

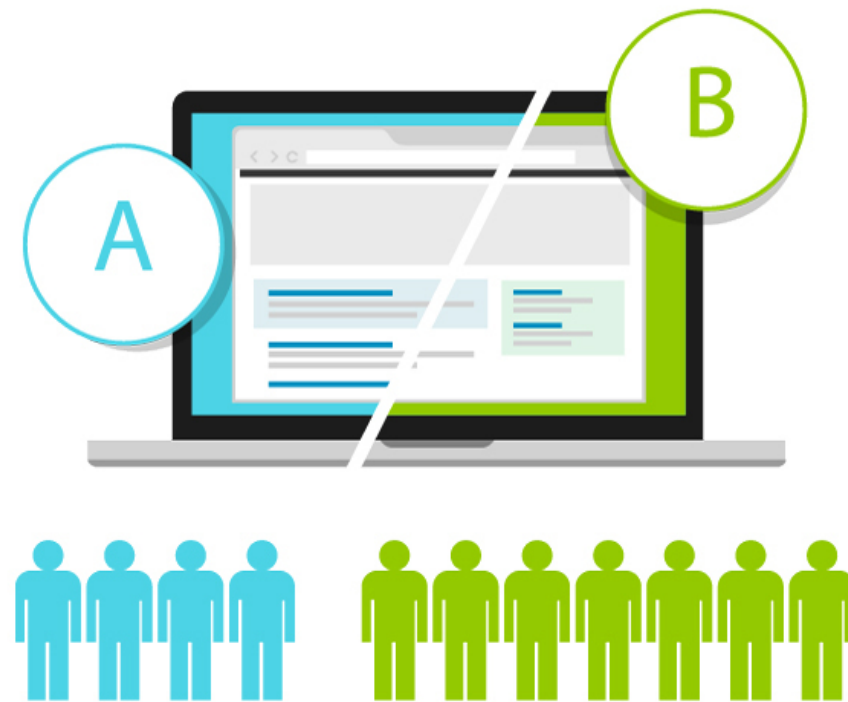


CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

Analyzing the A/B test results

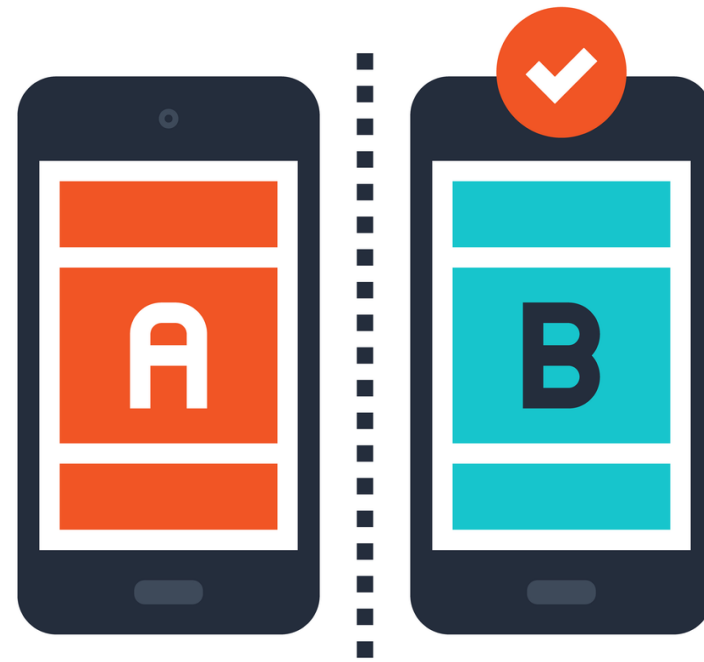
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Analyzing A/B Test Results





Evaluating our Test



A/B TESTING



Test Results

```
In [1]: test_demographics = pd.read_csv('test_demographics.csv')
```

```
In [2]: test_results = pd.read_csv('ab_test_results.csv')
```

```
In [3]: test_results.date = pd.to_datetime(test_results.date)
```

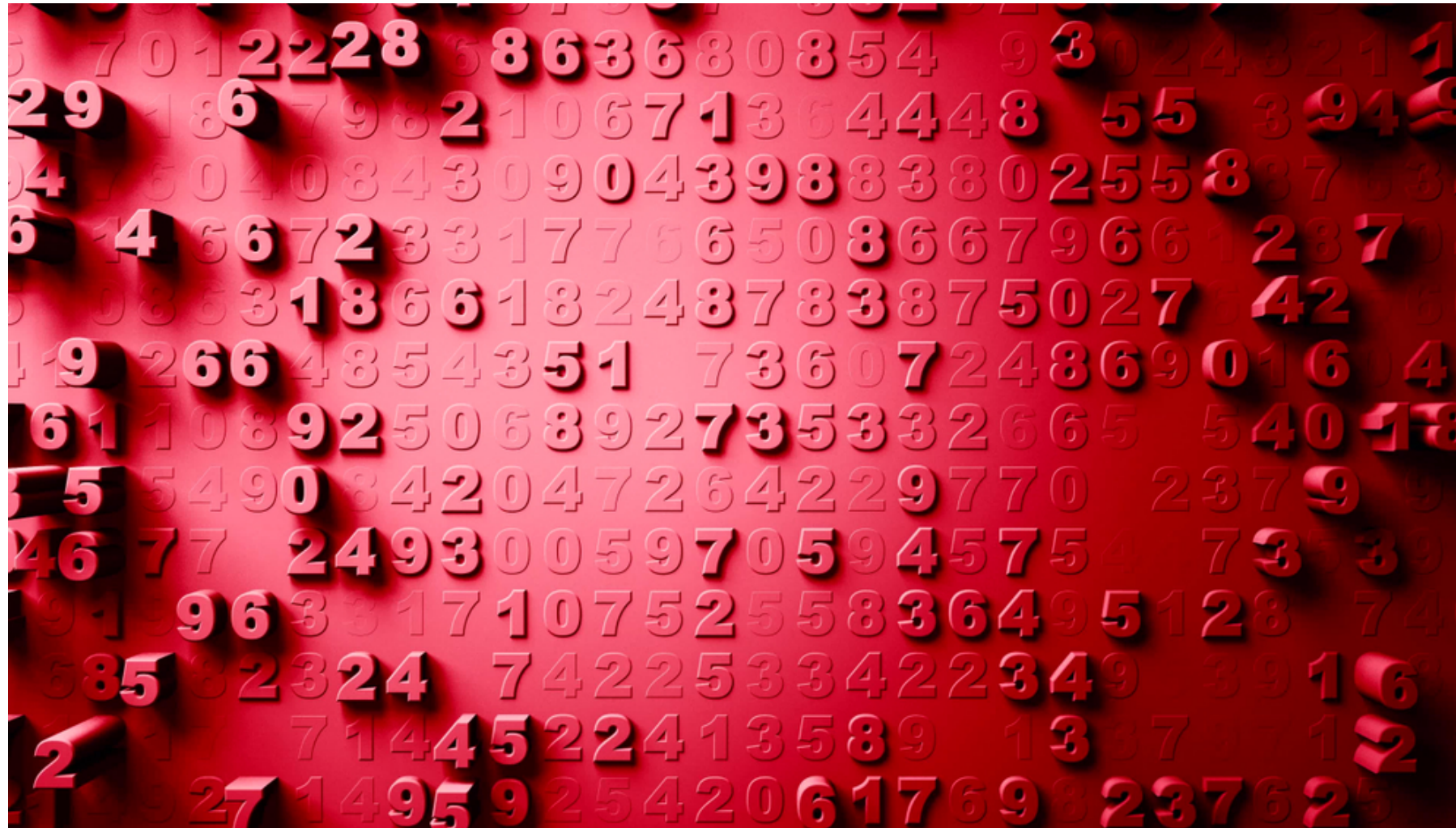
```
In [4]: test_results.head(n=5)
```

```
Out[4]:
```

uid	date	purchase	sku	price	group	
90554036.0	2018-02-27	14:22:12	0	NaN	NaN	C
90554036.0	2018-02-28	08:58:13	0	NaN	NaN	C
90554036.0	2018-03-01	09:21:18	0	NaN	NaN	C
90554036.0	2018-03-02	10:14:30	0	NaN	NaN	C
90554036.0	2018-03-03	13:29:45	0	NaN	NaN	C



Confirming Test Results





Confirming Test Results

```
In [5]: test_results_grpd = test_results.groupby(by=['group'],  
                                                as_index=False)
```

```
In [6]: test_results_grpd.uid.count()
```

```
Out[6]:
```

	group	uid
0	C	48236
1	V	49867



Confirming Test Results

```
In [7]: test_results_demo = test_results.merge(test_demo,
                                                how='inner', on='uid')

In [8]: test_results_grpd = test_results_demo.groupby(by=
                                                ['country', 'gender', 'device', 'group'],
                                                as_index=False)

In [9]: test_results_grpd.uid.count()
```

Out[9]:

country	gender	device	group	uid
BRA	F	and	C	5070
BRA	F	and	V	4136
BRA	F	iOS	C	3359
BRA	F	iOS	V	2817
BRA	M	and	C	3562
BRA	M	and	V	3673
BRA	M	iOS	C	2940
BRA	M	iOS	V	3109
CAN	F	and	C	747
CAN	F	and	V	806
CAN	F	iOS	C	447



Finding The Test & Control Group Conversion Rates

```
In [10]: test_results_grpd = test_results_demo.groupby(
        by=['group'], as_index=False)

In [11]: test_results_summary = test_results_grpd.agg(
        {'purchase': ['count', 'sum']})

In [12]: test_results_summary

Out[12]:
   group  purchase
count  sum
0      C    48236    1657
1      V    49867    2094

In [13]: test_results_summary['conv'] = (
        test_results_summary.purchase['sum'] /
        test_results_summary.purchase['count'])

In [14]: test_results_summary

Out[14]:
   group  purchase  conv
count  sum
0      C    48236    1657    0.034351
1      V    49867    2094    0.041984
```






p-Values

p-value:

- Probability under the Null Hypothesis of obtaining a result as or more extreme than the one observed.
- Represents a measure of the evidence against retaining the Null Hypothesis.

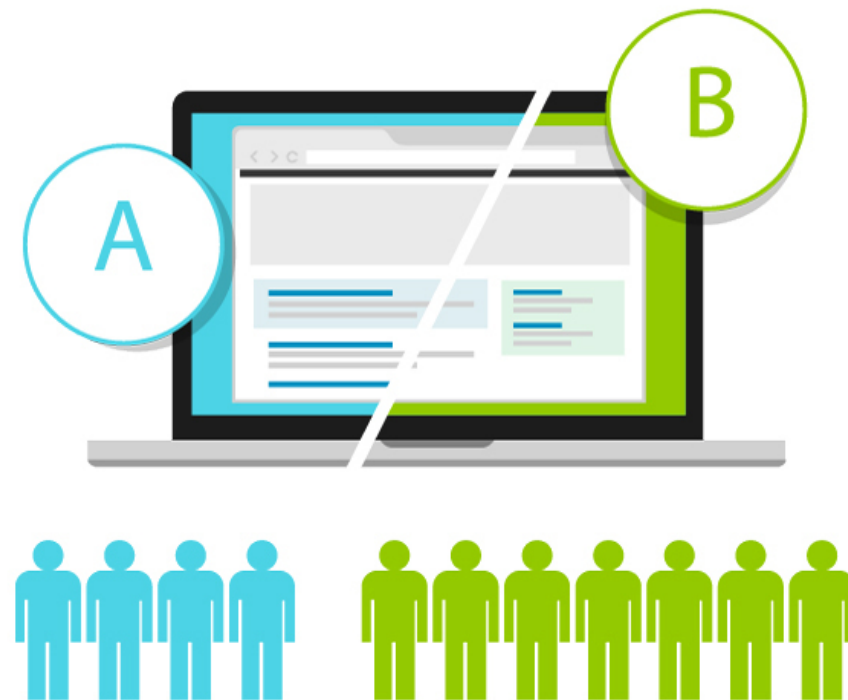


Interpreting a p-Value

p-value	Conclusion
< 0.01	very strong evidence against the Null Hypothesis
0.01 - 0.05	strong evidence against the Null Hypothesis
0.05 - 0.10	very weak evidence against the Null Hypothesis
> 0.1	small to no evidence against the Null Hypothesis



Next Steps





CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

Let's practice!



CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

Understanding statistical significance

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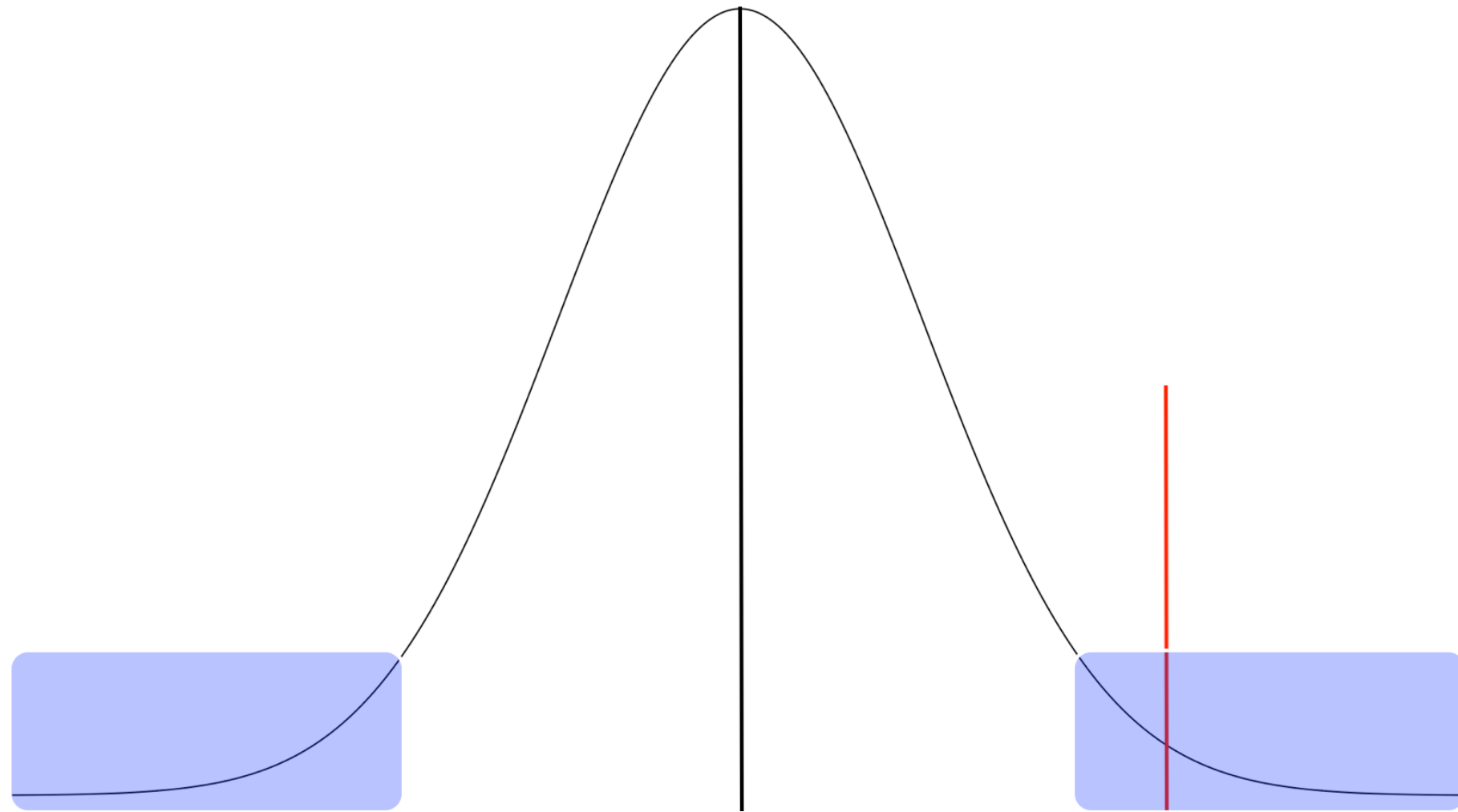


Next Steps In Our Analysis





Revisiting Statistical Significance



p-value Function

```
def get_pvalue(con_conv, test_conv, con_size, test_size,):  
    lift = - abs(test_conv - con_conv)  
  
    scale_one = con_conv * (1 - con_conv) * (1 / con_size)  
    scale_two = test_conv * (1 - test_conv) * (1 / test_size)  
    scale_val = (scale_one + scale_two)**0.5  
  
    p_value = 2 * stats.norm.cdf(lift, loc = 0, scale = scale_val )  
  
    return p_value
```



Calculating our p-value

```
In [1]: con_conv = 0.034351
In [2]: test_conv = 0.041984
In [3]: con_size = 48236
In [4]: test_size = 49867

In [5]: p_value = get_pvalue(con_conv, test_conv, con_size, test_size)

In [6]: p_value

Out[6]: 4.2572974855869089e-10
```



Finding the Test Power

```
In [7]: get_power(test_size, con_conv, test_conv, 0.95)
```

```
Out[7]: 0.99999259413722819
```



CONFIDENCE INTERVAL





Confidence Intervals

Confidence Interval

- Provides contextualization of the estimation process.
- The conversion rate is a fixed quantity, the estimation is what is variable.



Confidence Intervals

Two Sided Confidence Interval

- $\mu \pm \Phi \left(\alpha + \frac{1-\alpha}{2} \right) * \sigma$
- μ : Estimated Mean
- σ : Estimated Standard Deviation
- α : Desired Confidence Interval Width



Calculating Confidence Intervals

```
def get_ci(lift, alpha, sd):  
    val = abs(stats.norm.ppf((1 - alpha)/2))  
  
    lwr_bnd = lift - val * sd  
    upr_bnd = lift + val * sd  
  
    return_val = (lwr_bnd, upr_bnd)  
    return(return_val)
```



Calculating Confidence Intervals

```
In [8]: lift = test_conv - con_conv
```

```
In [9]: sd = ((test_conv * (1 - test_conv)) / test_size +  
              (con_conv * (1 - con_conv)) / con_size)**0.5
```

```
In [10]: get_ci(lift, 0.95, sd)
```

```
Out[10]: (0.0052371462948578272, 0.010028853705142175)
```


Next Steps





CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

Let's practice!



CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

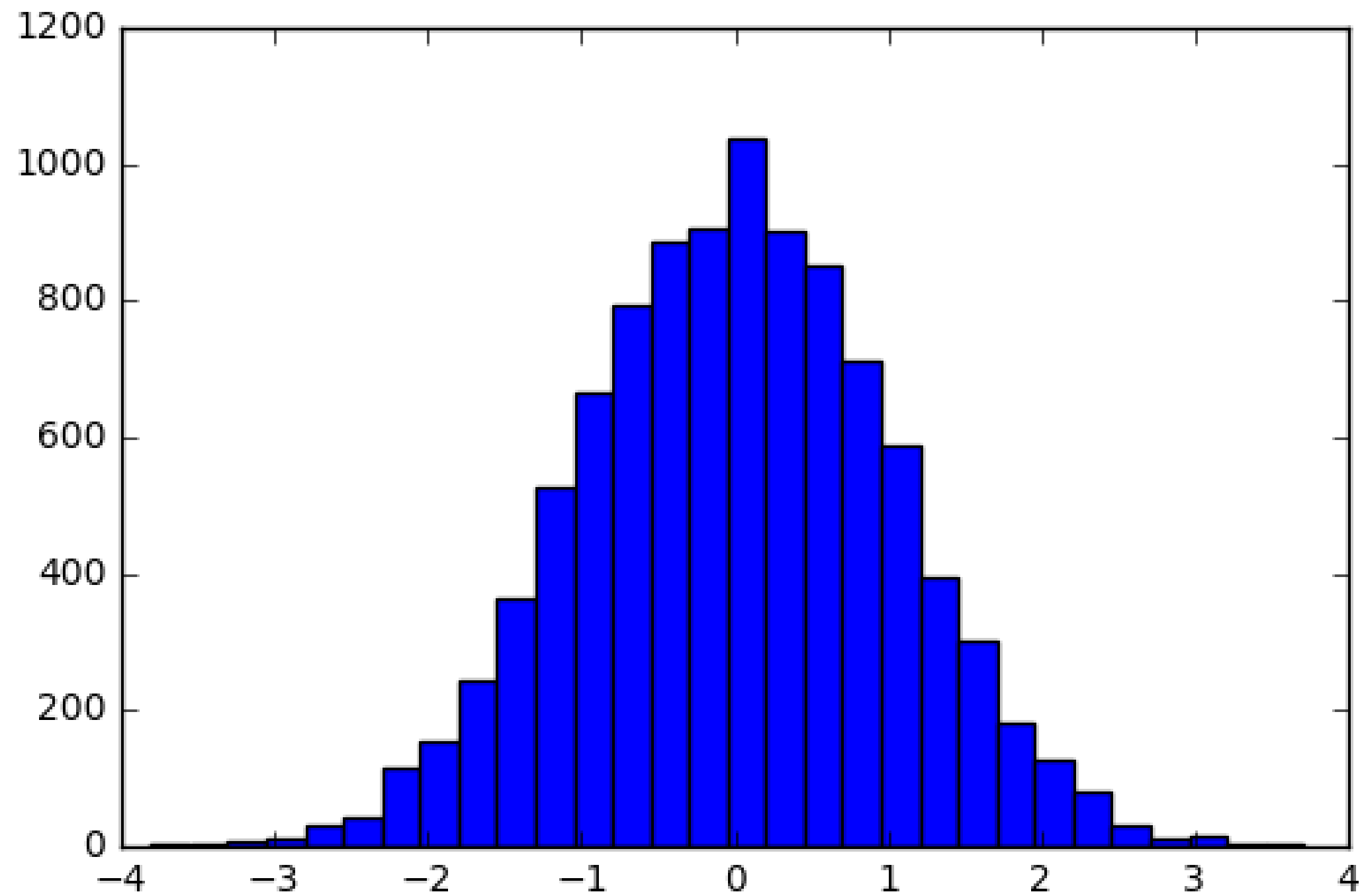
Interpreting your test results

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Communicating Your Test Results

	Test Group	Control Group
Sample Size	7030	6970
Run Time	2 Weeks	2 Weeks
Mean	3.12	2.69
Variance	3.20	2.64
Estimated Lift: 0.56 *		
Confidence Interval 0.56 \pm 0.4		

** Significant at the 0.05 Level*





Generating Histograms - Data

```
In [1]: test_results_rollup.head(n=10)
```

```
Out[1]:
```

uid	group	purchase
11128497.0	V	0.000000
11145206.0	V	0.050000
11163353.0	C	0.150000
11215368.0	C	0.000000
11248473.0	C	0.157895
11258429.0	V	0.086957
11271484.0	C	0.071429
11298958.0	V	0.157895
11325422.0	C	0.045455
11340821.0	C	0.040000

Generating Histograms - Code

```
In [2]: variant_results_rollup = test_results_rollup[
        test_results_rollup.group == 'V']

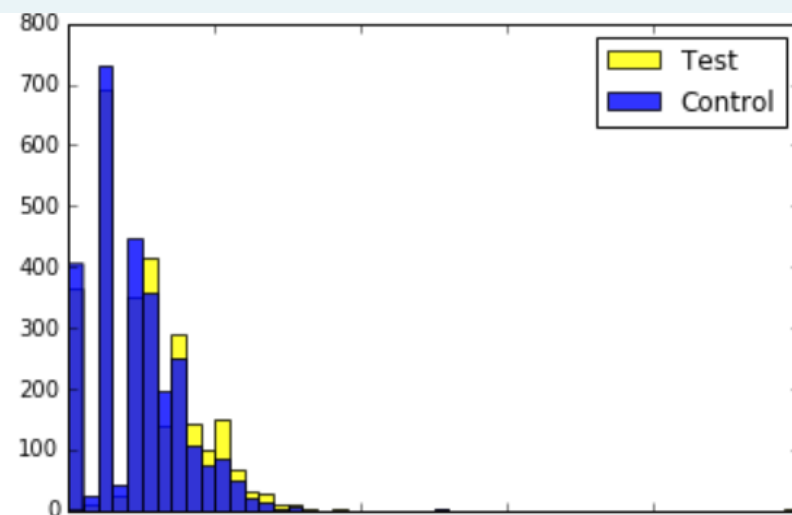
In [3]: control_results_rollup = test_results_rollup[
        test_results_rollup.group == 'C']

In [4]: plt.hist(variant_results_rollup['purchase'],
                 color = 'yellow', alpha = 0.8, bins = 50, label = 'Test')

In [5]: plt.hist(control_results_rollup['purchase'],
                 color = 'blue', alpha = 0.8, bins = 50, label = 'Control')

In [6]: plt.legend(loc='upper right')

In [7]: plt.show()
```

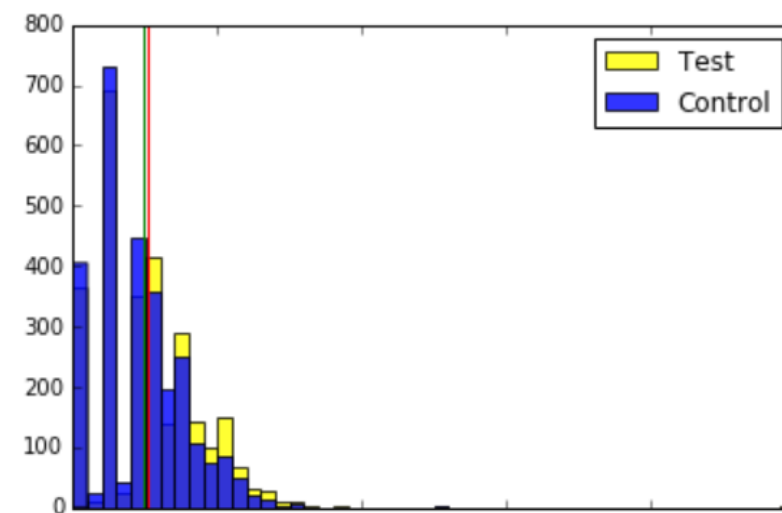


Adding Lines & Annotations

```
In [8]: plt.axvline(x = np.mean(variant_results_rollup.purchase), color = 'red')
```

```
In [9]: plt.axvline(x= np.mean(test_results_rollup.purchase), color = 'green')
```

```
In [10]: plt.show()
```





Plotting the Distribution

```
In [11]: mean_control = 0.090965
In [12]: mean_test = 0.102005
In [13]: var_control = (mean_control * (1 - mean_control)) / 58583
In [14]: var_test = (mean_test * (1 - mean_test)) / 56350

In [15]: control_line = np.linspace(-3 * var_control**0.5 +
                                     mean_control, 3 * var_control**0.5 +
                                     mean_control, 100)

In [16]: test_line = np.linspace(-3 * var_test**0.5 +
                                  mean_test, 3 * var_test**0.5 +
                                  mean_test, 100)
```



Plotting the Distribution

```
In [17]: plt.plot(control_line,mlab.normpdf(control_line,  
      mean_control, var_control**0.5))
```

```
In [18]: plt.plot(test_line,mlab.normpdf(test_line,  
      mean_test, var_test**0.5))
```

```
In [19] plt.show()
```



alt



Plotting the Difference of Distributions

```
In [20]: lift = mean_test - mean_control
```

```
In [21]: var = var_test + var_control
```

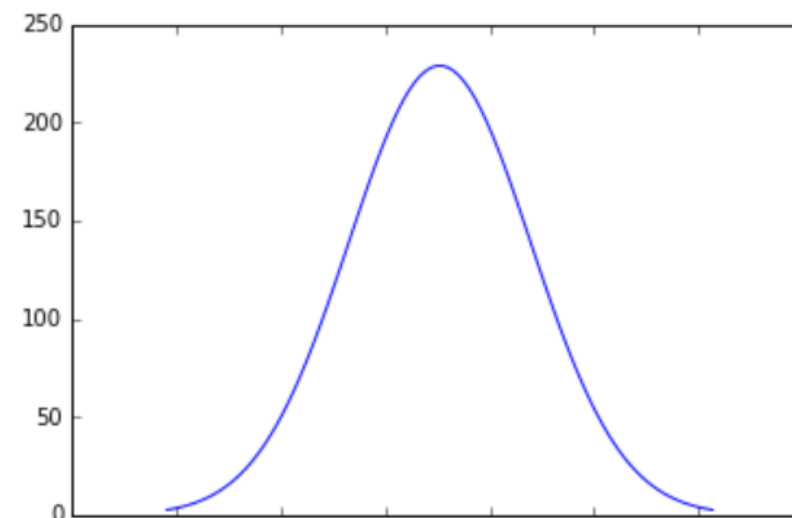


Plotting the Difference of Distributions

```
In [22]: diff_line = np.linspace(-3 * var**0.5 +  
    lift, 3 * var**0.5  
    + lift, 100)
```

```
In [23]: plt.plot(diff_line, mlab.normpdf(diff_line,  
    lift, var**0.5))
```

```
In [24] plt.show()
```





Plotting the Confidence Interval

```
In [25]: section = np.arange(0.007624, 0.01445 , 1/10000)
```

```
In [26]: plt.fill_between(section,  
                           mlab.normpdf(section,  
                           lift, var**0.5))
```

```
In [27]: plt.plot(diff_line,mlab.normpdf(diff_line,  
                                           lift, var**0.5))
```

```
In [28]: plt.show()
```



Plotting the Confidence Interval



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Let's practice!



CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

Finale

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CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

Let's practice!