Let’s say we have two themes, dark mode and light mode. A company wants to understand which theme looks the best on its website. We need a dataset of user interaction data on two themes or design templates.

```
import pandas as pd
import plotly.express as px
import plotly.graph_objects as go
from statsmodels.stats.proportion import proportions_ztest
from scipy import stats

data = pd.read_csv("website_ab_test.csv")
data.head()
```

	Theme	Click Through Rate	Conversion Rate	Bounce Rate	Scroll_Depth	Age	Location	Session_Durat
0	Light Theme	0.054920	0.282367	0.405085	72.489458	25	Chennai	1
1	Light Theme	0.113932	0.032973	0.732759	61.858568	19	Pune	
2	Dark Theme	0.323352	0.178763	0.296543	45.737376	47	Chennai	
3	Light Theme	0.485836	0.325225	0.245001	76.305298	58	Pune	
4	Light Theme	0.034783	0.196766	0.765100	48.927407	25	New Delhi	1

```
data.shape
```

```
(1000, 10)
```

```
#check if dataset has null values
data.isnull().sum()
```

```
Theme                0
Click Through Rate   0
Conversion Rate      0
Bounce Rate          0
Scroll_Depth         0
Age                  0
Location             0
Session_Duration     0
Purchases            0
Added_to_Cart        0
dtype: int64
```

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 10 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
```

```
 0   Theme               1000 non-null   object
 1   Click Through Rate  1000 non-null   float64
 2   Conversion Rate     1000 non-null   float64
 3   Bounce Rate         1000 non-null   float64
 4   Scroll_Depth        1000 non-null   float64
 5   Age                 1000 non-null   int64
 6   Location            1000 non-null   object
 7   Session_Duration    1000 non-null   int64
 8   Purchases           1000 non-null   object
 9   Added_to_Cart       1000 non-null   object
dtypes: float64(4), int64(2), object(4)
memory usage: 78.2+ KB
```

```
data['Theme'].value_counts()
```

```
Dark Theme     514
Light Theme    486
Name: Theme, dtype: int64
```

```
data.describe()
```

	Click Through Rate	Conversion Rate	Bounce Rate	Scroll_Depth	Age	Session_Durati
count	1000.000000	1000.000000	1000.000000	1000.000000	1000.000000	1000.000(
mean	0.256048	0.253312	0.505758	50.319494	41.528000	924.999(
std	0.139265	0.139092	0.172195	16.895269	14.114334	508.231
min	0.010767	0.010881	0.200720	20.011738	18.000000	38.000(
25%	0.140794	0.131564	0.353609	35.655167	29.000000	466.500(
50%	0.253715	0.252823	0.514049	51.130712	42.000000	931.000(
75%	0.370674	0.373040	0.648557	64.666258	54.000000	1375.250(
max	0.499989	0.498916	0.799658	79.997108	65.000000	1797.000(

Now before moving forward, here's the detail of all the columns you should know:

Theme: dark or light

Click Through Rate: The proportion of the users who click on links or buttons on the website

Conversion Rate: The percentage of users who signed up on the platform after visiting for the first time.

Bounce Rate: The percentage of users who leave the website without further interaction after visiting a single page.

Scroll Depth: The depth to which users scroll through the website pages.

Age: The age of the user.

Location: The location of the user.

Session Duration: The duration of the user's session on the website.

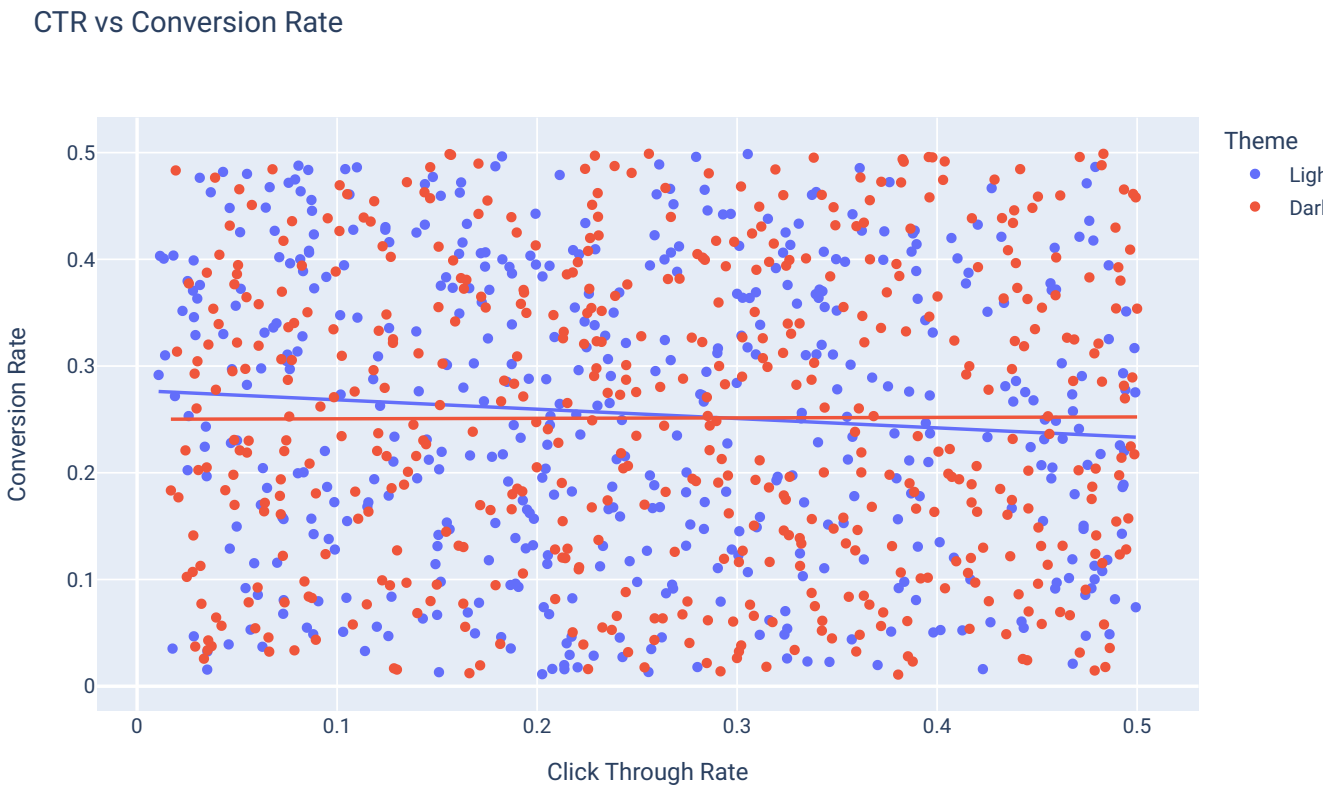
Purchases: Whether the user purchased the book (Yes/No).

Added_to_Cart: Whether the user added books to the cart (Yes/No).

So conversion rate in this data means the daily percentage of users who signed up on the website.

Let's have a look at the relationship between CTR and conversion rate of both themes:

```
#Scatter plot for Click Through Rate and Conversion Rate

fig = px.scatter(data, x='Click Through Rate',
                 y='Conversion Rate', color='Theme',
                 title='CTR vs Conversion Rate', trendline='ols')
fig.show()
```

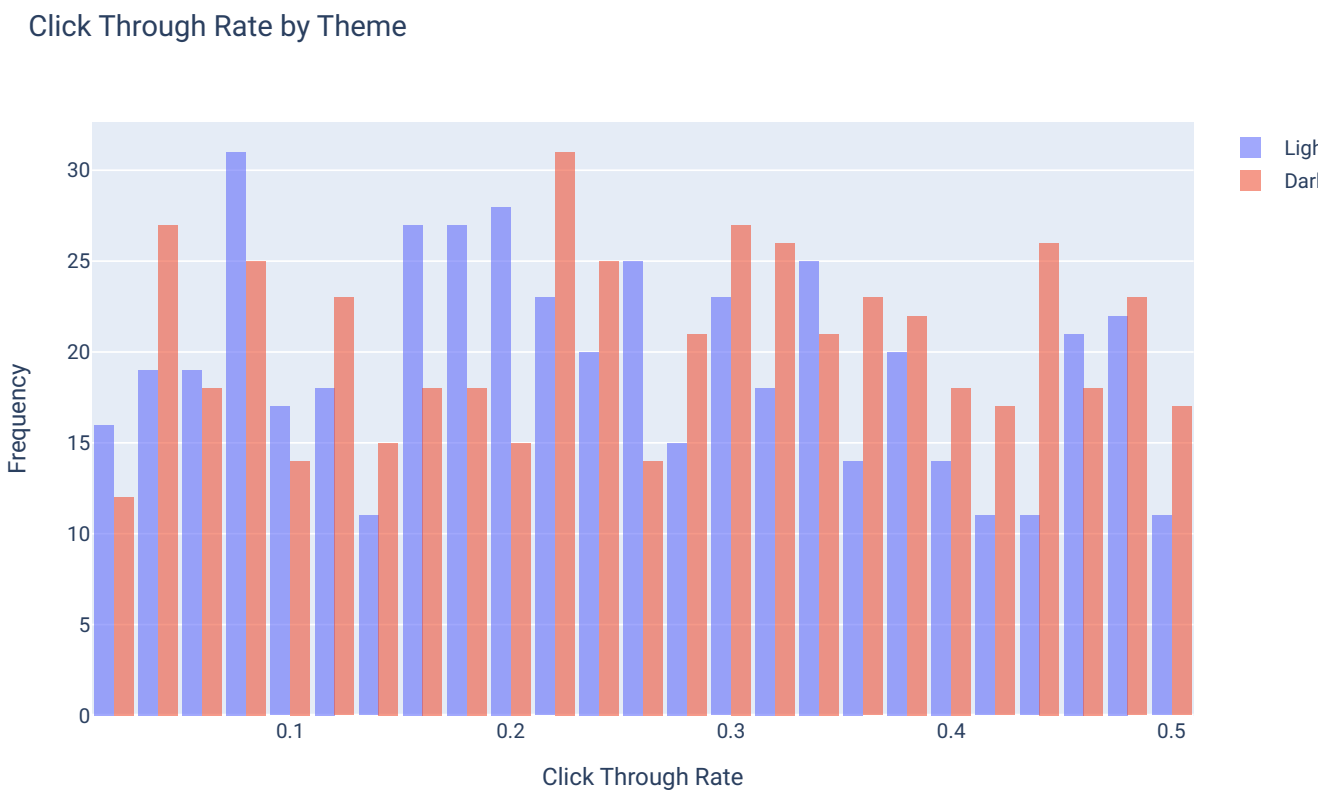


The relationship between the Click Through Rate (CTR) and Conversion Rate is consistent and nearly unchanged, as shown by the scatter plot. It means that as more users click on links or buttons (CTR increases), a similar proportion of them also end up signing up daily (Conversion Rate remains stable). In other words, the percentage of users who take the desired action of signing up remains roughly the same regardless of how many users initially clicked on links or buttons to explore the website.

Now, let's have a look at the histogram of the CTR of both themes:

```
# Extract data for each theme
light_theme_data = data[data['Theme'] == 'Light Theme']
dark_theme_data = data[data['Theme'] == 'Dark Theme']

# Create grouped bar chart for Click Through Rate
fig = go.Figure()

fig.add_trace(go.Histogram(x=light_theme_data['Click Through Rate'], name='Light Theme', opacity=0.6
```

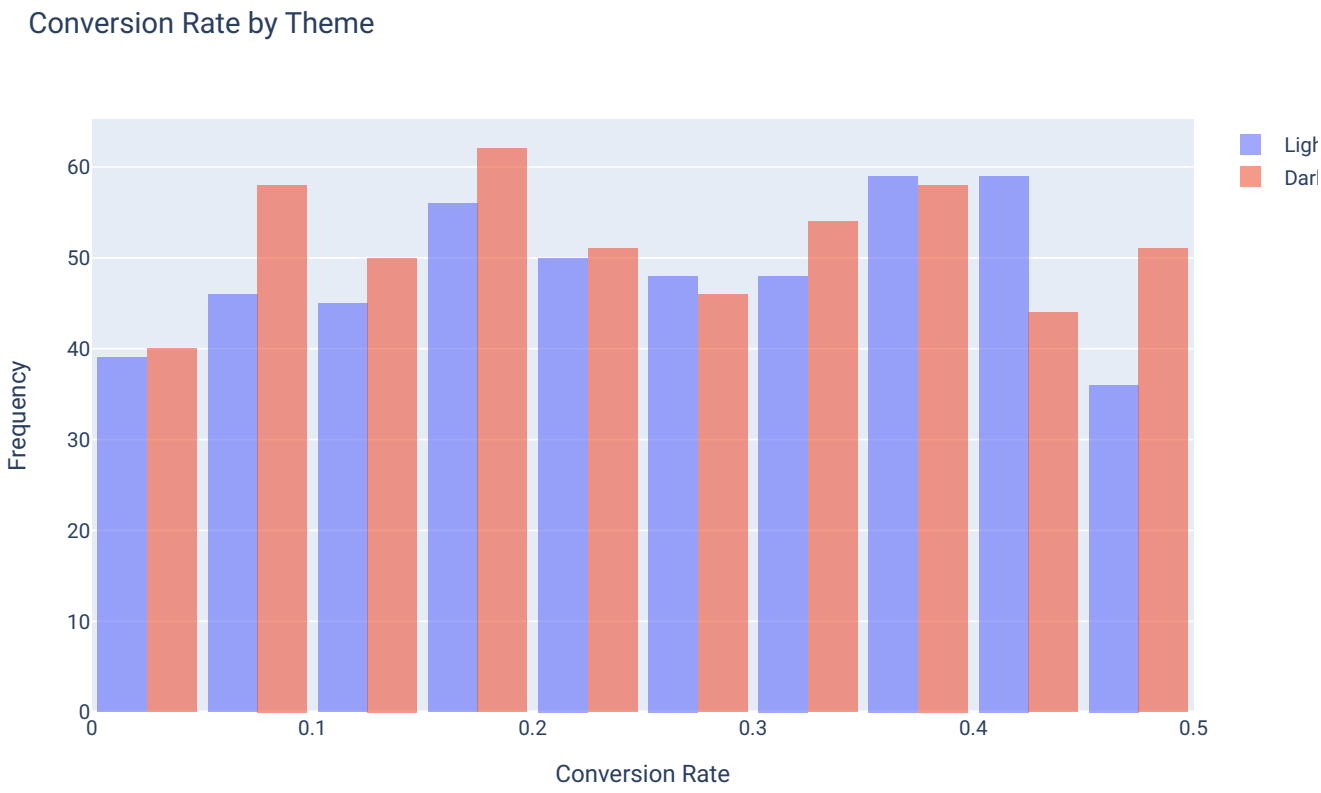
```
fig.add_trace(go.Histogram(x=dark_theme_data['Click Through Rate'], name='Dark Theme', opacity=0.6))

fig.update_layout(
    title_text='Click Through Rate by Theme',
    xaxis_title_text='Click Through Rate',
    yaxis_title_text='Frequency',
    barmode='group',
    bargap=0.1
)

fig.show()
```



We can see in the above histogram that there's not much difference between the performance of both themes. Now let's have a look at the histogram of the conversion rates of both themes:

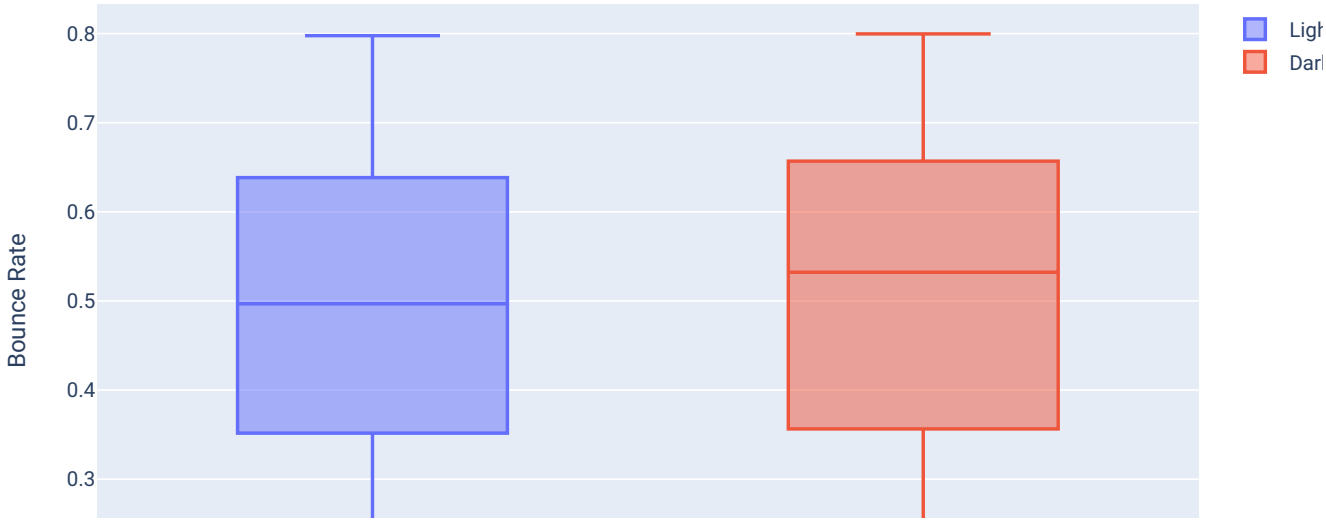
```
fig = go.Figure()

fig.add_trace(go.Histogram(x=light_theme_data['Conversion Rate'],
                           name='Light Theme', opacity=0.6, nbinsx=20))
fig.add_trace(go.Histogram(x=dark_theme_data['Conversion Rate'],
                           name='Dark Theme', opacity=0.6, nbinsx=20))

fig.update_layout(
    title_text='Conversion Rate by Theme',
    xaxis_title_text='Conversion Rate',
    yaxis_title_text='Frequency',
    barmode='group',
    bargap=0.1
```

```
)

fig.show()
```



Although there's not much difference, the conversion rate of the dark theme is slightly better than the light theme. Now let's have a look at the distribution of the bounce rates of both themes:

```
fig = go.Figure()
fig.add_trace(go.Box(y=light_theme_data['Bounce Rate'],
                     name='Light Theme'))
fig.add_trace(go.Box(y=dark_theme_data['Bounce Rate'],
                     name='Dark Theme'))

fig.update_layout(
    title_text='Bounce Rate by Theme',
    yaxis_title_text='Bounce Rate',
)

fig.show()
```



There's not much difference between the bounce rates of both themes still, the bounce rate of the light theme is slightly lower (which means it's slightly better). Now let's have a look at the scroll depth of both themes:

```
fig = go.Figure()
fig.add_trace(go.Box(y=light_theme_data['Scroll_Depth'],
                     name='Light Theme'))
fig.add_trace(go.Box(y=dark_theme_data['Scroll_Depth'],
                     name='Dark Theme'))

fig.update_layout(
    title_text='Scroll Depth by Theme',
    yaxis_title_text='Scroll Depth',
)

fig.show()
```

There's not much difference, but the scroll depth of the light theme is slightly better.

Comparison of Both Themes based on Purchases:

Now I'll perform a two-sample performance test to compare the purchases from both themes:

```
# A/B testing for Purchases
light_theme_conversions = light_theme_data[light_theme_data['Purchases'] == 'Yes'].shape[0]
light_theme_total = light_theme_data.shape[0]

dark_theme_conversions = dark_theme_data[dark_theme_data['Purchases'] == 'Yes'].shape[0]
dark_theme_total = dark_theme_data.shape[0]

conversion_counts = [light_theme_conversions, dark_theme_conversions]
sample_sizes = [light_theme_total, dark_theme_total]

light_theme_conversion_rate = light_theme_conversions / light_theme_total
dark_theme_conversion_rate = dark_theme_conversions / dark_theme_total

# Perform two-sample proportion test
zstat, pval = proportions_ztest(conversion_counts, sample_sizes)
print("Light Theme Conversion Rate:", light_theme_conversion_rate)
print("Dark Theme Conversion Rate:", dark_theme_conversion_rate)
print("A/B Testing - z-statistic:", zstat, " p-value:", pval)
```

```
Light Theme Conversion Rate: 0.5308641975308642
Dark Theme Conversion Rate: 0.5038910505836576
A/B Testing - z-statistic: 0.8531246206222649  p-value: 0.39359019934127804
```

In the comparison of conversion rates based on purchases from both themes, we conducted an A/B test to determine if there is a statistically significant difference in the conversion rates between the two themes. The results of the A/B test are as follows:

z-statistic: 0.8531 p-value: 0.3936

The z-statistic measures the difference between the conversion rates of the two themes in terms of standard deviations. In this case, the z-statistic is approximately 0.8531.

The positive z-statistic value indicates that the conversion rate of the Light Theme is slightly higher than the conversion rate of the Dark Theme.

The p-value represents the probability of observing the observed difference in conversion rates or a more extreme difference if the null hypothesis is true. The null hypothesis assumes that there is no statistically significant difference in conversion rates between the two themes. In this case, the p-value is approximately 0.3936.

Since the p-value is greater than the typical significance level of 0.05 (commonly used in A/B testing), we do not have enough evidence to reject the null hypothesis. It means that the observed difference in conversion rates between the

two themes is not statistically significant.

The results suggest that any observed difference in the number of purchases could be due to random variation rather than a true difference caused by the themes. In simpler terms, based on the current data and statistical analysis, we cannot confidently say that one theme performs significantly better than the other in terms of purchases.

Comparison of Both Themes based on Session Duration:

The session duration is also an important metric to determine how much users like to stay on your website. Now I'll perform a two-sample t-test to compare the session duration from both themes:

```
light_theme_session_duration = light_theme_data['Session_Duration']
dark_theme_session_duration = dark_theme_data['Session_Duration']

# Calculate the average session duration for both themes
light_theme_avg_duration = light_theme_session_duration.mean()
dark_theme_avg_duration = dark_theme_session_duration.mean()

# Print the average session duration for both themes
print("Light Theme Average Session Duration:", light_theme_avg_duration)
print("Dark Theme Average Session Duration:", dark_theme_avg_duration)

# Perform two-sample t-test for session duration
tstat, pval = stats.ttest_ind(light_theme_session_duration, dark_theme_session_duration)
print("A/B Testing for Session Duration - t-statistic:", tstat, " p-value:", pval)
```

```
Light Theme Average Session Duration: 930.8333333333334
Dark Theme Average Session Duration: 919.4824902723735
A/B Testing for Session Duration - t-statistic: 0.3528382474155483  p-value: 0.7242842138292167
```

In the comparison of session duration from both themes, we performed an A/B test to determine if there is a statistically significant difference in the average session duration between the two themes.

The results of the A/B test are as follows:

t-statistic: 0.3528 p-value: 0.7243

The t-statistic measures the difference in the average session duration between the two themes, considering the variability within the datasets. In this case, the t-statistic is approximately 0.3528. A positive t-statistic value indicates that the average session duration of the Light Theme is slightly higher than the average session duration of the Dark Theme.

The p-value represents the probability of observing the observed difference in average session duration or a more extreme difference if the null hypothesis is true. The null hypothesis assumes there is no statistically significant difference in average session duration between the two themes. In this case, the p-value is approximately 0.7243.

Since the p-value is much greater than the typical significance level of 0.05, we do not have enough evidence to reject the null hypothesis. It means that the observed difference in average session duration between the two themes is not statistically significant.

The results suggest that any observed difference in session duration could be due to random variation rather than a true difference caused by the themes.

In simpler terms, results indicate that **the average session duration for both themes is similar, and any differences observed may be due to chance.**

Summary

So this is how you can perform A/B testing of themes or designs using Python. A/B testing is a powerful and widely used technique to compare and evaluate marketing strategies, designs, layouts, or themes. The primary purpose of A/B testing is to make data-driven decisions that lead to improved user experiences, enhanced performance metrics, and ultimately better business outcomes.