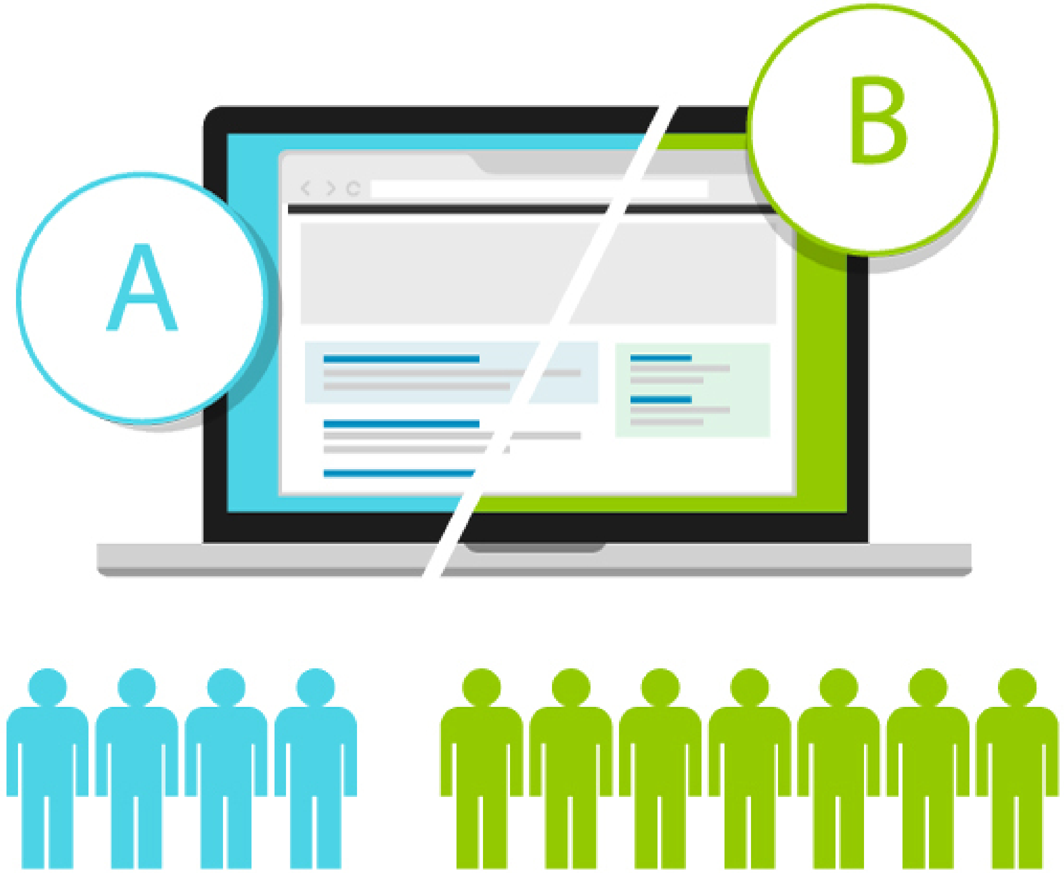
Analyzing the A/B test results

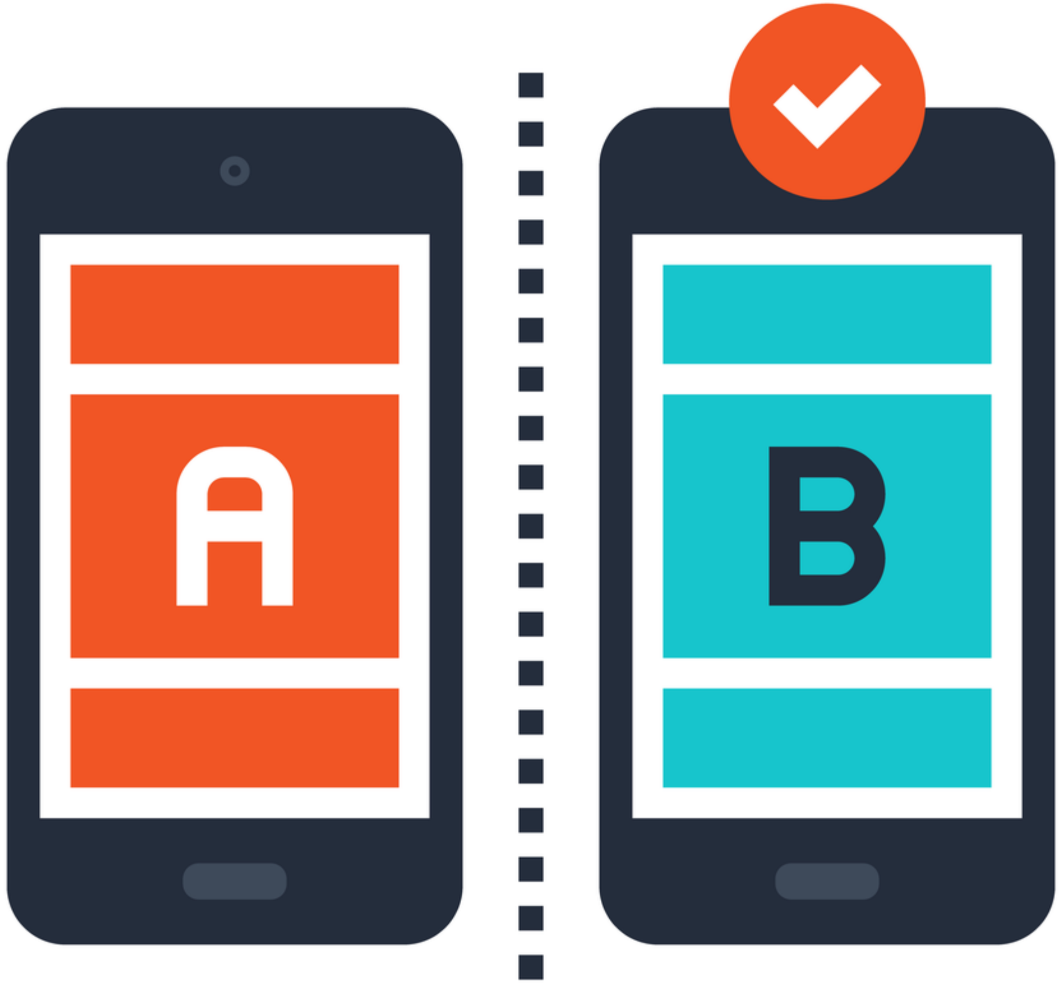
CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

Ryan Grossman
Data Scientist, EDO

Analyzing A/B Test Results



Evaluating our Test

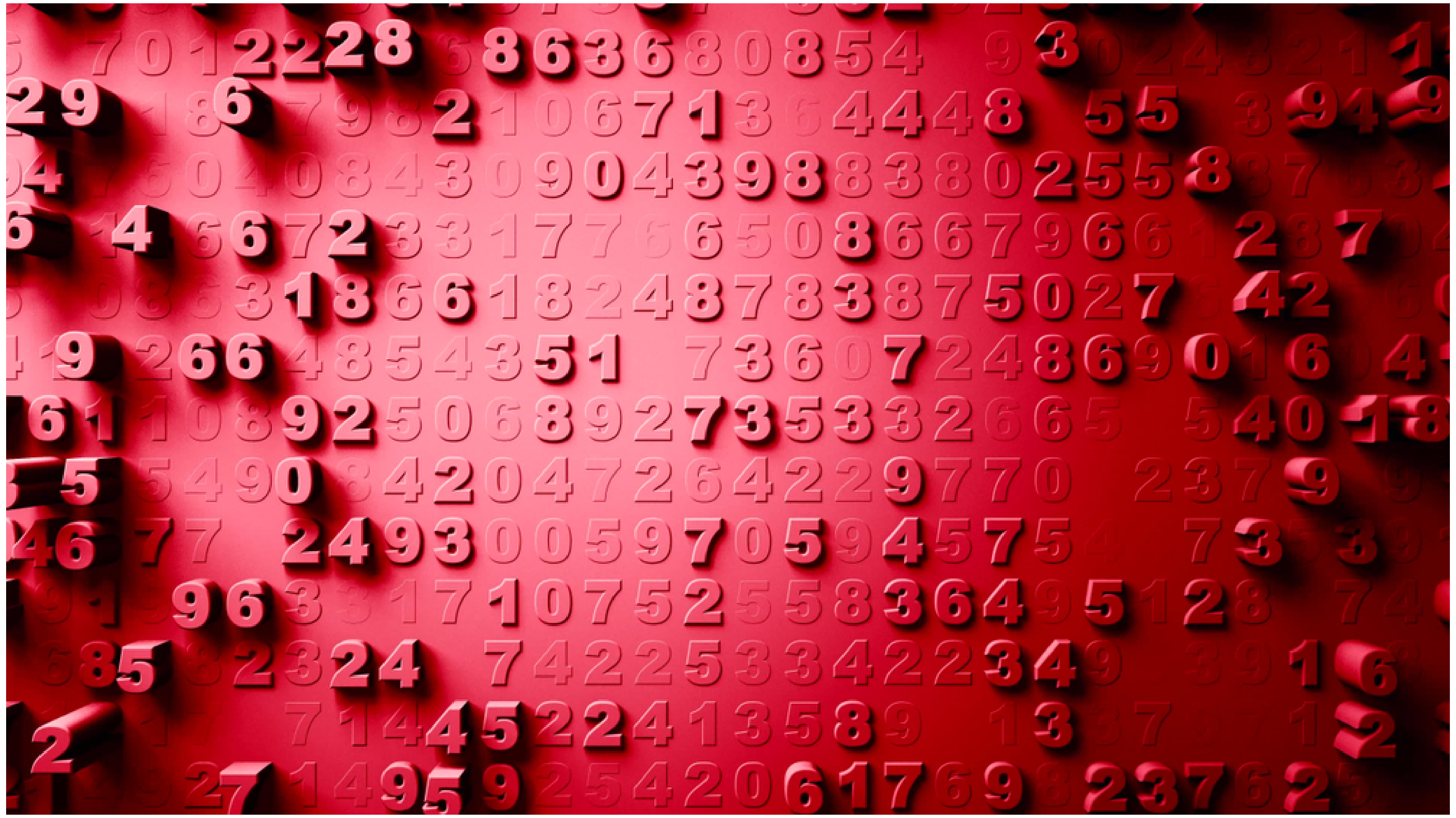


Test Results

```
test_demographics = pd.read_csv('test_demographics.csv`)

test_results = pd.read_csv('ab_test_results.csv')

test_results.date = pd.to_datetime(test_results.date)

test_results.head(n=5)
```

```
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

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

test_results_grpd.uid.count()
```

```
    group    uid
0     C        48236
1     V        49867
```

Confirming Test Results

```
test_results_demo = test_results.merge(test_demo,
                                      how='inner', on='uid')
test_results_grpd = test_results_demo.groupby(by=
                                      ['country','gender', 'device', 'group' ],
                                      as_index=False)
test_results_grpd.uid.count()
```

```
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

```
test_results_grpd = test_results_demo.groupby(by=['group'], as_index=False)
test_results_summary = test_results_grpd.agg({'purchase': ['count', 'sum']})
test_results_summary
```

```
    group    purchase
count    sum
0    C    48236    1657
1    V    49867    2094
```

```
test_results_summary['conv'] = (test_results_summary.purchase['sum'] / test_results_summary.purchase['count'])
test_results_summary
```

```
    group    purchase    conv
count    sum
0    C    48236    1657    0.034351
1    V    49867   2094     0.041984
```

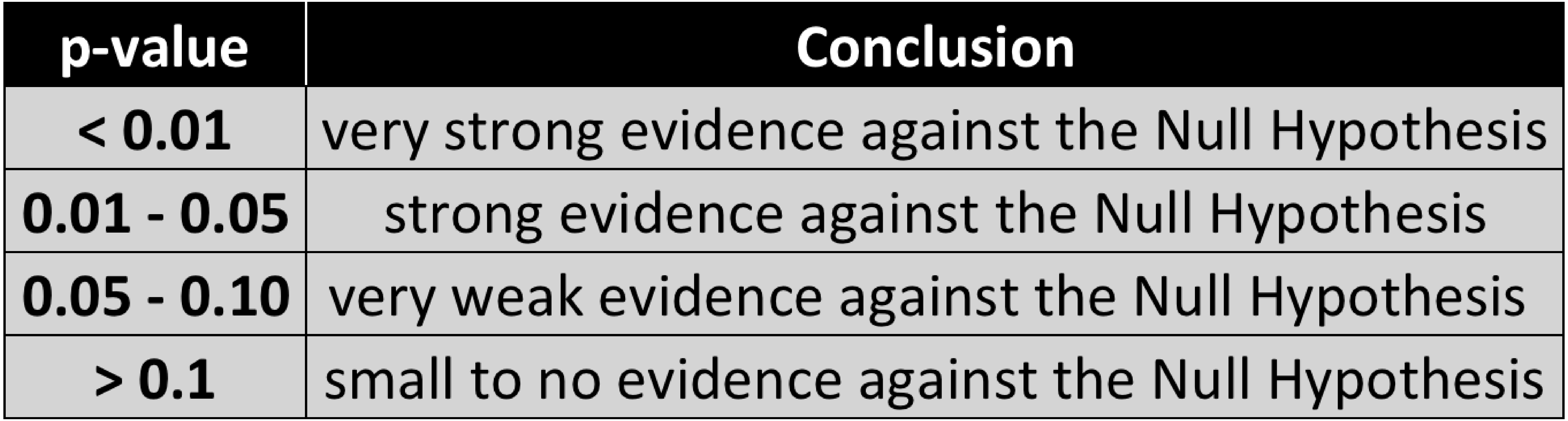
STATISTICAL SIGNIFICANCE

p-Values

p-value:

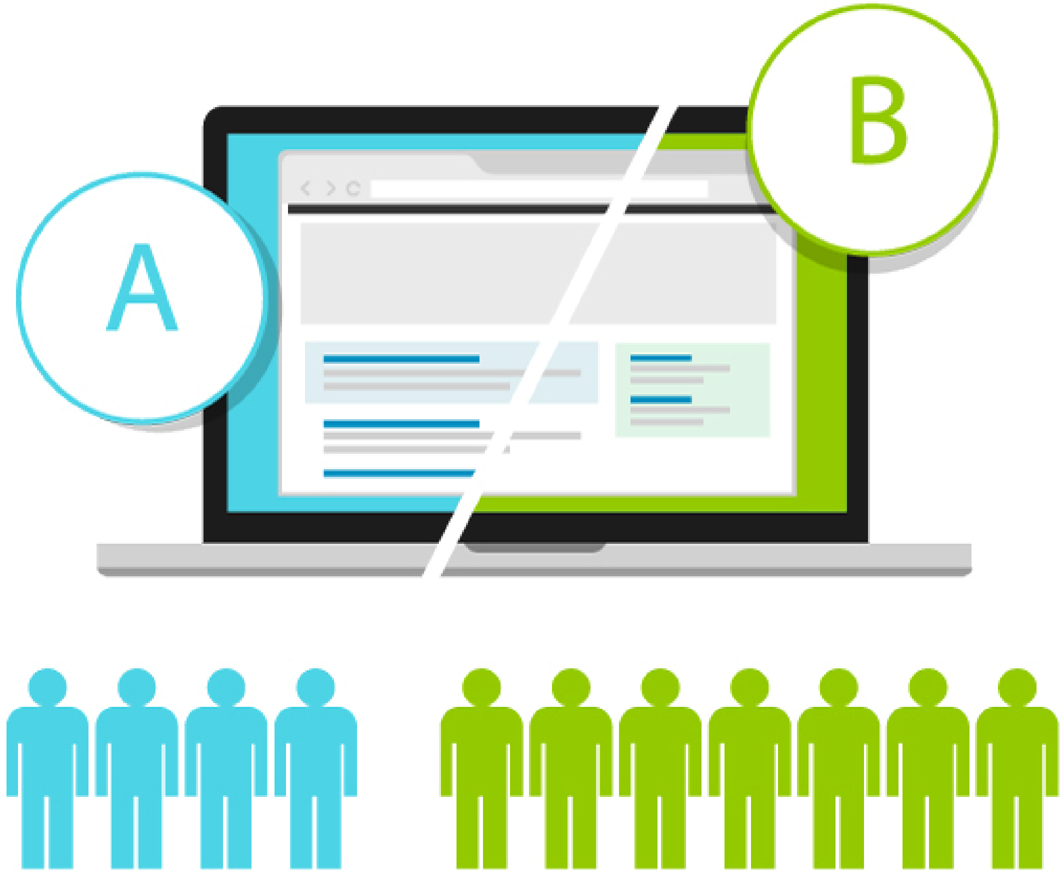
- Probability under the Null Hypothesis of obtaining a result as or more extreme than the one observed.
- Represents a measure of the evidence against retaining the Null Hypothesis.

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



Let's practice!

CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

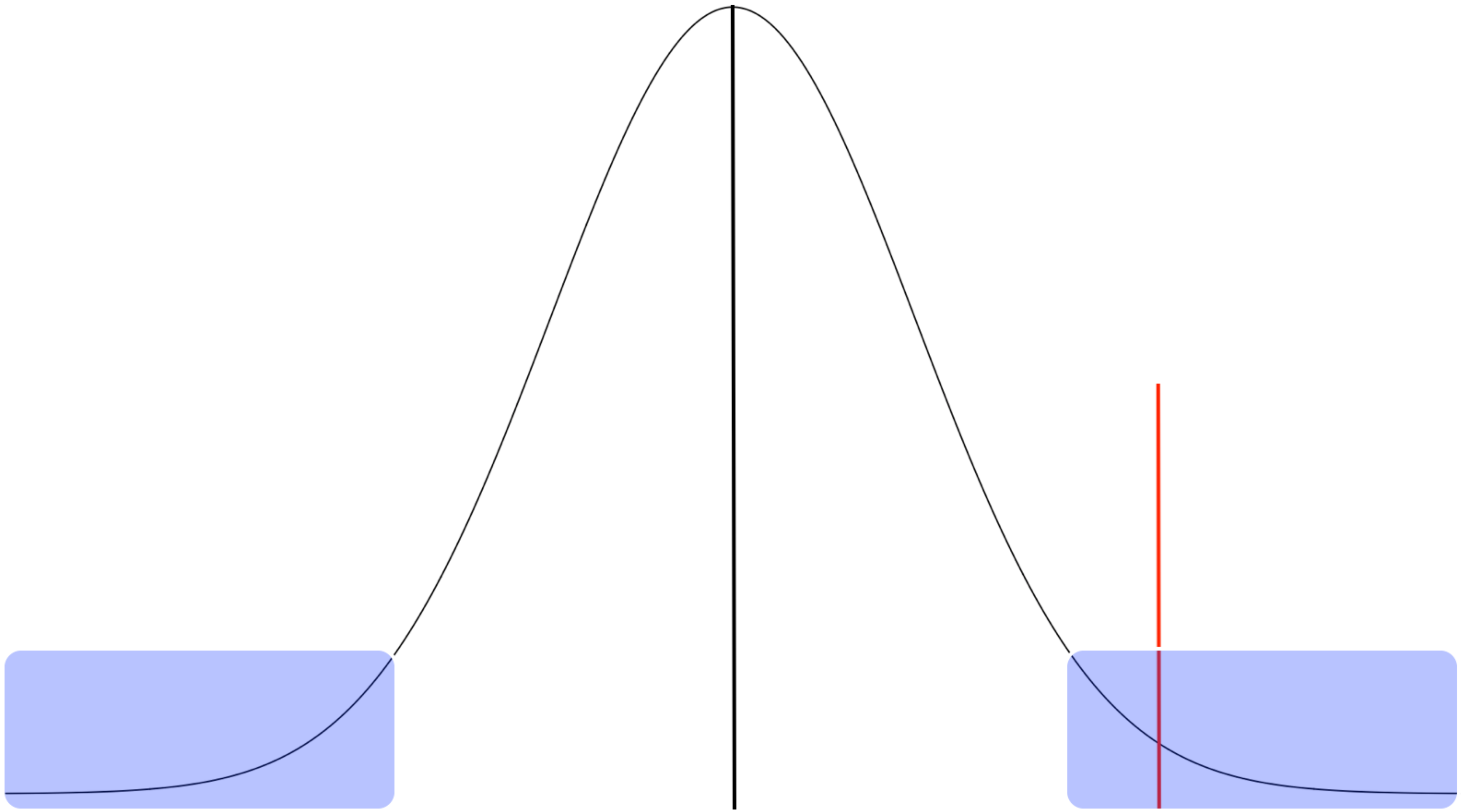
Understanding statistical significance

CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

Ryan Grossman
Data Scientist, EDO

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

```
con_conv = 0.034351
test_conv = 0.041984
con_size = 48236
test_size = 49867

p_value = get_pvalue(con_conv, test_conv, con_size, test_size)

p_value
```

```
4.2572974855869089e-10
```

Finding the Test Power

```
get_power(test_size, con_conv, test_conv, 0.95)
```

```
0.9999259413722819
```

CONFIDENCE INTERVAL

Confidence Intervals

Confidence Interval

- Provides contextualizaton 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

```python
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

```
lift = test_conv - con_conv

sd = ((test_conv * (1 - test_conv)) / test_size +
            (con_conv * (1 - con_conv)) / con_size)**0.5

get_ci(lift, 0.95, sd)
```

```
(0.005237146294857827 2, 0.010028853705142175)
```

Next Steps

Let's practice!

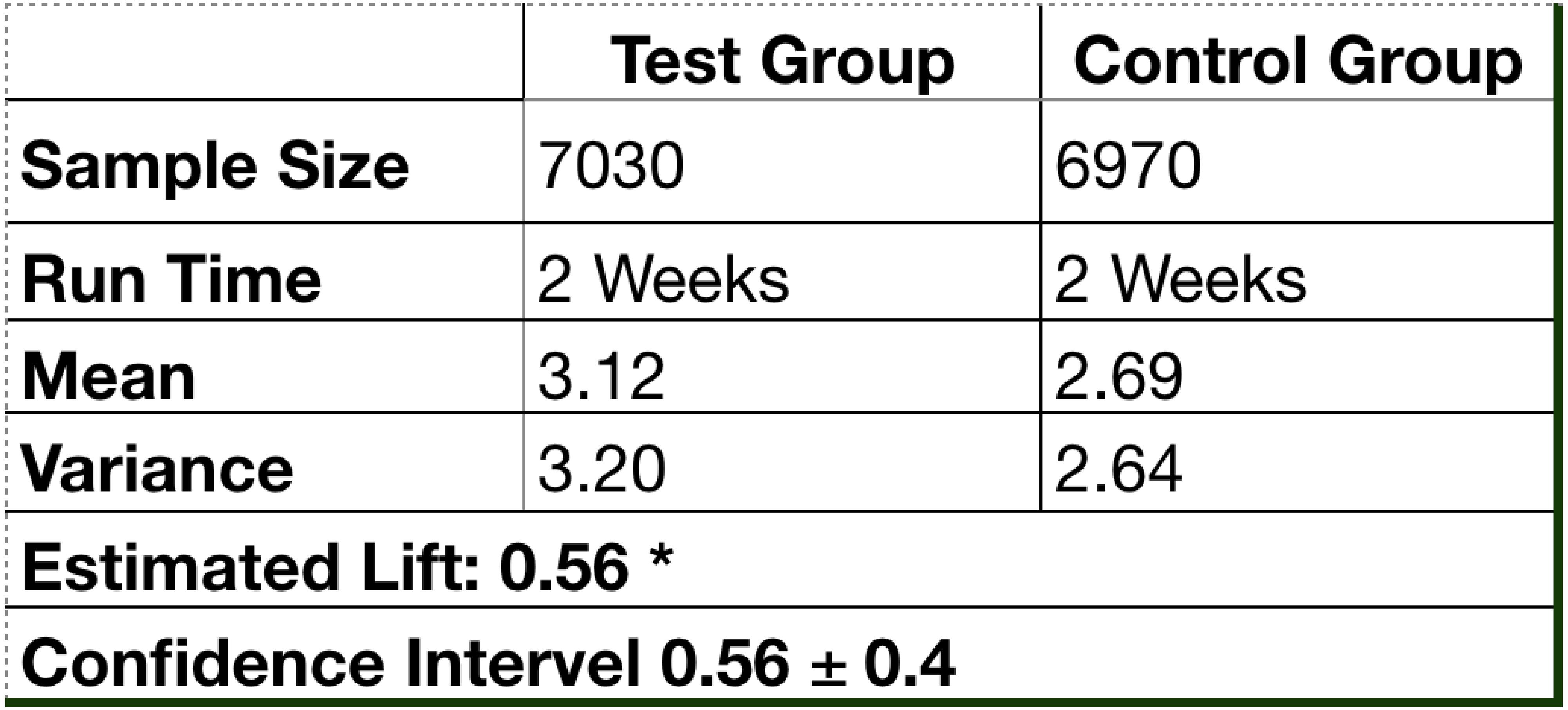
CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

Interpreting your test results

CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

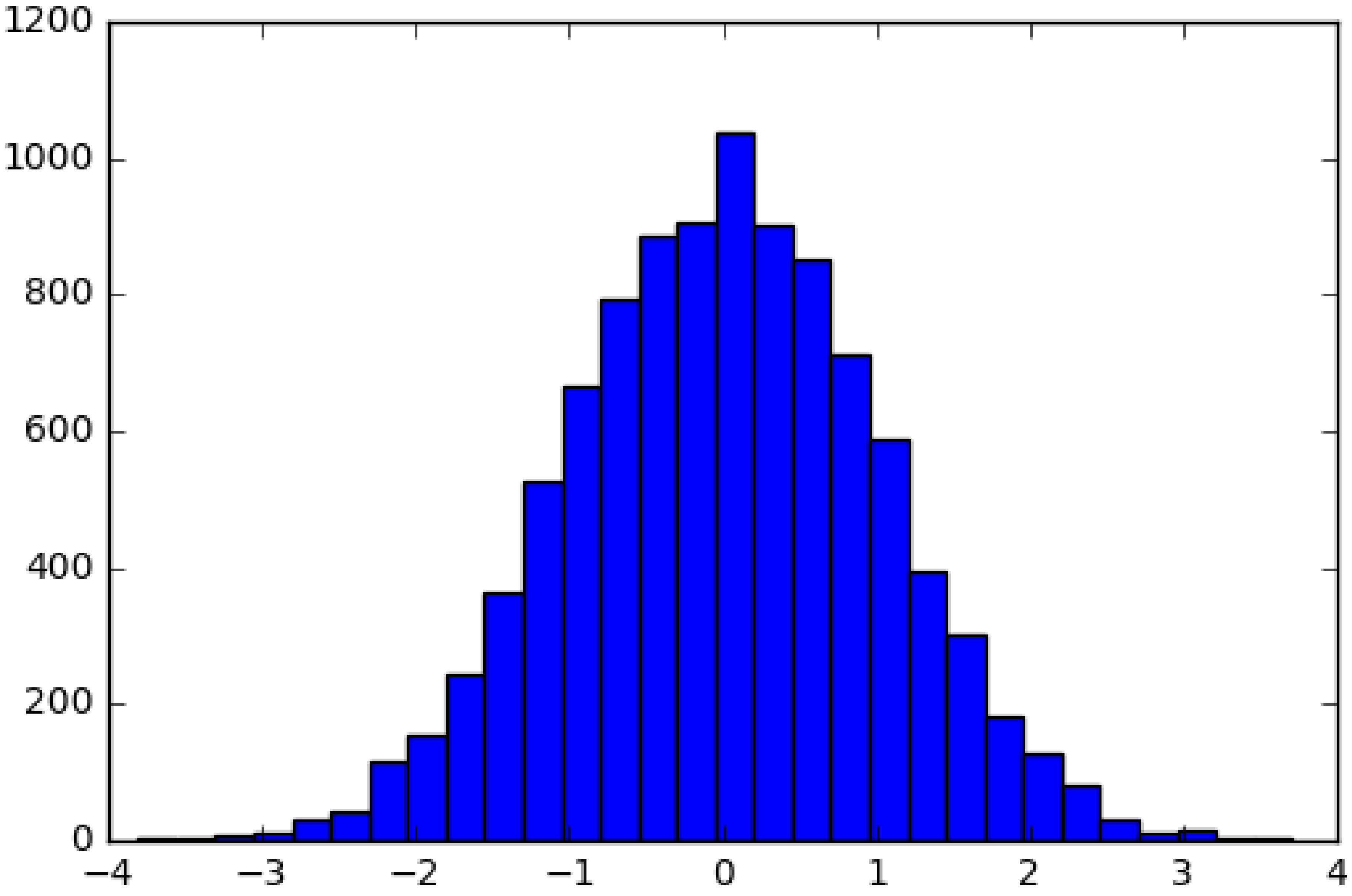
Ryan Grossman
Data Scientist, EDO

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 Intervel 0.56 ± 0.4		

** Significant at the 0.05 Level*


1200
1000
800
600
400
200
0
−4
−3
−2
−1
0
1
2
3
4

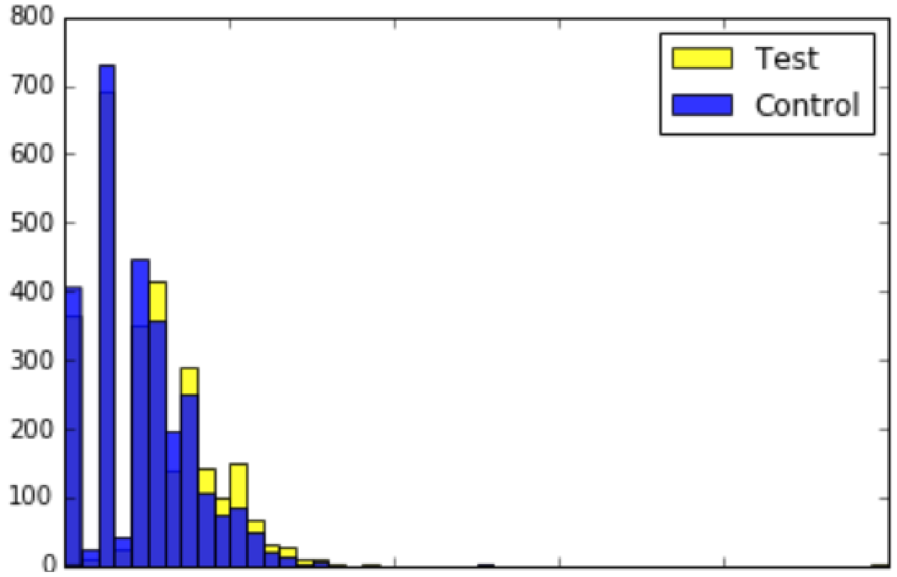
Generating Histograms - Data

```
test_results_rollup.head(n=10)
```

```
    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
```

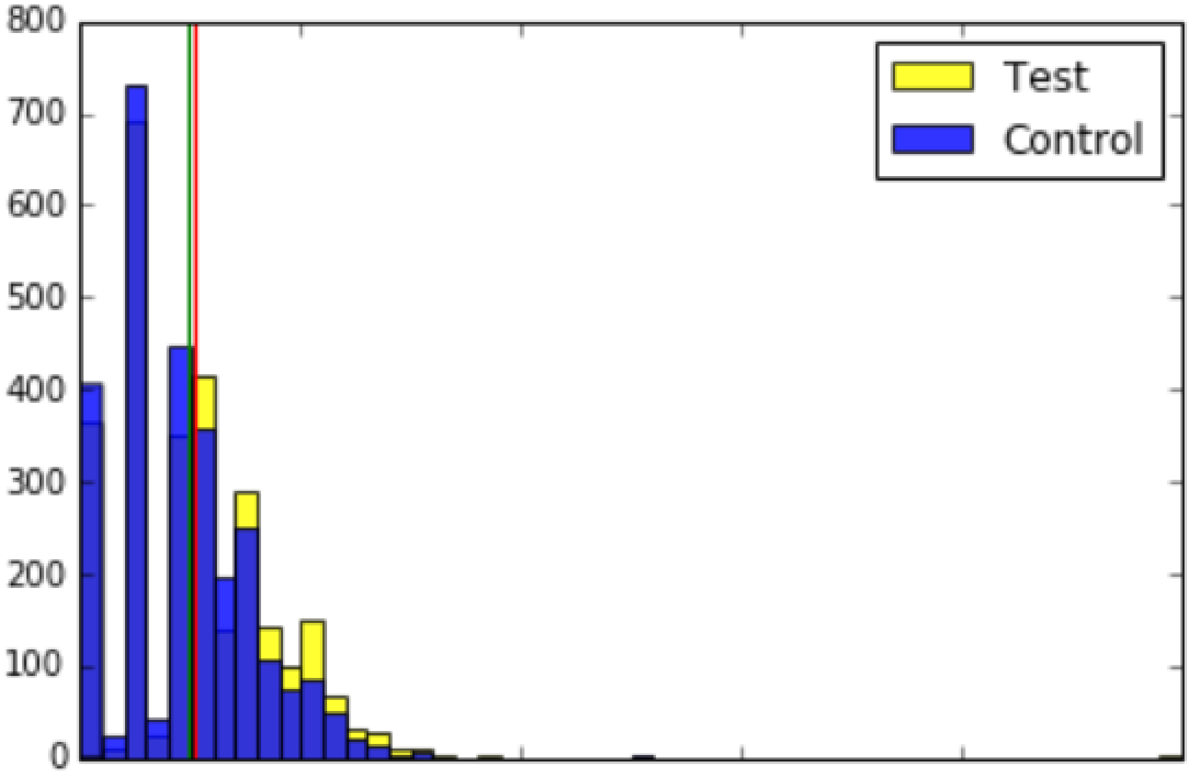
Generating Histograms - Code

```
variant_results_rollup = test_results_rollup[test_results_rollup.group == 'V']
control_results_rollup = test_results_rollup[test_results_rollup.group == 'C']
plt.hist(variant_results_rollup['purchase'],color = 'yellow', alpha = 0.8, bins =50, label = 'Test')
plt.hist(control_results_rollup['purchase'],  color = 'blue', alpha = 0.8, bins = 50, label = 'Control')
plt.legend(loc='upper right')
plt.show()
```



Adding Lines & Annotations

```
plt.axvline(x = np.mean(variant_results_rollup.purchase), color = 'red')
plt.axvline(x= np.mean(test_results_rollup.purchase), color = 'green')
plt.show()
```

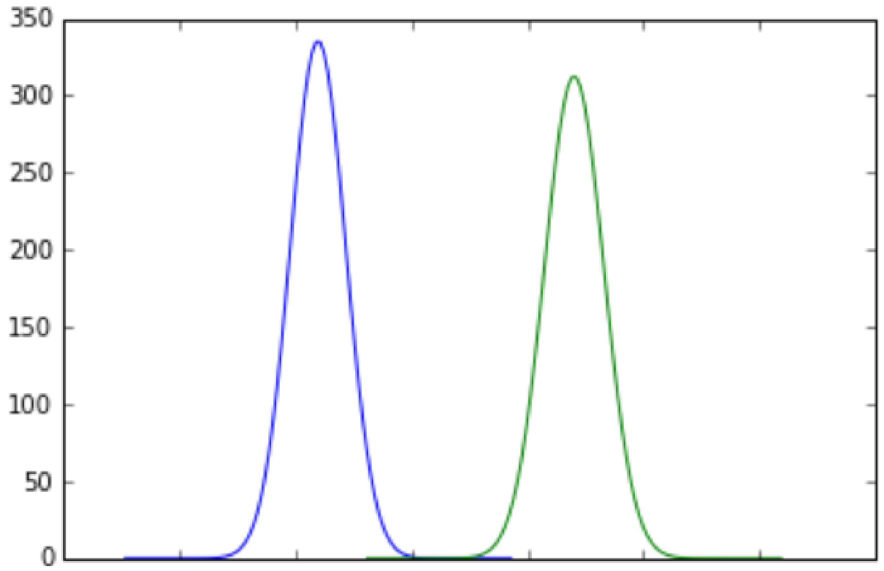


Plotting the Distribution

```
mean_control = 0.090965
mean_test = 0.102005
var_control = (mean_control * (1 - mean_control)) / 58583
var_test = (mean_test * (1 - mean_test)) / 56350

control_line = np.linspace(-3 * var_control**0.5 +
                mean_control, 3 * var_control**0.5 +
                mean_control, 100)

test_line = np.linspace(-3 * var_test**0.5 +
            mean_test, 3 * var_test**0.5
            + mean_test, 100)
```

Plotting the Distribution

```
plt.plot(control_line,mlab.normpdf(control_line,
                mean_control, var_control**0.5))
plt.plot(test_line,mlab.normpdf(test_line,
                mean_test, var_test**0.5))
plt.show()
```

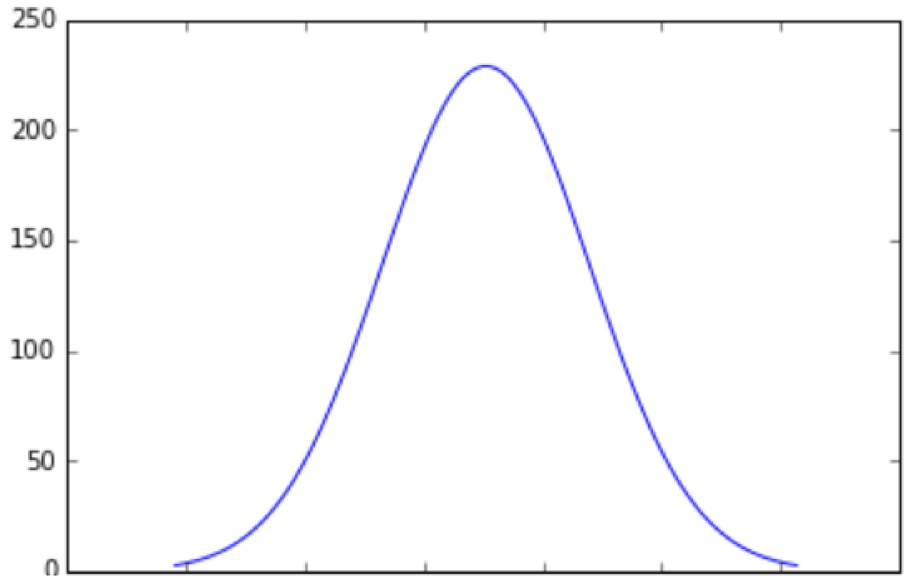


Plotting the Difference of Distributions

```
lift = mean_test - mean_control

var = var_test + var_control
```

Plotting the Difference of Distributions

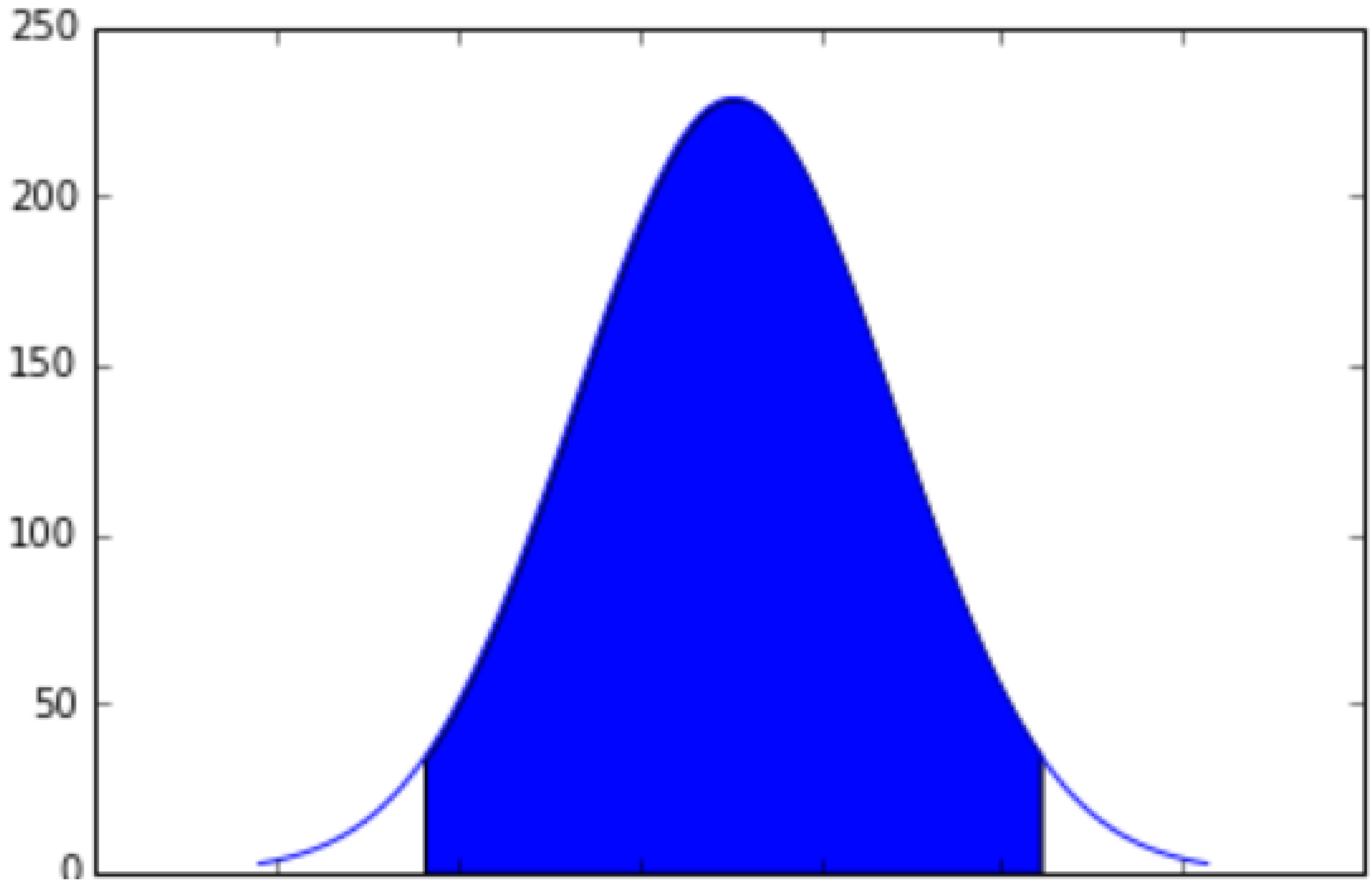
```
diff_line = np.linspace(-3 * var**0.5 + lift, 3 * var**0.5 + lift, 100)
plt.plot(diff_line,mlab.normpdf(diff_line, lift, var**0.5))
plt.show()
```



Plotting the Confidence Interval

```
section = np.arange(0.007624, 0.01445 , 1/10000)

plt.fill_between(section, mlab.normpdf(section,lift, var**0.5))

plt.plot(diff_line,mlab.normpdf(diff_line, lift, var**0.5))

plt.show()
```

Plotting the Confidence Interval



Let's practice!

CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

Finale

CUSTOMER ANALYTICS & A/B TESTING IN PYTHON

Ryan Grossman
Data Scientist, EDO

Let's practice!

CUSTOMER ANALYTICS & A/B TESTING IN PYTHON