GloBox

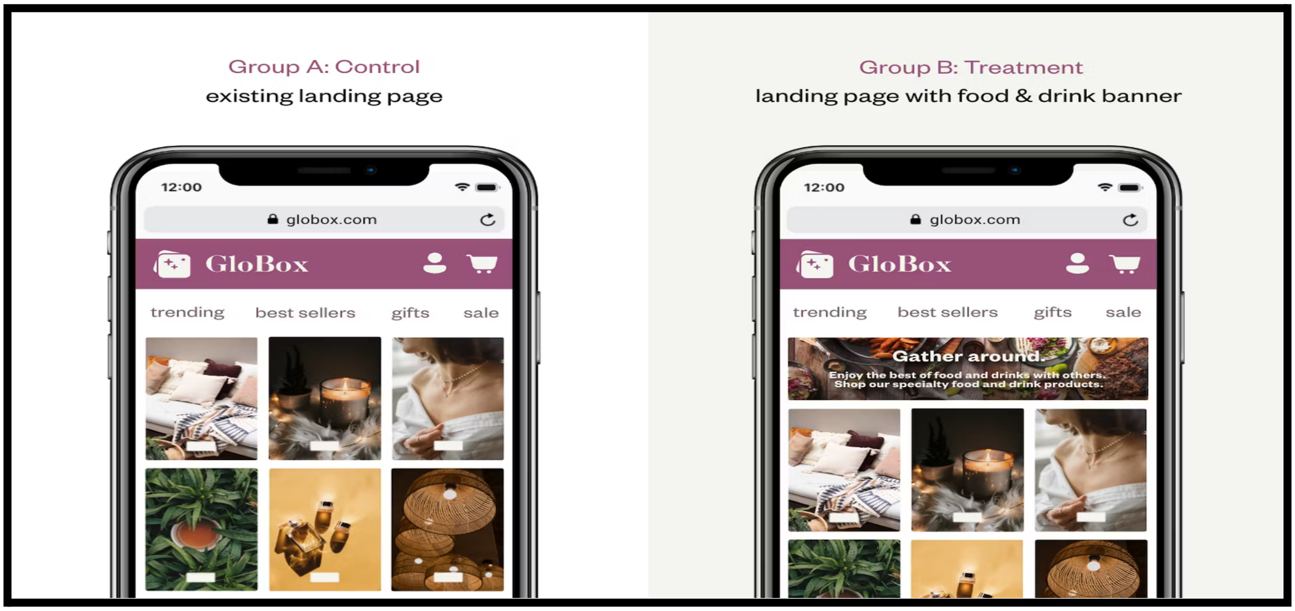
An e-commerce company

A/B Testing Analysis of new webpage

Company Overview

GloBox is an online marketplace that specializes in sourcing unique and high-quality products from around the world.GloBox is primarily known amongst its customer base for boutique fashion items and high-end decor products. However, their food and drink offerings have grown tremendously in the last few months, and the company wants to bring awareness to this product category to increase revenue.

The Growth team decides to run an A/B test that highlights key products in the food and drink category as a banner at the top of the website. The control group does not see the banner, and the test group sees it as shown below:


Group A: Control
existing landing page
Group B: Treatment
landing page with food & drink banner
12:00
globox.com
GloBox
trending
best sellers
gifts
sale
Gather around.
Enjoy the best of food and drinks with others.
Shop our specialty food and drink products.

The setup of the A/B test is as follows:

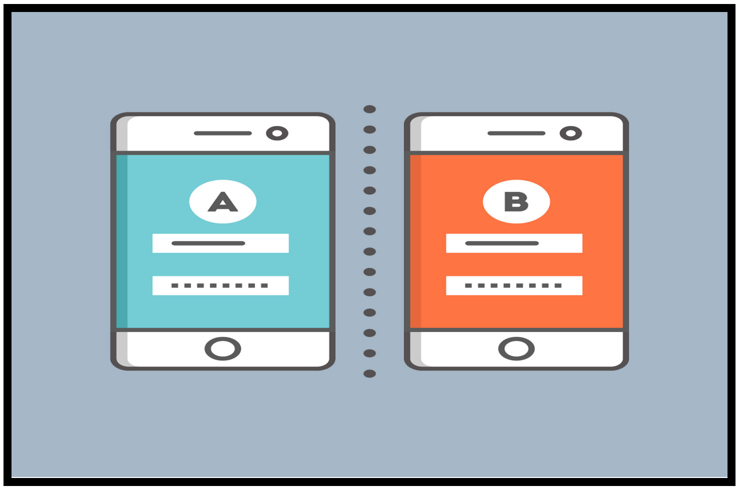
1. The experiment is only being run on the mobile website.
2. A user visits the GloBox main page and is randomly assigned to either the control or test group. This is the join date for the user.
3. The page loads the banner if the user is assigned to the test group, and does not load the banner if the user is assigned to the control group.
4. The user subsequently may or may not purchase products from the website. It could be on the same day they join the experiment, or days later. If they do make one or more purchases, this is considered a "conversion".

Task

To analyze the results of the A/B test and provide a recommendation to our stakeholders about whether GloBox should launch the experience to all users.

Summary

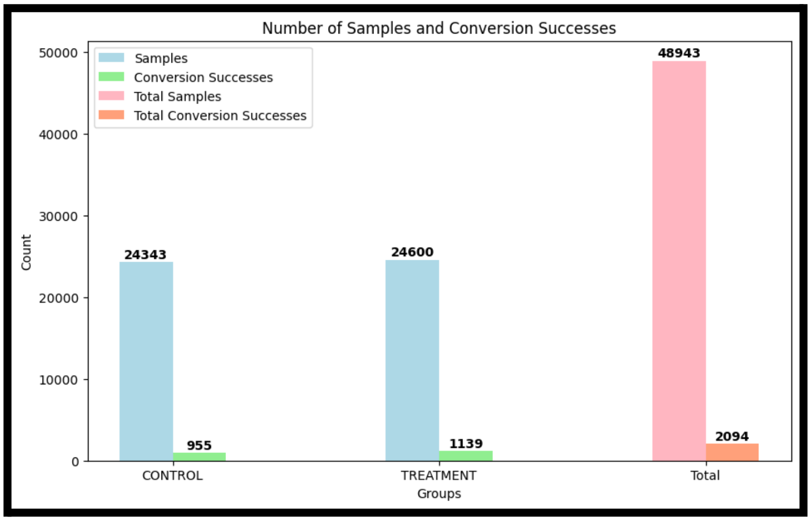
I recommend that we do launch the new homepage because we did observe strong evidence that there was an increase in conversion rate during the stipulated period when the test was run. The new homepage with foods and drinks offerings would substantially increase the revenue.



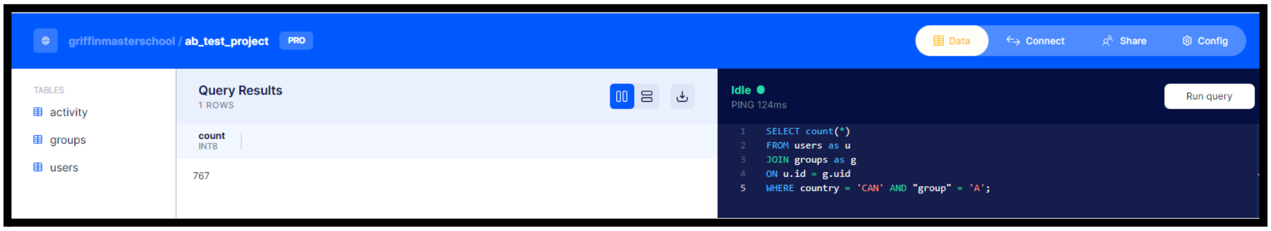
Analysis:

- ★ Total no of sample users in each group and conversion successes were:

To demonstrate the visual understanding of the above conclusion we used python to get the graph plotted with the following code:



- ★ There were **767** Users in the control group in Canada.



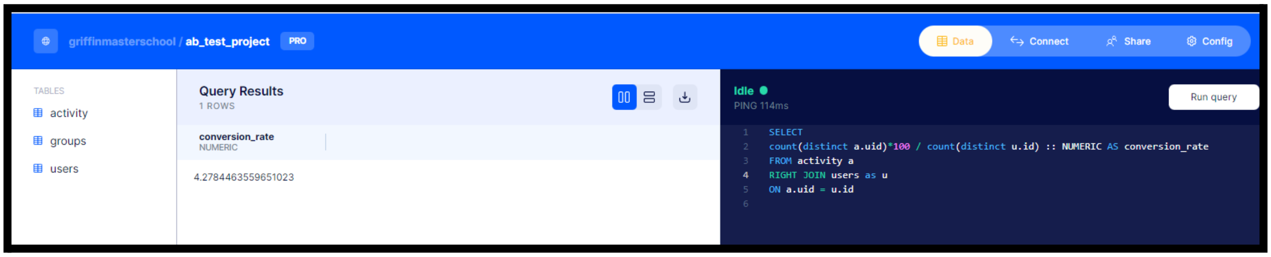
Query Results
1 ROWS

count INT8
767

```
SELECT count(*)
FROM users as u
JOIN groups as g
ON u.id = g.uid
WHERE country = 'CAN' AND "group" = 'A';
```

The

- ★ Conversion rate for all users were **4.28%**

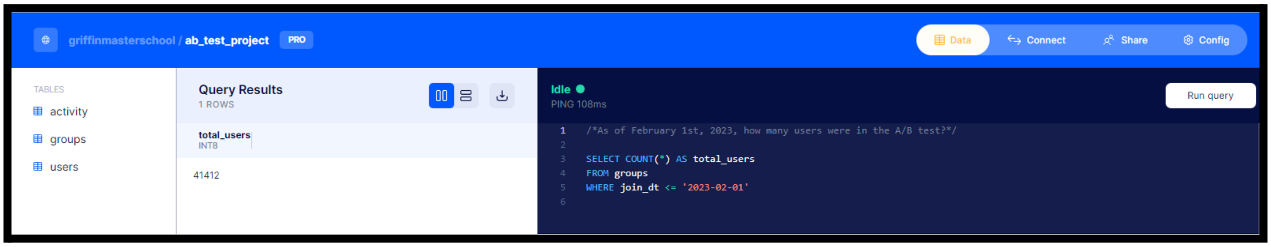


Query Results
1 ROWS

conversion_rate NUMERIC
4.2784463559651023

```
SELECT
count(distinct a.uid)*100 / count(distinct u.id) :: NUMERIC AS conversion_rate
FROM activity a
RIGHT JOIN users as u
ON a.uid = u.id
```

★ There were total **41412** users as of February 1st 2023 in the A/B test

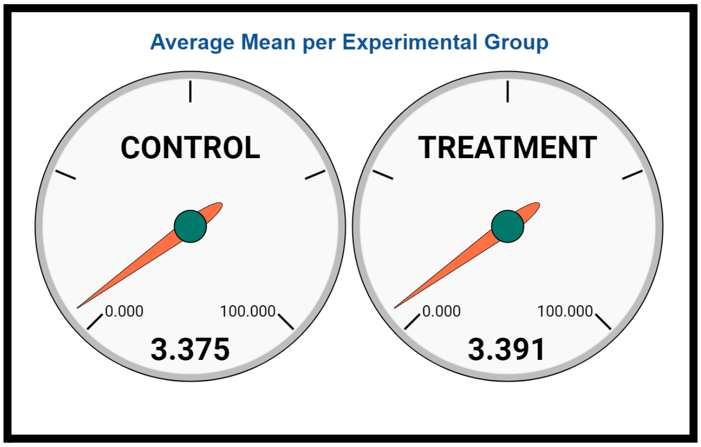


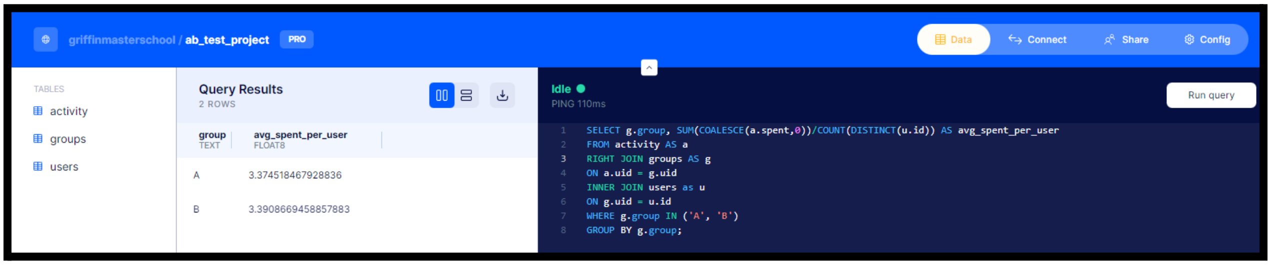
total_users INT8
41412

```sql
/*As of February 1st, 2023, how many users were in the A/B test?*/

SELECT COUNT(*) AS total_users
FROM groups
WHERE join_dt <= '2023-02-01'
```

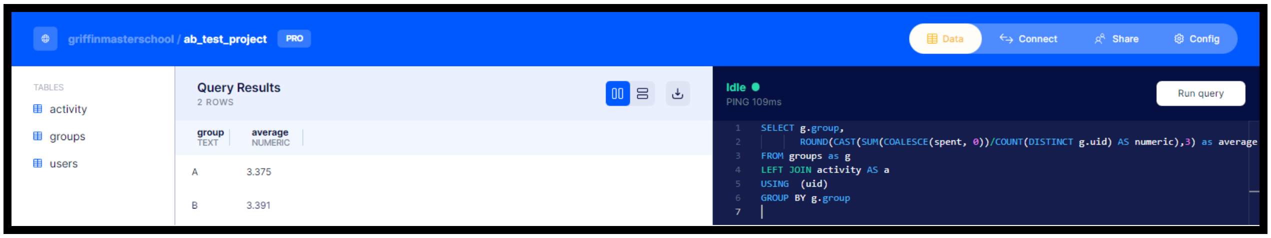
★ The average amount spent per user for the control and treatment groups were:





group TEXT	avg_spent_per_user FLOAT8
A	3.374518467928836
B	3.3908669458857883

```sql
SELECT g.group, SUM(COALESCE(a.spent,0))/COUNT(DISTINCT(u.id)) AS avg_spent_per_user
FROM activity AS a
RIGHT JOIN groups AS g
ON a.uid = g.uid
INNER JOIN users as u
ON g.uid = u.id
WHERE g.group IN ('A', 'B')
GROUP BY g.group;
```

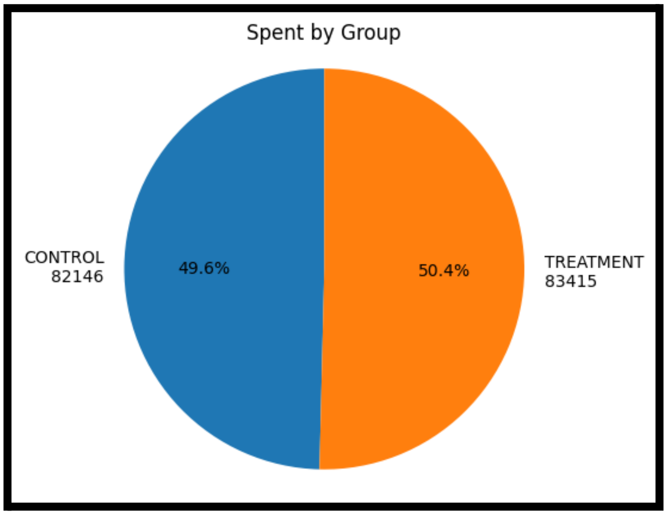


group TEXT	average NUMERIC
A	3.375
B	3.391

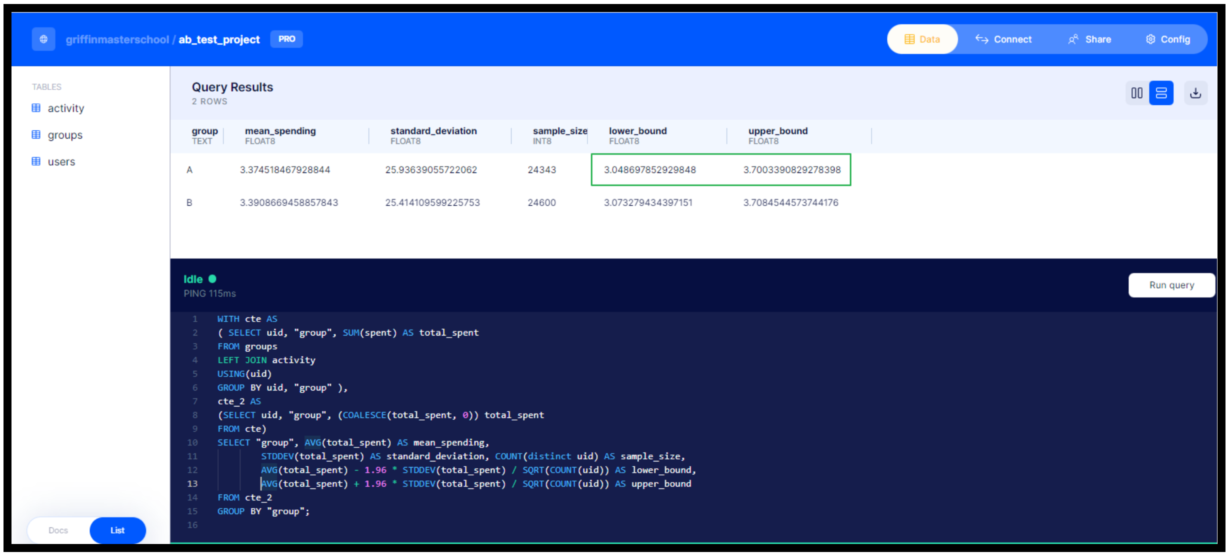
```sql
SELECT g.group,
        ROUND(CAST(SUM(COALESCE(spent, 0))/COUNT(DISTINCT g.uid) AS numeric),3) as average
FROM groups as g
LEFT JOIN activity AS a
USING  (uid)
GROUP BY g.group
```

- ★ The total spent on each group and percentage share:

To demonstrate the visual understanding of the above conclusion we used python to get the graph plotted with the following code:



- ★ The 95% confidence interval for the average amount spent per user in the control (used the t distribution)



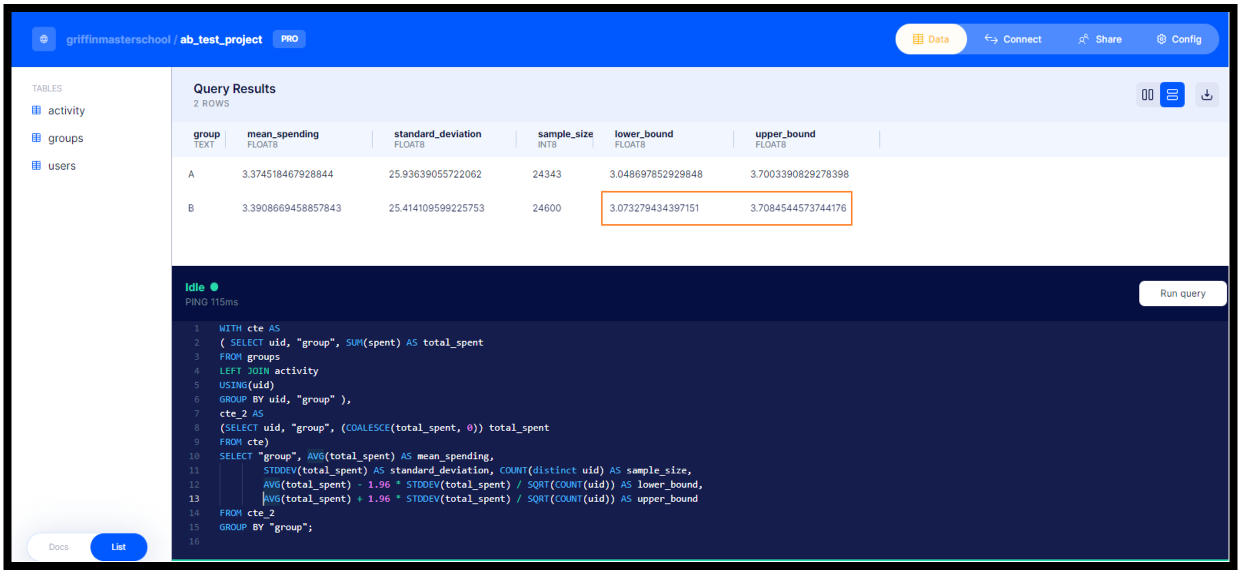
Query Results
2 ROWS

group TEXT	mean_spending FLOAT8	standard_deviation FLOAT8	sample_size INT8	lower_bound FLOAT8	upper_bound FLOAT8
A	3.374518467928844	25.93639055722062	24343	3.048697852929848	3.7003390829278398
B	3.3908669458857843	25.414109599225753	24600	3.073279434397151	3.7084544573744176

Idle ●
PING 115ms

```
WITH cte AS
( SELECT uid, "group", SUM(spent) AS total_spent
FROM groups
LEFT JOIN activity
USING(uid)
GROUP BY uid, "group" ),
cte_2 AS
(SELECT uid, "group", (COALESCE(total_spent, 0)) total_spent
FROM cte)
SELECT "group", AVG(total_spent) AS mean_spending,
        STDDEV(total_spent) AS standard_deviation, COUNT(distinct uid) AS sample_size,
        AVG(total_spent) - 1.96 * STDDEV(total_spent) / SQRT(COUNT(uid)) AS lower_bound,
        AVG(total_spent) + 1.96 * STDDEV(total_spent) / SQRT(COUNT(uid)) AS upper_bound
FROM cte_2
GROUP BY "group";
```

- ★ The 95% confidence interval for the average amount spent per user in the treatment. (Used the t distribution)



Query Results
2 ROWS

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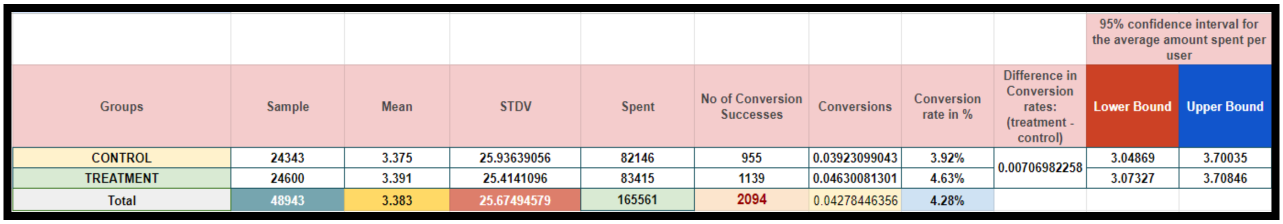
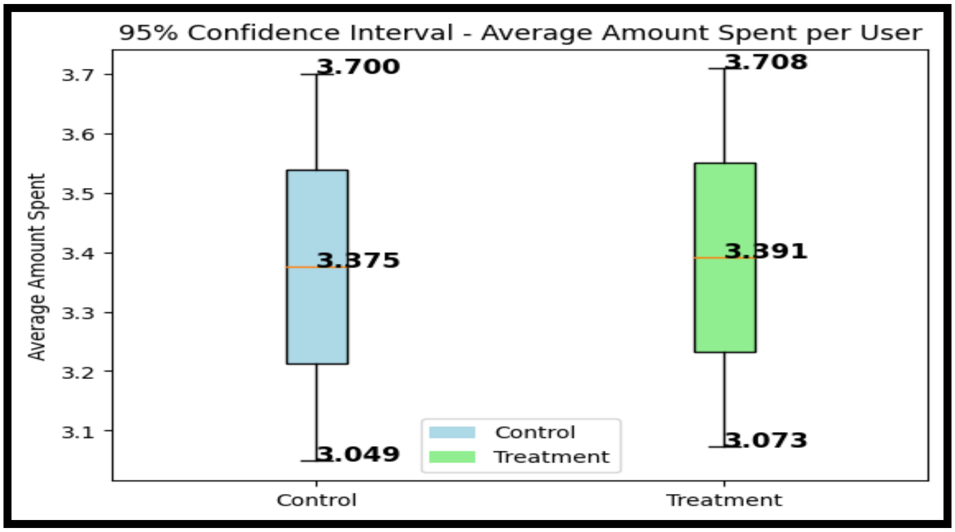
USING(uid)
GROUP BY uid, "group" ),
cte_2 AS
(SELECT uid, "group", (COALESCE(total_spent, 0)) total_spent
FROM cte)
SELECT "group", AVG(total_spent) AS mean_spending,
        STDDEV(total_spent) AS standard_deviation, COUNT(distinct uid) AS sample_size,
        AVG(total_spent) - 1.96 * STDDEV(total_spent) / SQRT(COUNT(uid)) AS lower_bound,
        AVG(total_spent) + 1.96 * STDDEV(total_spent) / SQRT(COUNT(uid)) AS upper_bound
FROM cte_2
GROUP BY "group";
```

To demonstrate the visual understanding of the above conclusion we used python to get the graph plotted with the following code:

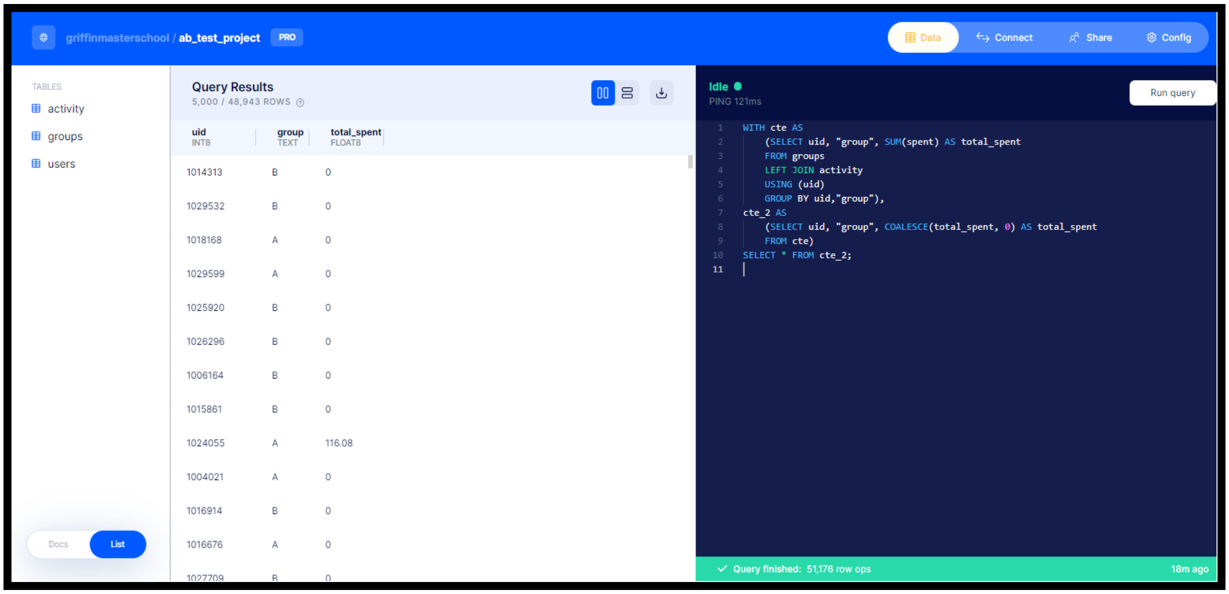


									95% confidence interval for the average amount spent per user	
Groups	Sample	Mean	STDV	Spent	No of Conversion Successes	Conversions	Conversion rate in %	Difference in Conversion rates: (treatment - control)	Lower Bound	Upper Bound
CONTROL	24343	3.375	25.93639056	82146	955	0.03923099043	3.92%	0.00706982258	3.04869	3.70035
TREATMENT	24600	3.391	25.4141096	83415	1139	0.04630081301	4.63%		3.07327	3.70846
Total	48943	3.383	25.67494579	165561	2094	0.04278446356	4.28%			



- ★ To Conduct a hypothesis test to see whether there is a difference in the average amount spent per user between the two groups. (Used the t distribution and a 5% significance level. Assuming unequal variance.)

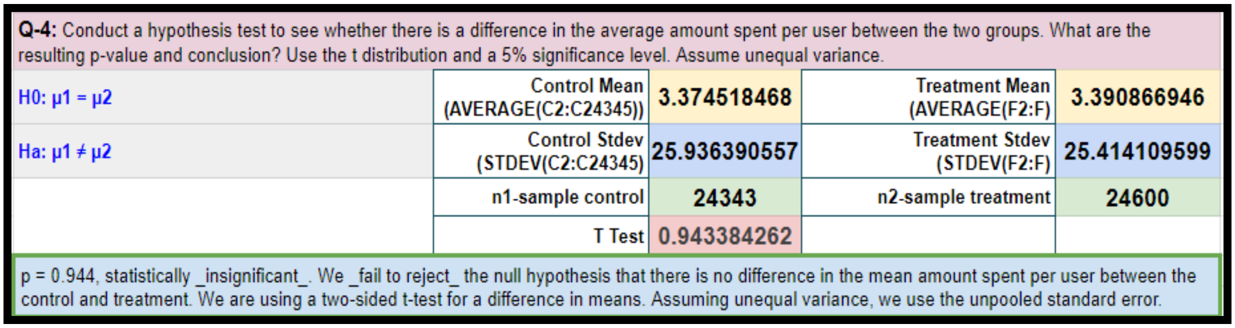
We used this code to download the required columns as csv file to further process the query in google sheets.



uid INT8	group TEXT	total_spent FLOAT8
1014313	B	0
1029532	B	0
1018168	A	0
1029599	A	0
1025920	B	0
1026296	B	0
1006164	B	0
1015861	B	0
1024055	A	116.08
1004021	A	0
1016914	B	0
1016676	A	0
1027709	B	0

```sql
WITH cte AS
    (SELECT uid, "group", SUM(spent) AS total_spent
    FROM groups
    LEFT JOIN activity
    USING (uid)
    GROUP BY uid,"group"),
cte_2 AS
    (SELECT uid, "group", COALESCE(total_spent, 0) AS total_spent
    FROM cte)
SELECT * FROM cte_2;
```

The resulting p-value and conclusion derived from the sheet calculations:

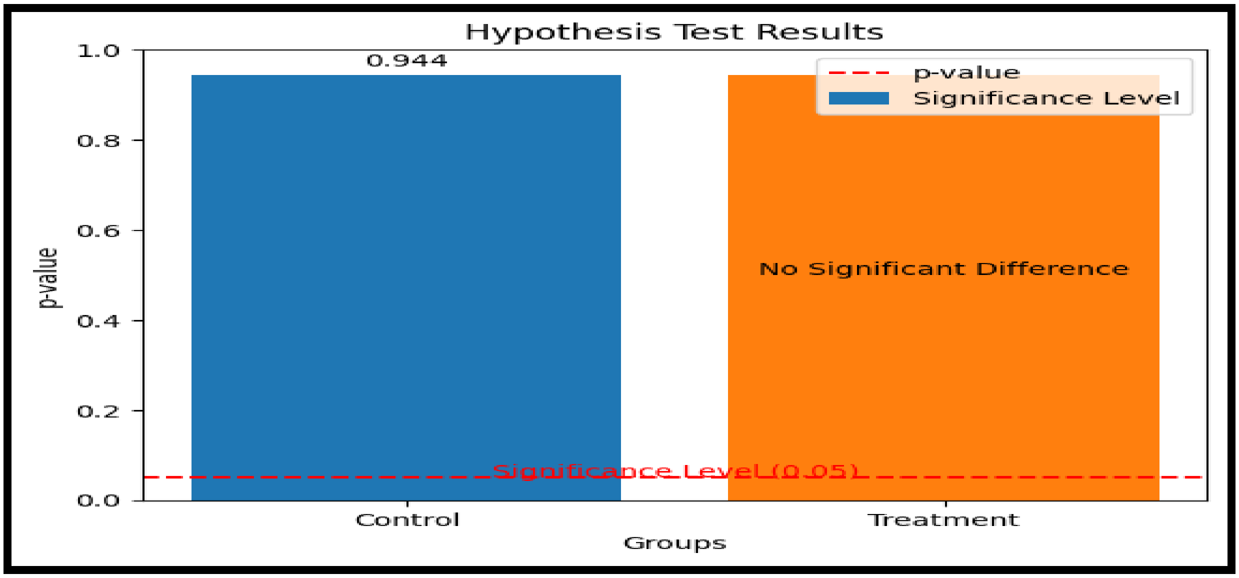


Q-4: Conduct a hypothesis test to see whether there is a difference in the average amount spent per user between the two groups. What are the resulting p-value and conclusion? Use the t distribution and a 5% significance level. Assume unequal variance.

H0: μ1 = μ2	Control Mean (AVERAGE(C2:C24345))	3.374518468	Treatment Mean (AVERAGE(F2:F))	3.390866946
Ha: μ1 ≠ μ2	Control Stdev (STDEV(C2:C24345)	25.936390557	Treatment Stdev (STDEV(F2:F))	25.414109599
	n1-sample control	24343	n2-sample treatment	24600
	T Test	0.943384262		

p = 0.944, statistically _insignificant_. We _fail to reject_ the null hypothesis that there is no difference in the mean amount spent per user between the control and treatment. We are using a two-sided t-test for a difference in means. Assuming unequal variance, we use the unpooled standard error.

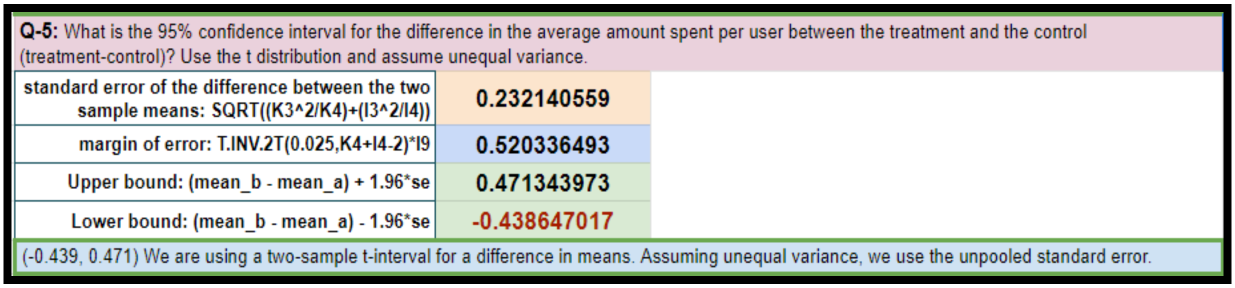
To demonstrate the visual understanding of the above conclusion we used python to get the graph plotted with the following code:



Based on the given options and assuming a 5% significance level, p = 0.944, statistically insignificant. We reject the null hypothesis that there is no difference in the mean amount spent per user between the control and treatment.

Since the p-value calculated from your t-test is 0.9434 and it is greater than the significance level of 0.05, we cannot reject the null hypothesis that there is no difference in the mean amount spent per user between the two groups. However, if the significance level were higher or if the p-value were lower, we would have sufficient evidence to reject the null hypothesis and conclude that there is a statistically significant difference in the mean amount spent per user between the two groups.

- ★ The 95% confidence interval for the difference in the average amount spent per user between the treatment and the control (treatment-control) using the t distribution and assumed unequal variance.



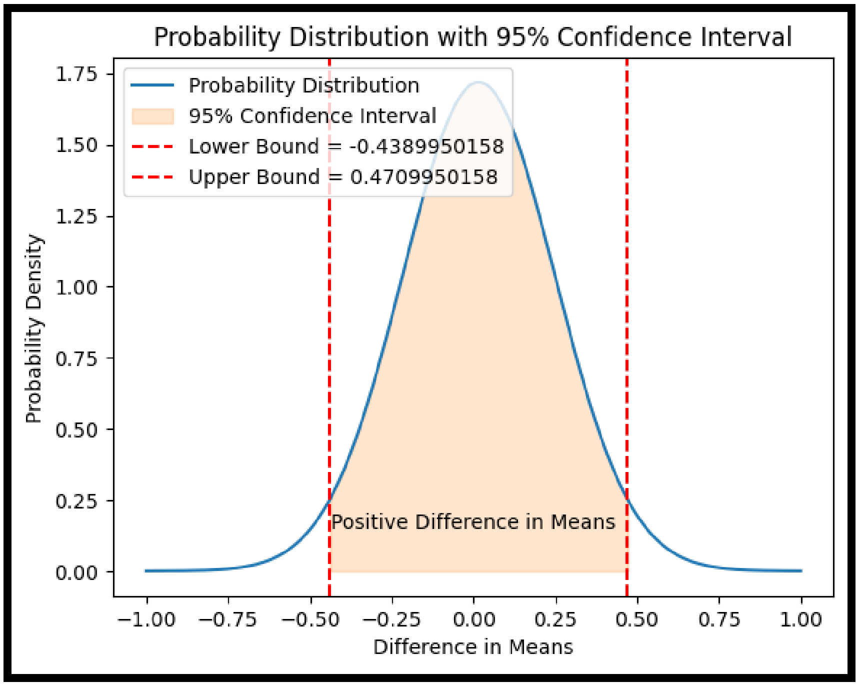
Q-5: What is the 95% confidence interval for the difference in the average amount spent per user between the treatment and the control (treatment-control)? Use the t distribution and assume unequal variance.

standard error of the difference between the two sample means: SQRT((K3^2/K4)+(I3^2/I4))	0.232140559
margin of error: T.INV.2T(0.025,K4+I4-2)*I9	0.520336493
Upper bound: (mean_b - mean_a) + 1.96*se	0.471343973
Lower bound: (mean_b - mean_a) - 1.96*se	-0.438647017

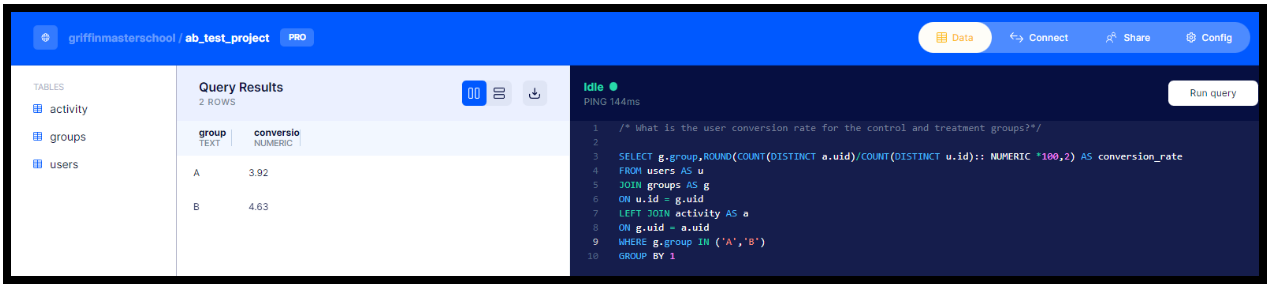
(-0.439, 0.471) We are using a two-sample t-interval for a difference in means. Assuming unequal variance, we use the unpooled standard error.

(-0.439, 0.471) are the confidence intervals where we are using a two-sample t-interval for a difference in means. Assuming unequal variance, we use the unpooled standard error.

To demonstrate the visual understanding of the above conclusion we used python to get the graph plotted with the following code:



- ★ The user conversion rate for the control and treatment groups

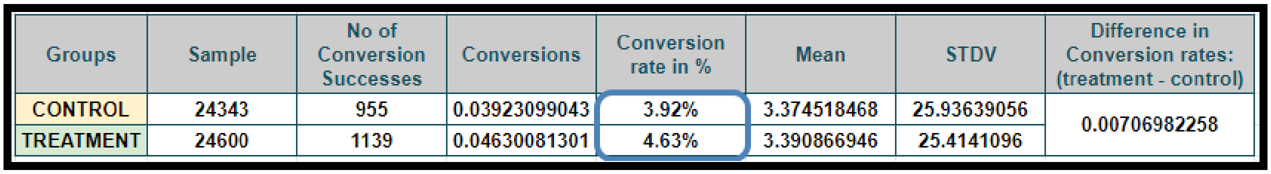


Query Results
2 ROWS

group TEXT	conversio NUMERIC
A	3.92
B	4.63

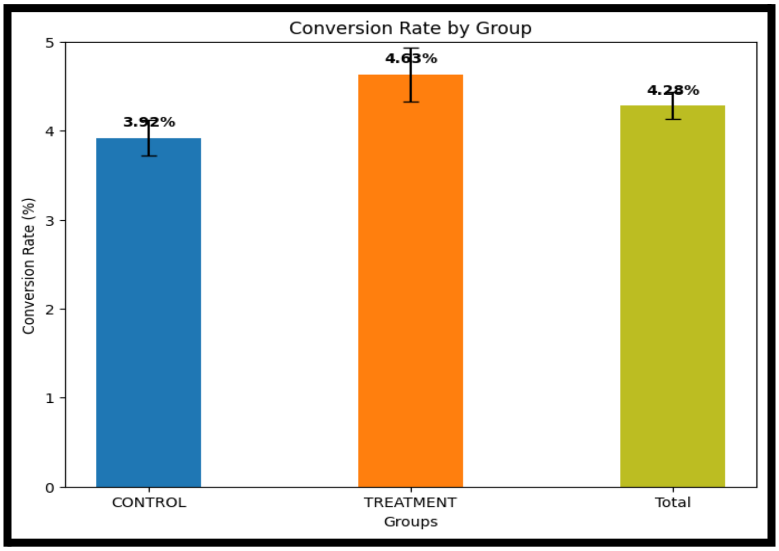
```
/* What is the user conversion rate for the control and treatment groups?*/

SELECT g.group,ROUND(COUNT(DISTINCT a.uid)/COUNT(DISTINCT u.id):: NUMERIC *100,2) AS conversion_rate
FROM users AS u
JOIN groups AS g
ON u.id = g.uid
LEFT JOIN activity AS a
ON g.uid = a.uid
WHERE g.group IN ('A','B')
GROUP BY 1
```

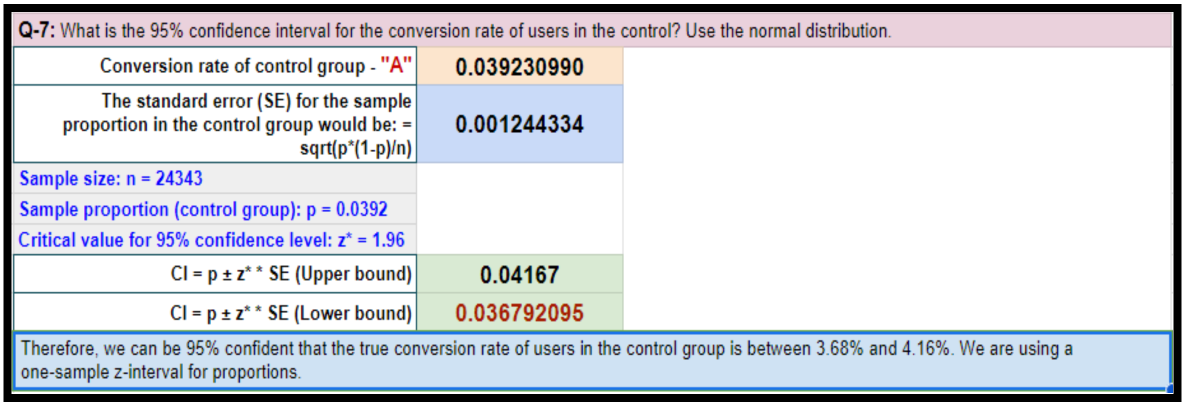


Groups	Sample	No of Conversion Successes	Conversions	Conversion rate in %	Mean	STDV	Difference in Conversion rates: (treatment - control)
CONTROL	24343	955	0.03923099043	3.92%	3.374518468	25.93639056	0.00706982258
TREATMENT	24600	1139	0.04630081301	4.63%	3.390866946	25.4141096	

To demonstrate the visual understanding of the above conclusion we used python to get the graph plotted with the following code:



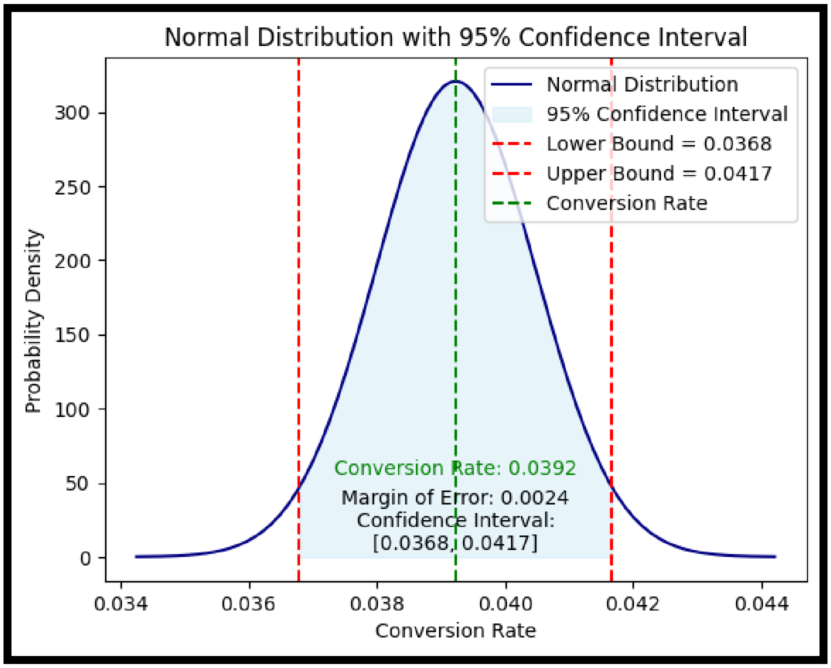
- ★ The 95% confidence interval for the conversion rate of users in the control using the normal distribution.



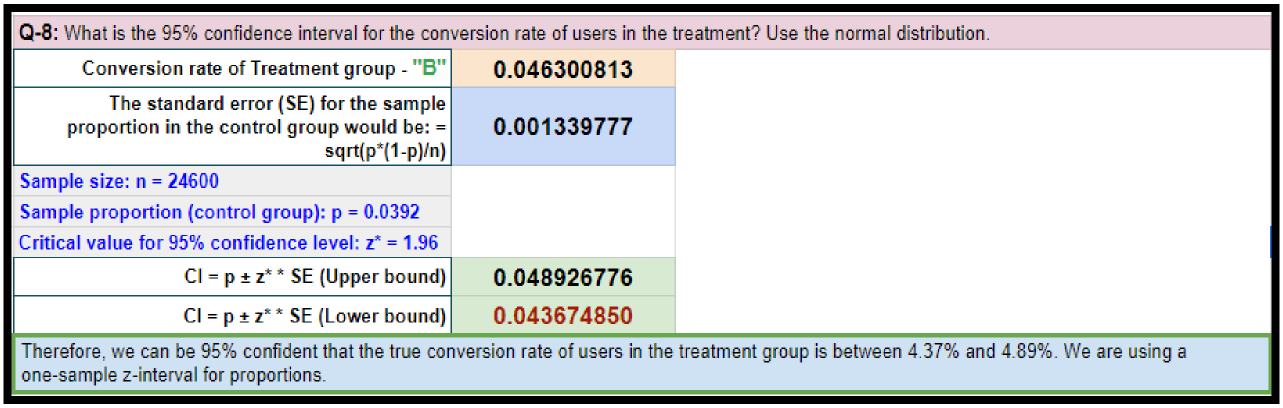
Q-7: What is the 95% confidence interval for the conversion rate of users in the control? Use the normal distribution.	
Conversion rate of control group - "A"	0.039230990
The standard error (SE) for the sample proportion in the control group would be: = sqrt(p*(1-p)/n)	0.001244334
Sample size: n = 24343	
Sample proportion (control group): p = 0.0392	
Critical value for 95% confidence level: z* = 1.96	
CI = p ± z* * SE (Upper bound)	0.04167
CI = p ± z* * SE (Lower bound)	0.036792095
Therefore, we can be 95% confident that the true conversion rate of users in the control group is between 3.68% and 4.16%. We are using a one-sample z-interval for proportions.	

Therefore, we can be 95% confident that the true conversion rate of users in the control group is between 3.68% and 4.17%. We are using a one-sample z-interval for proportions.

To demonstrate the visual understanding of the above conclusion we used python to get the graph plotted with the following code:



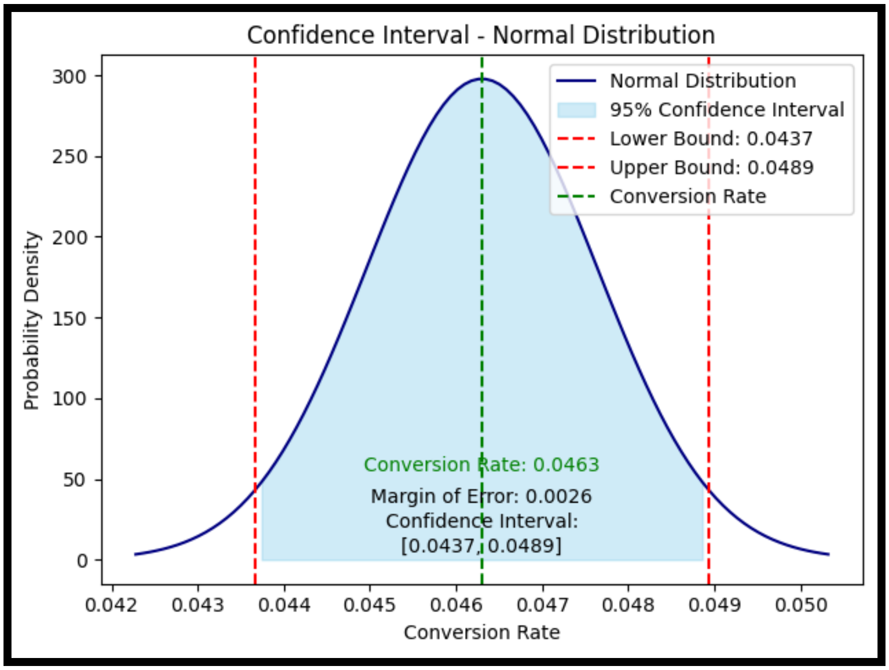
★ The 95% confidence interval for the conversion rate of users in the treatment using the normal distribution.



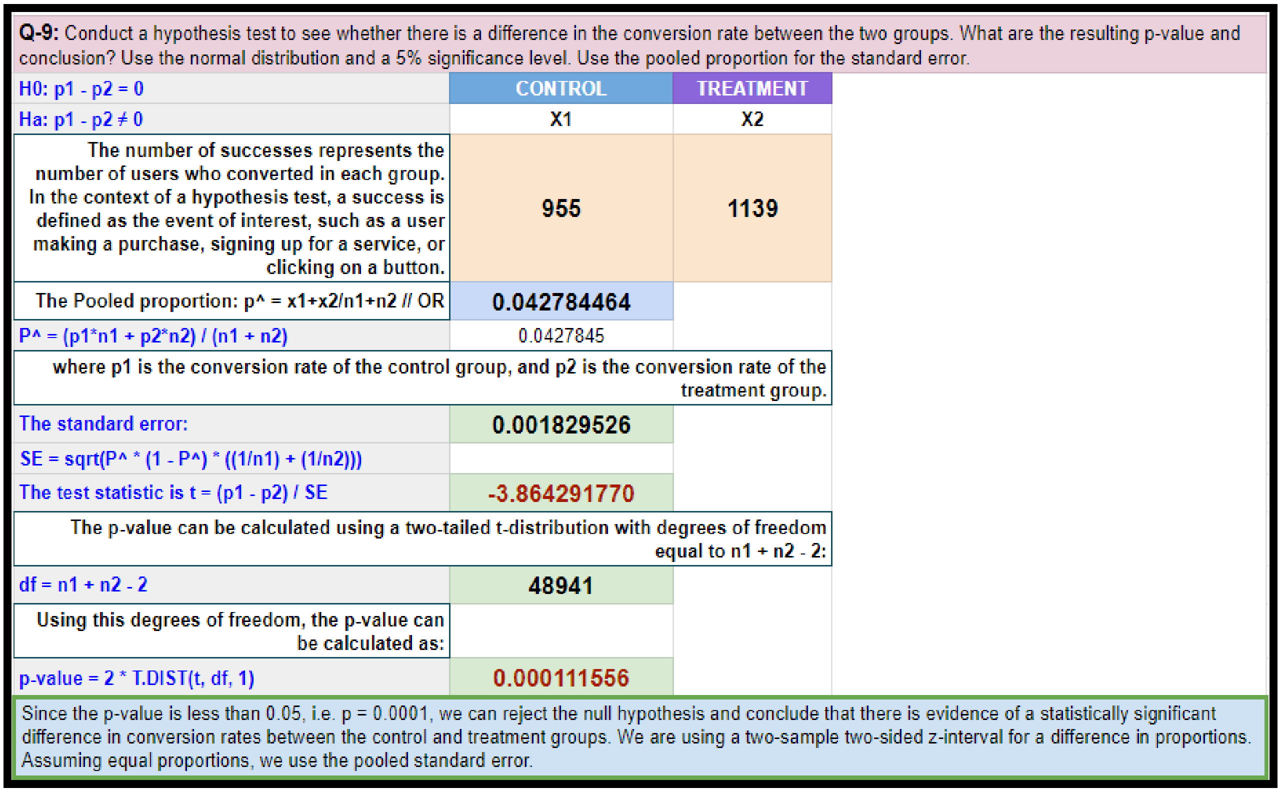
Q-8: What is the 95% confidence interval for the conversion rate of users in the treatment? Use the normal distribution.	
Conversion rate of Treatment group - "B"	0.046300813
The standard error (SE) for the sample proportion in the control group would be: = sqrt(p*(1-p)/n)	0.001339777
Sample size: n = 24600	
Sample proportion (control group): p = 0.0392	
Critical value for 95% confidence level: z* = 1.96	
CI = p ± z* * SE (Upper bound)	0.048926776
CI = p ± z* * SE (Lower bound)	0.043674850
Therefore, we can be 95% confident that the true conversion rate of users in the treatment group is between 4.37% and 4.89%. We are using a one-sample z-interval for proportions.	

Therefore, we can be 95% confident that the true conversion rate of users in the treatment group is between 4.37% and 4.89%. We are using a one-sample z-interval for proportions.

To demonstrate the visual understanding of the above conclusion we used python to get the graph plotted with the following code:


Confidence Interval - Normal Distribution
Normal Distribution
95% Confidence Interval
Lower Bound: 0.0437
Upper Bound: 0.0489
Conversion Rate
Conversion Rate: 0.0463
Margin of Error: 0.0026
Confidence Interval:
[0.0437, 0.0489]
Probability Density
300
250
200
150
100
50
0
0.042
0.043
0.044
0.045
0.046
0.047
0.048
0.049
0.050
Conversion Rate

★ To Conduct a hypothesis test to see whether there is a difference in the conversion rate between the two groups using the normal distribution and a 5% significance level. Taken into consideration the pooled proportion for the standard error.



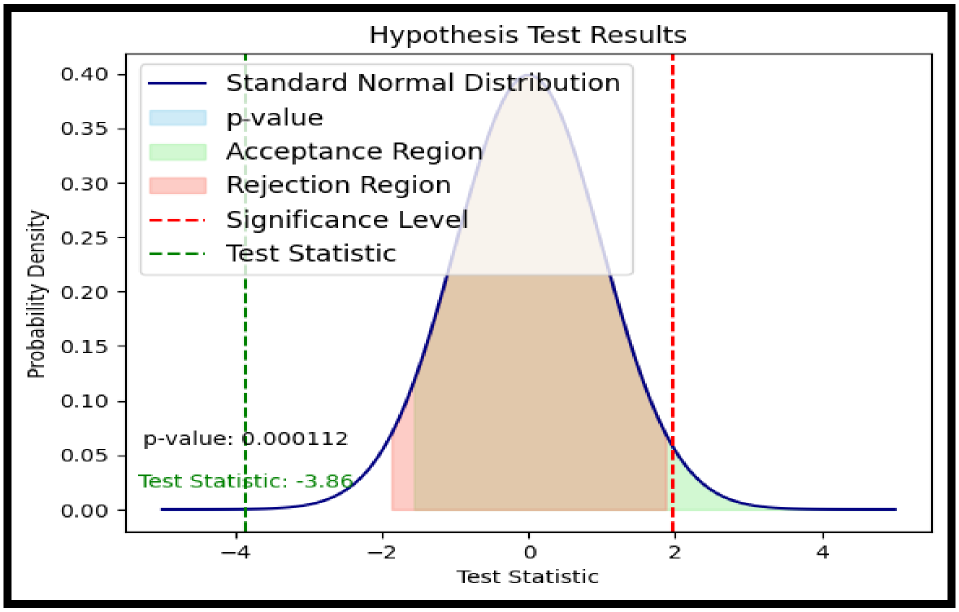
Q-9: Conduct a hypothesis test to see whether there is a difference in the conversion rate between the two groups. What are the resulting p-value and conclusion? Use the normal distribution and a 5% significance level. Use the pooled proportion for the standard error.

H0: p1 - p2 = 0	CONTROL	TREATMENT
Ha: p1 - p2 ≠ 0	X1	X2
The number of successes represents the number of users who converted in each group. In the context of a hypothesis test, a success is defined as the event of interest, such as a user making a purchase, signing up for a service, or clicking on a button.	955	1139
The Pooled proportion: p^ = x1+x2/n1+n2 // OR	0.042784464	
P^ = (p1*n1 + p2*n2) / (n1 + n2)	0.0427845	
where p1 is the conversion rate of the control group, and p2 is the conversion rate of the treatment group.		
The standard error:	0.001829526	
SE = sqrt(P^ * (1 - P^) * ((1/n1) + (1/n2)))		
The test statistic is t = (p1 - p2) / SE	-3.864291770	
The p-value can be calculated using a two-tailed t-distribution with degrees of freedom equal to n1 + n2 - 2:		
df = n1 + n2 - 2	48941	
Using this degrees of freedom, the p-value can be calculated as:		
p-value = 2 * T.DIST(t, df, 1)	0.000111556	

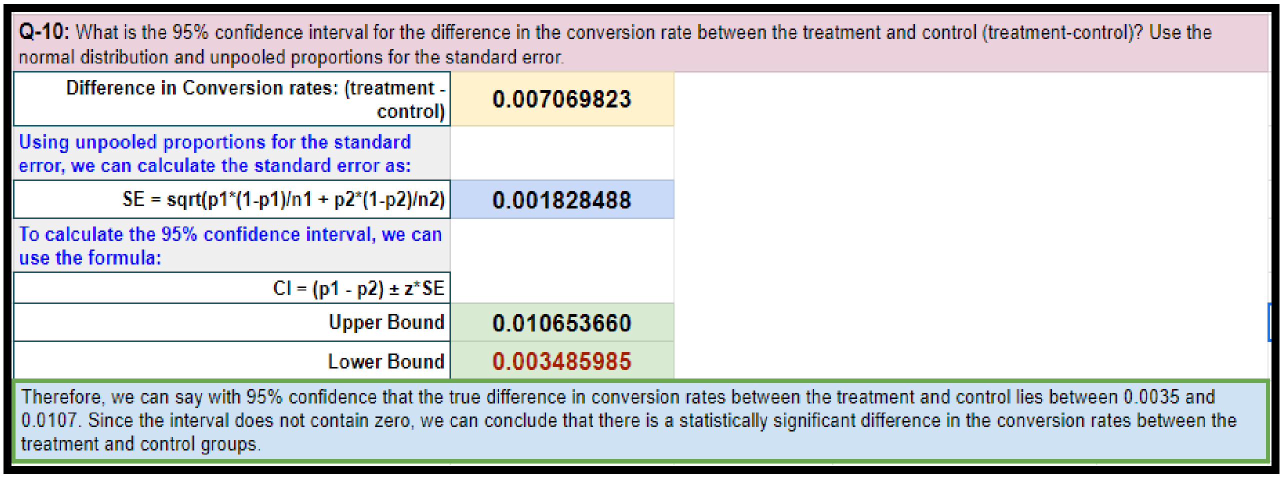
Since the p-value is less than 0.05, i.e. p = 0.0001, we can reject the null hypothesis and conclude that there is evidence of a statistically significant difference in conversion rates between the control and treatment groups. We are using a two-sample two-sided z-interval for a difference in proportions. Assuming equal proportions, we use the pooled standard error.

Since the p-value is less than 0.05, i.e. p = 0.0001, we can reject the null hypothesis and conclude that there is evidence of a statistically significant difference in conversion rates between the control and treatment groups. We are using a two-sample two-sided z-interval for a difference in proportions. Assuming equal proportions, we use the pooled standard error.

To demonstrate the visual understanding of the above conclusion we used python to get the graph plotted with the following code:



★ The 95% confidence interval for the difference in the conversion rate between the treatment and control (treatment-control) using the normal distribution and unpooled proportions for the standard error.



Q-10: What is the 95% confidence interval for the difference in the conversion rate between the treatment and control (treatment-control)? Use the normal distribution and unpooled proportions for the standard error.

Difference in Conversion rates: (treatment - control)	**0.007069823**
Using unpooled proportions for the standard error, we can calculate the standard error as:	
SE = sqrt(p1*(1-p1)/n1 + p2*(1-p2)/n2)	**0.001828488**
To calculate the 95% confidence interval, we can use the formula:	
CI = (p1 - p2) ± z*SE	
Upper Bound	**0.010653660**
Lower Bound	**0.003485985**

Therefore, we can say with 95% confidence that the true difference in conversion rates between the treatment and control lies between 0.0035 and 0.0107. Since the interval does not contain zero, we can conclude that there is a statistically significant difference in the conversion rates between the treatment and control groups.

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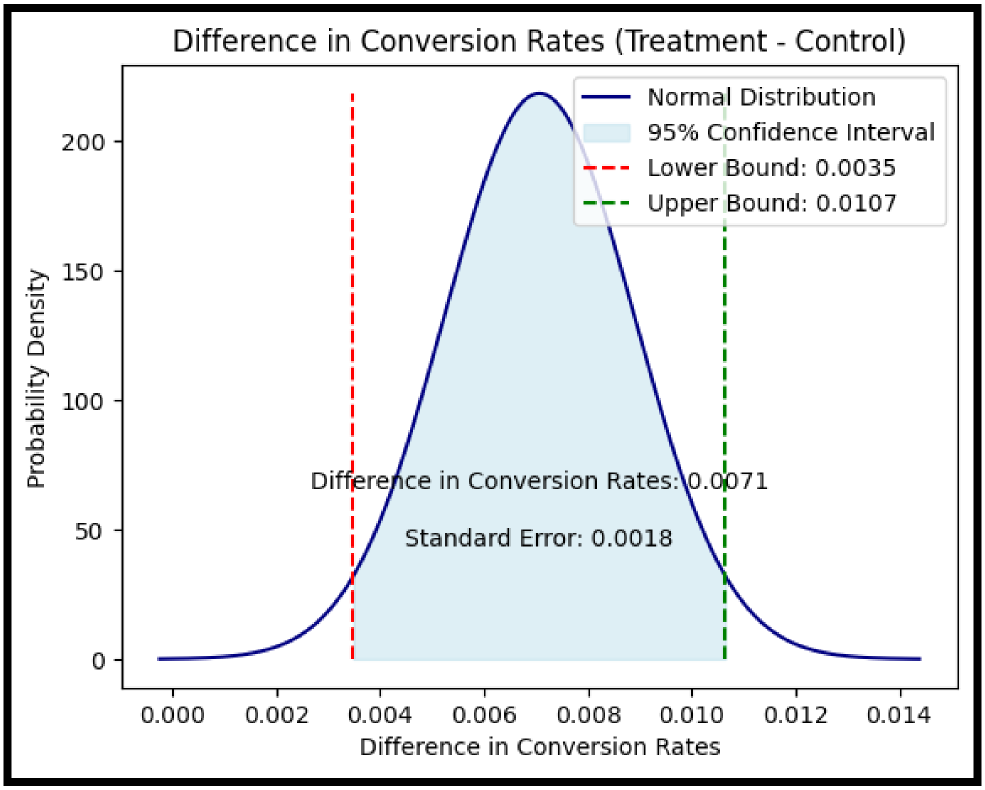
To demonstrate the visual understanding of the above conclusion we used python to get the graph plotted with the following code:



Recommendation

Based on the results above, it does make sense to launch the treatment because we did observe an increase in conversion rate per user. I recommend that we do launch it. So the significant surge on the Conversion rates do give confidence that our revenue would also increase significantly with the introduction of foods and drinks on the new homepage. On the other hand I also observed that the difference of p-value with the significance level is very small and understand if possibility of increasing the sample size is there than we can relaunch the test to get better results.

Appendices

- **Analysis in Python - Code file attached as zip folder.**
- **Analysis in SQL - Code file attached as zip folder.**
- **DA201 Mastery Projects- A/B Testing Analysis for an e-commerce company called GloBox.csv**
- **DA201 Mastery Projects- A/B Testing Presentation for an e-commerce company called GloBox**