
2          8125.0             2312.0          1804.0          424.0      275.0
3          2277.0             2475.0          1984.0         1629.0      734.0
4          3750.0             2893.0          2617.0         1075.0      668.0
```

In [10]:
```
print(ab_data["Campaign Name"].value_counts())
```

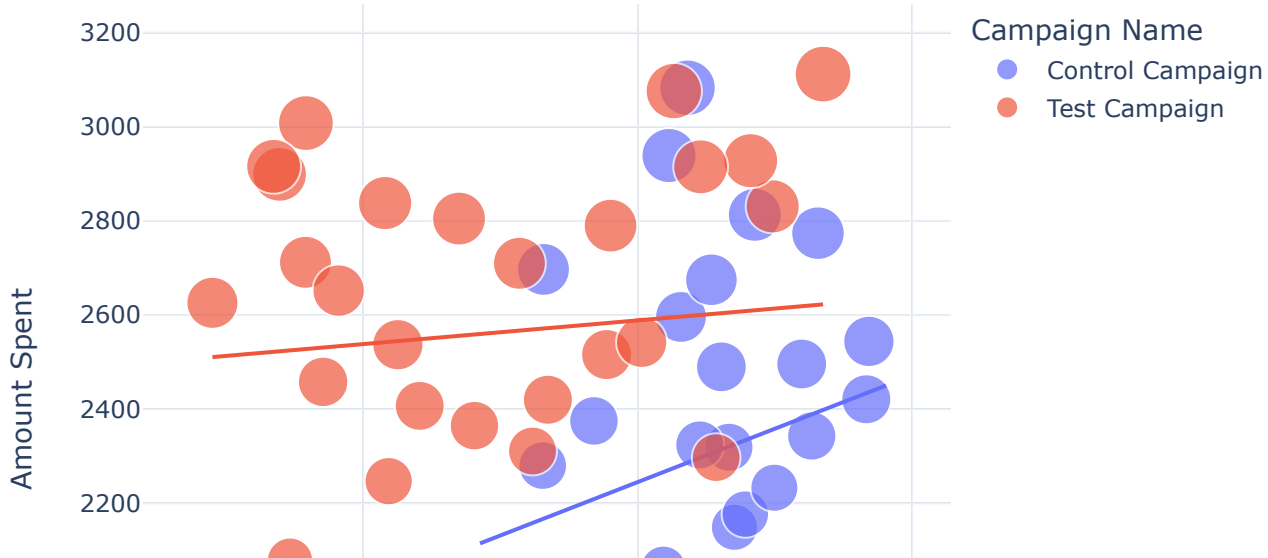
```
Campaign Name
Control Campaign    30
Test Campaign       30
Name: count, dtype: int64
```

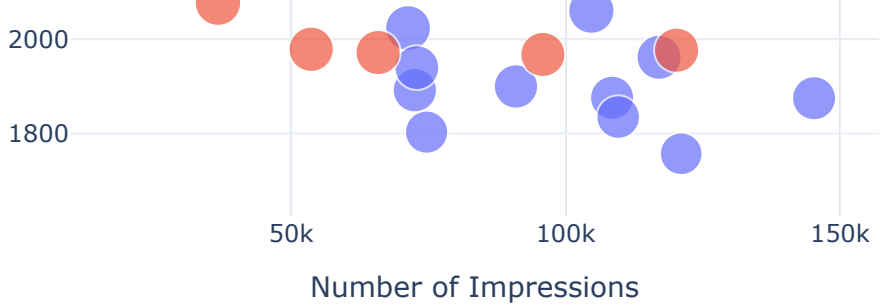
Data Analysis

A/B Testing to Find the Best Marketing Strategy

In [11]:
```
print("First analyzed the relationship between the number of impressions we got from bot
figure = px.scatter(data_frame = ab_data,
                    x="Number of Impressions",
                    y="Amount Spent",
                    size="Amount Spent",
                    color= "Campaign Name",
                    trendline="ols")
figure.show()
```

```
First analyzed the relationship between the number of impressions we got from both campa
igns and the amount spent on both campaigns
```

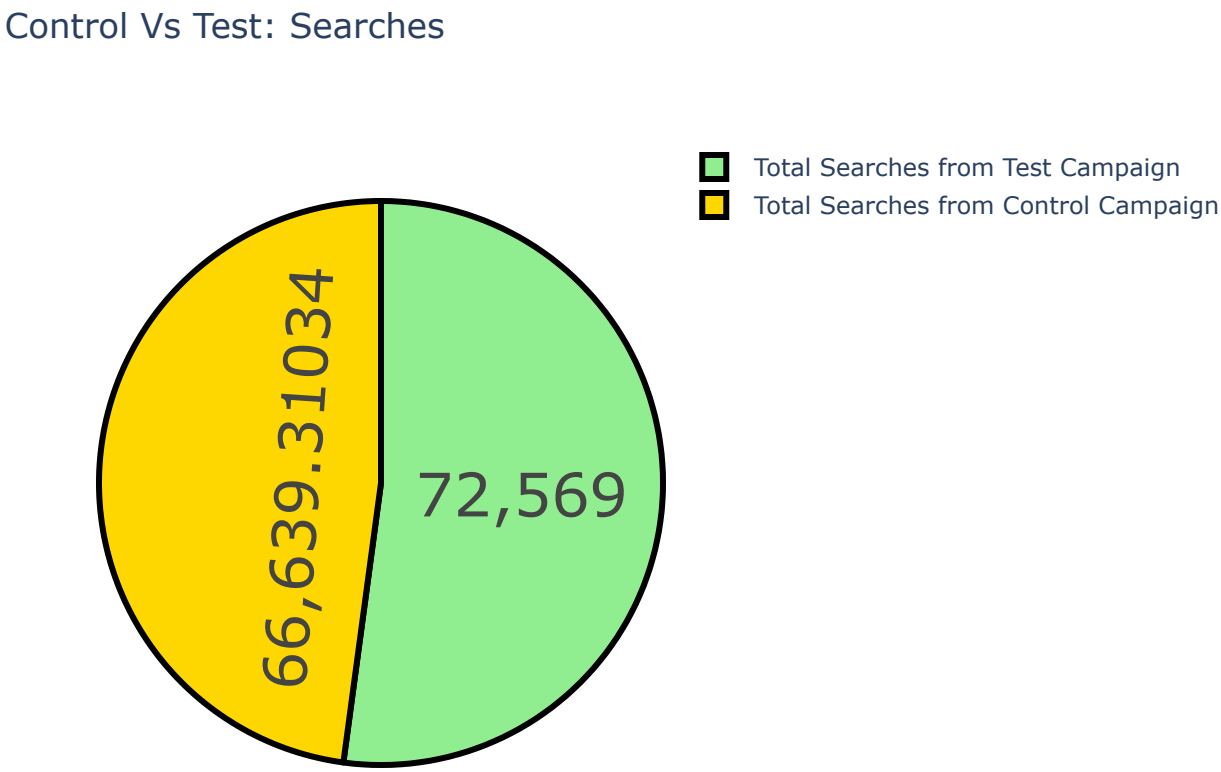




The control campaign resulted in more impressions according to the amount spent on both campaigns.

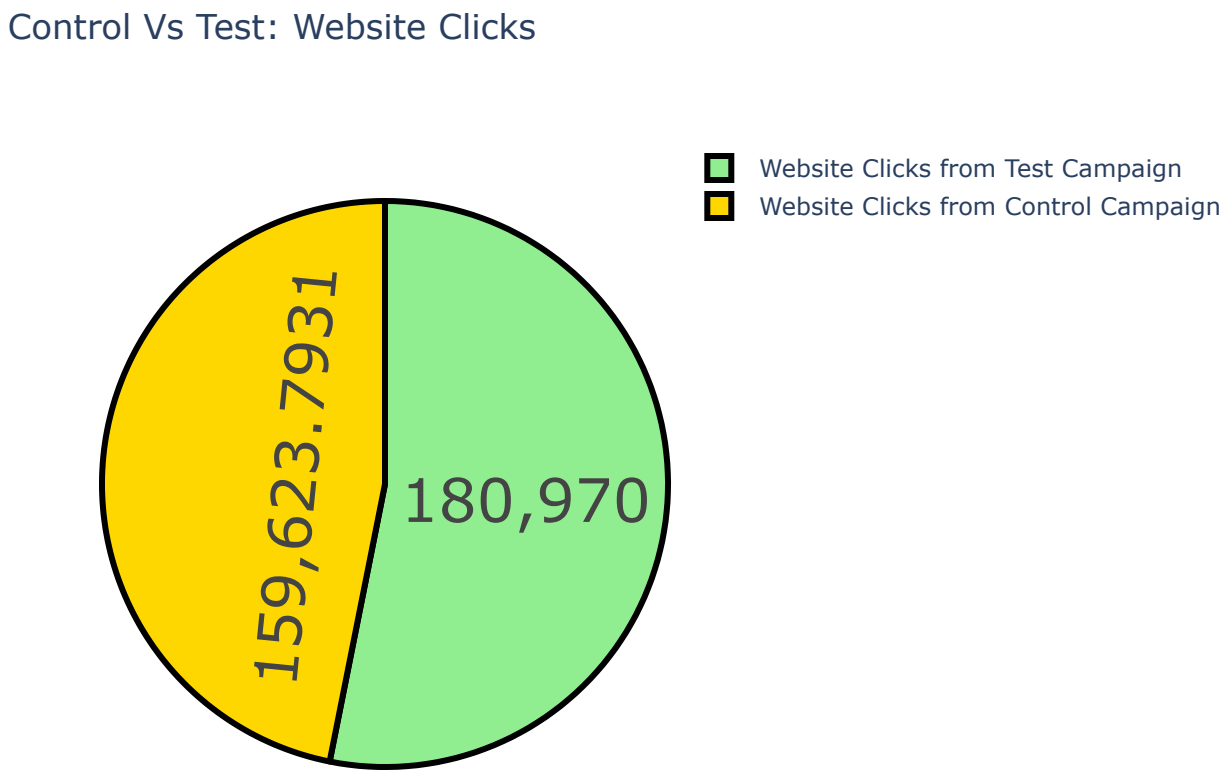
In [12]:
```
print("Number of searches performed on the website from both campaigns")
label = ["Total Searches from Control Campaign",
         "Total Searches from Test Campaign"]
counts = [sum(control_data["Searches Received"]),
          sum(test_data["Searches Received"])]
colors = ['gold','lightgreen']
fig = go.Figure(data=[go.Pie(labels=label, values=counts)])
fig.update_layout(title_text='Control Vs Test: Searches')
fig.update_traces(hoverinfo='label+percent', textinfo='value',
                  textfont_size=30,
                  marker=dict(colors=colors,
                              line=dict(color='black', width=3)))
fig.show()
print("")
```

```
Number of searches performed on the website from both campaigns
```



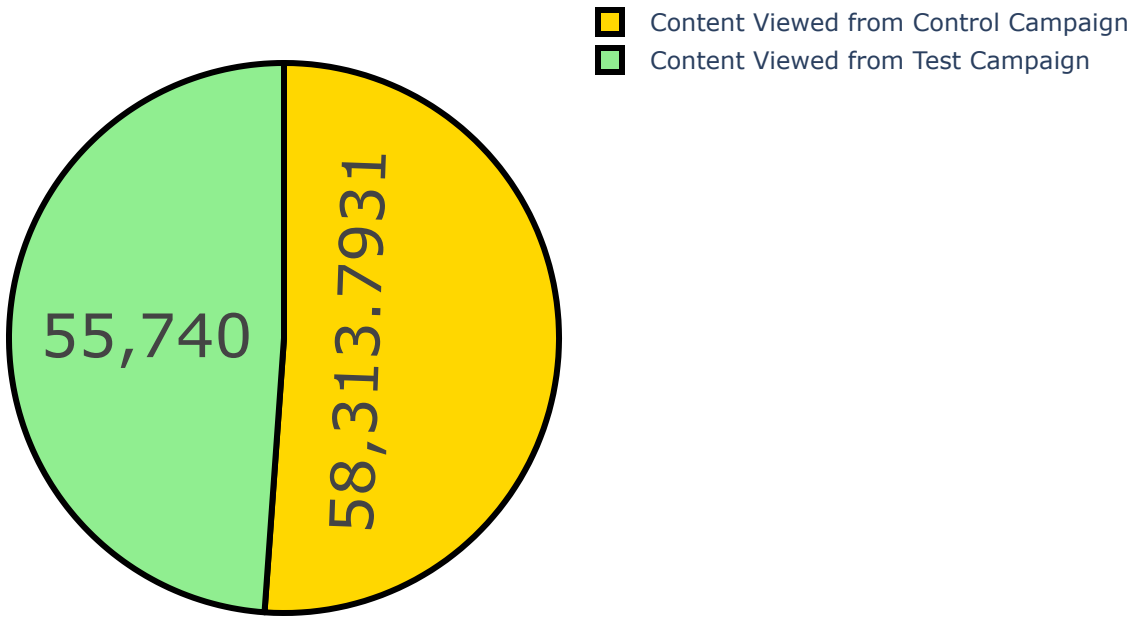
In [13]:
```
print("Number of website clicks from both campaigns")
label = ["Website Clicks from Control Campaign",
         "Website Clicks from Test Campaign"]
counts = [sum(control_data["Website Clicks"]),
          sum(test_data["Website Clicks"])]
colors = ['gold','lightgreen']
fig = go.Figure(data=[go.Pie(labels=label, values=counts)])
fig.update_layout(title_text='Control Vs Test: Website Clicks')
fig.update_traces(hoverinfo='label+percent', textinfo='value',
                  textfont_size=30,
                  marker=dict(colors=colors,
                              line=dict(color='black', width=3)))
fig.show()
```

```
Number of website clicks from both campaigns
```



In [14]:
```
print("Amount of content viewed after reaching the website from both campaigns")
label = ["Content Viewed from Control Campaign",
         "Content Viewed from Test Campaign"]
counts = [sum(control_data["Content Viewed"]),
          sum(test_data["Content Viewed"])]
colors = ['gold','lightgreen']
fig = go.Figure(data=[go.Pie(labels=label, values=counts)])
fig.update_layout(title_text='Control Vs Test: Content Viewed')
fig.update_traces(hoverinfo='label+percent', textinfo='value',
                  textfont_size=30,
                  marker=dict(colors=colors,
                              line=dict(color='black', width=3)))
fig.show()
```

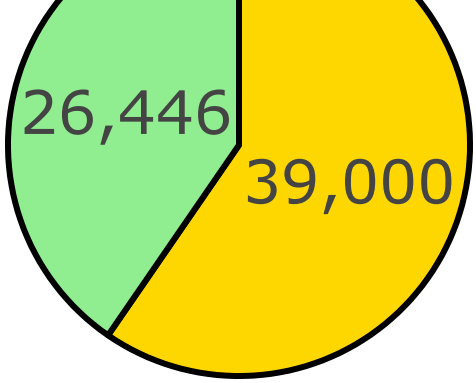
```
Amount of content viewed after reaching the website from both campaigns
```



The audience of the control campaign viewed more content than the test campaign. Although there is not much difference, as the website clicks of the control campaign were low, its engagement on the website is higher than the test campaign.

In [15]:
```
print("Number of products added to the cart from both campaigns")
label = ["Products Added to Cart from Control Campaign",
         "Products Added to Cart from Test Campaign"]
counts = [sum(control_data["Added to Cart"]),
          sum(test_data["Added to Cart"])]
colors = ['gold','lightgreen']
fig = go.Figure(data=[go.Pie(labels=label, values=counts)])
fig.update_layout(title_text='Control Vs Test: Added to Cart')
fig.update_traces(hoverinfo='label+percent', textinfo='value',
                  textfont_size=30,
                  marker=dict(colors=colors,
                              line=dict(color='black', width=3)))
fig.show()
```

```
Number of products added to the cart from both campaigns
```



Despite low website clicks more products were added to the cart from the control campaign.

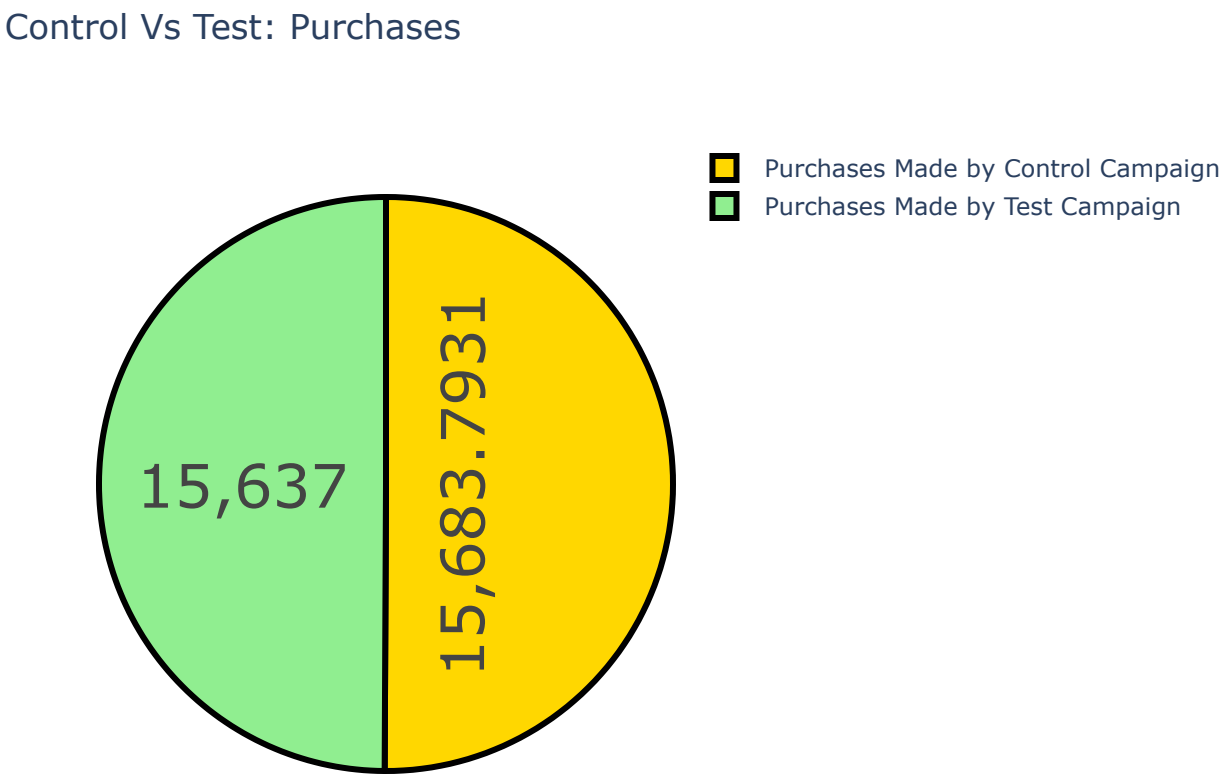
In [16]:
```
print("Amount spent on both campaigns")
label = ["Amount Spent in Control Campaign",
         "Amount Spent in Test Campaign"]
counts = [sum(control_data["Amount Spent"]),
          sum(test_data["Amount Spent"])]
colors = ['gold','lightgreen']
fig = go.Figure(data=[go.Pie(labels=label, values=counts)])
fig.update_layout(title_text='Control Vs Test: Amount Spent')
fig.update_traces(hoverinfo='label+percent', textinfo='value',
                  textfont_size=30,
                  marker=dict(colors=colors,
                              line=dict(color='black', width=3)))
fig.show()
```

```
Amount spent on both campaigns
```

The amount spent on the test campaign is higher than the control campaign. But as we can see that the control campaign resulted in more content views and more products in the cart, the control campaign is more efficient than the test campaign.

In [17]:
```
print("purchases made by both campaigns")
label = ["Purchases Made by Control Campaign",
         "Purchases Made by Test Campaign"]
counts = [sum(control_data["Purchases"]),
          sum(test_data["Purchases"])]
colors = ['gold','lightgreen']
fig = go.Figure(data=[go.Pie(labels=label, values=counts)])
fig.update_layout(title_text='Control Vs Test: Purchases')
fig.update_traces(hoverinfo='label+percent', textinfo='value',
                  textfont_size=30,
                  marker=dict(colors=colors,
                              line=dict(color='black', width=3)))
fig.show()
```

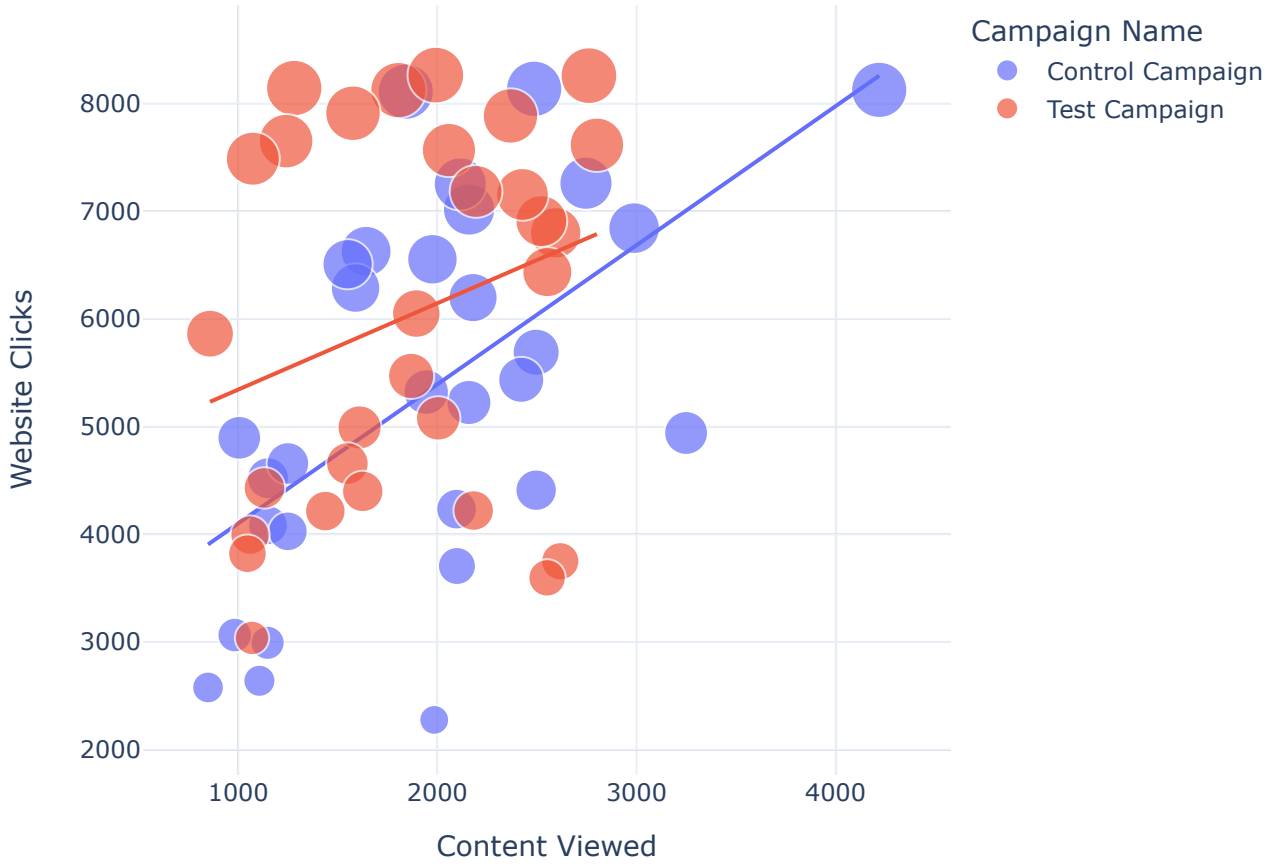
```
purchases made by both campaigns
```



There's only a difference of around 1% in the purchases made from both ad campaigns. As the Control campaign resulted in more sales in less amount spent on marketing, the control campaign wins here!

In [18]:
```
print("Relationship between the number of website clicks and content viewed from both ca
figure = px.scatter(data_frame = ab_data,
                    x="Content Viewed",
                    y="Website Clicks",
                    size="Website Clicks",
                    color= "Campaign Name",
                    trendline="ols")
figure.show()
```

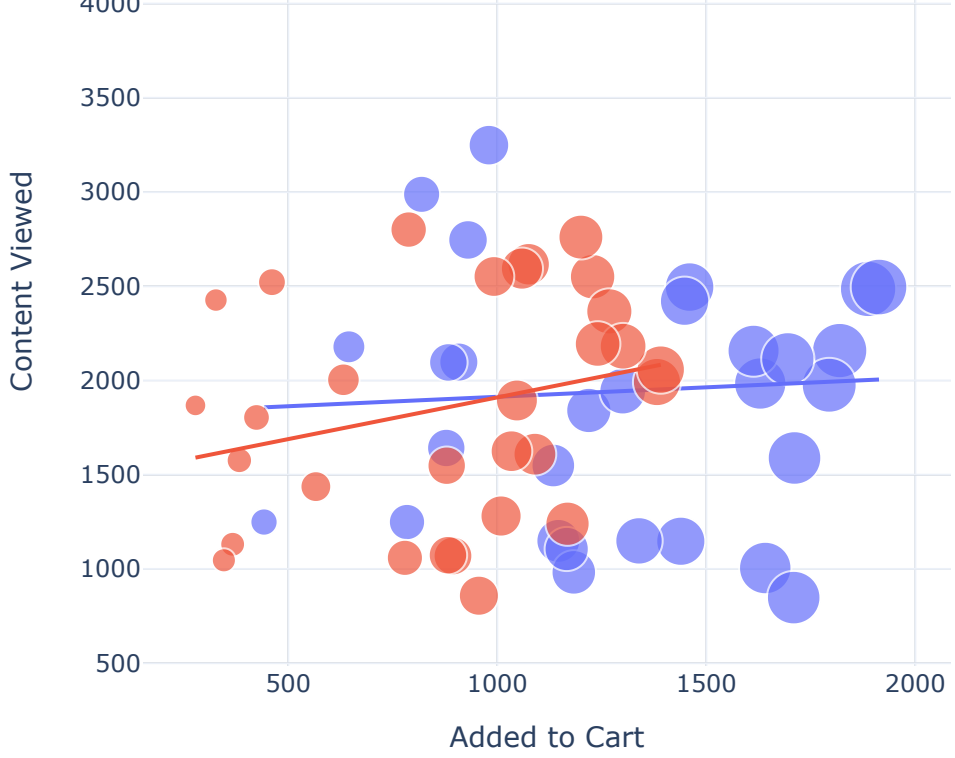
```
Relationship between the number of website clicks and content viewed from both campaigns
```



The website clicks are higher in the test campaign, but the engagement from website clicks is higher in the control campaign. So the control campaign wins!

In [19]:
```
print("Amount of content viewed and the number of products added to the cart from both c
figure = px.scatter(data_frame = ab_data,
                    x="Added to Cart",
                    y="Content Viewed",
                    size="Added to Cart",
                    color= "Campaign Name",
                    trendline="ols")
figure.show()
```

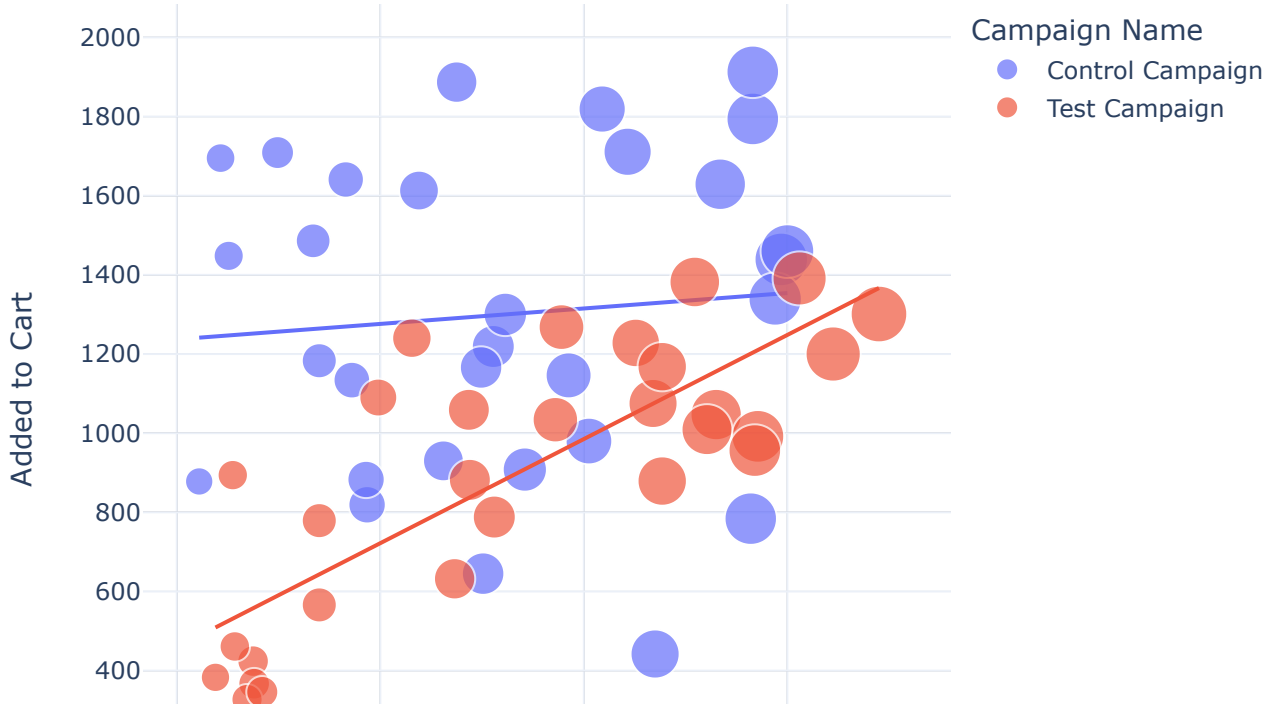
```
Amount of content viewed and the number of products added to the cart from both campaign
s
```



Control campaign have upper hand!

In [20]:
```
print("Relationship between the number of products added to the cart and the number of s
figure = px.scatter(data_frame = ab_data,
                    x="Purchases",
                    y="Added to Cart",
                    size="Purchases",
                    color= "Campaign Name",
                    trendline="ols")
figure.show()
```

```
Relationship between the number of products added to the cart and the number of sales fr
om both campaigns
```



Although the control campaign resulted in more sales and more products in the cart, the conversation rate of the test campaign is higher.

Conclusion

From the above A/B tests, we found that the control campaign resulted in more sales and engagement from the visitors. More products were viewed from the control campaign, resulting in more products in the cart and more sales. But the conversation rate of products in the cart is higher in the test campaign. The test campaign resulted in more sales according to the products viewed and added to the cart. And the control campaign results in more sales overall. So, the Test campaign can be used to market a specific product to a specific audience, and the Control campaign can be used to market multiple products to a wider audience.