# Power Analysis

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By

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# Power Analysis

## What is Power In Testing The Difference Between 2 Proportions

Most of my experience has been in automotive direct marketing.

Example

Direct mail for automotive

- Sent mail with incentive
- Sent email

Send mail and ask did the mail help sell cars? Did it sell enough cars to make a profit?

How to ascertain if the mail worked? Treated group and a control group.

Test difference in buy rates and estimate **incremental sales** – ( treated purchase rate – control purchase rate) x N of treated

For testing we need a significance level

In marketing 90% confidence is common - It means that there is only 1 chance in 10 that the differences we see occur by chance

Marketing people want to mail everyone, sometimes you need to convince them to have a control group

Usually the N of the mailing is determined by budget.

So the usual question is how many people are going to be in the control group?

# Power Analysis

## What is Power In Testing The Difference Between 2 Proportions

Power is the probability that, given the significance lever we will accept, p1, p2, n1, and n2 we will find a difference large enough that we will call it statistically significant

Why is power important?

- If you're performing a test and you have a low probability of finding a difference
  1. Why go through the effort and expense
  2. Low power could cause you to miss an important difference
  3. Underpowered tests build a history of failure with your client

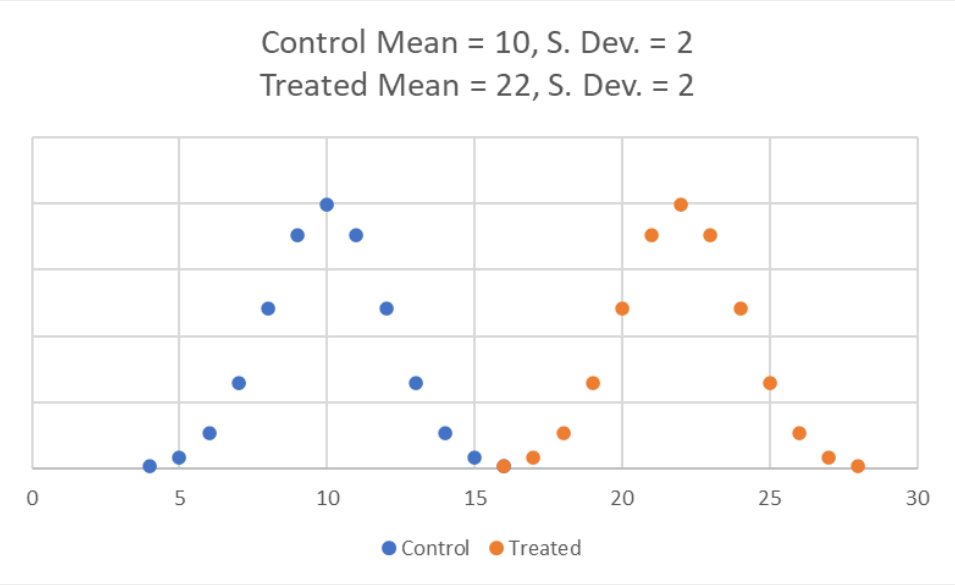
Hypothesis Testing
Alpha – p of calling a difference if the isn't one – false positive
Beta – the p of saying there is no difference when there is one – false negative
1 – beta - power

What influences power?

- D – effect size - the difference between groups
- Variance - the variability within the samples
- N – the number of observations in each group
- Alpha – the significance level you wish to achieve
- One tailed or two tailed test

# Power Analysis

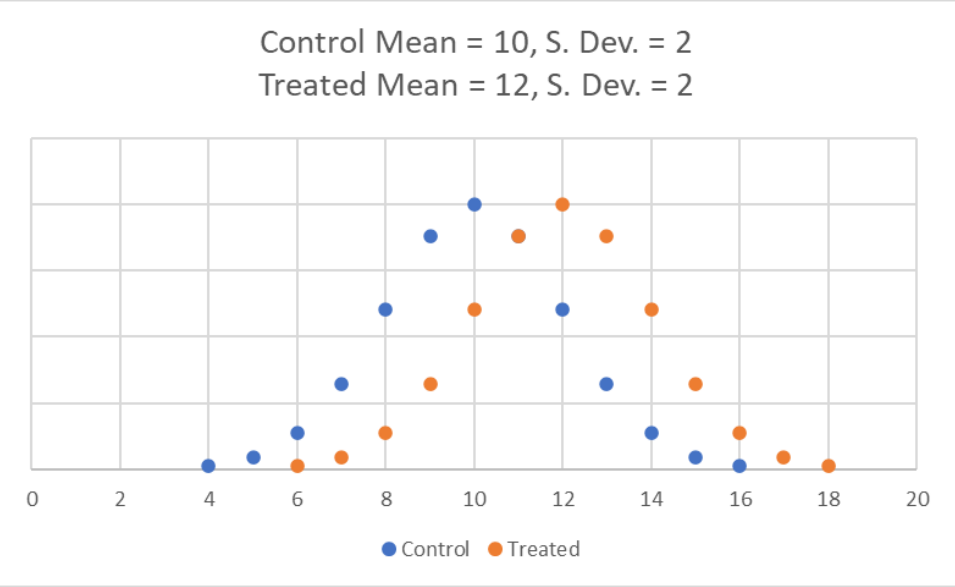
## What is Power In Testing The Difference Between 2 Proportions

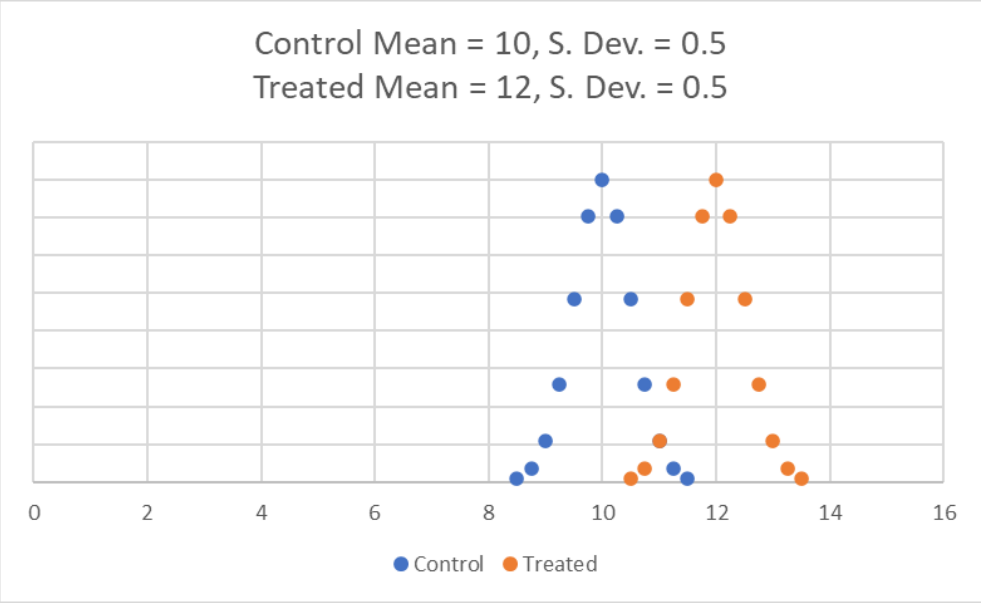



Left – distributions of treated and control that do not overlap
D is large

Lower left – D is made smaller and it is unlikely the difference will be called significant

Lower right – same D but the variance is reduced because I increased N



# Power Analysis

P1 and p2 in this example are buy rates – the proportion of owners who purchased a vehicle
Where does p1 and p1 come from?

- Experience
- Projection – decide how much of a difference is worth finding

Where do we get the significance level?

What about n1 and n2?

Usually we choose a power level we want to achieve and calculate the n required to get there

In this case we have a fixed N and are looking to see how many we need to assign to the control group

# Power Analysis

```
data _null_;
 controlp = .0063;  mailp = controlp * 1.05;
 call symput('control',controlp);  call symput('treated',mailp);
run;

proc power  ;
 twosamplefreq     /* specify the test you're interested in */
 power = .         /* set the parameter you want calculated to missing */
 alpha = .1        /* set alpha */
 sides = U         /* specify 1 tail or two tail test */
 grouppproportions = (&control,&treated)  /* p of control and treated */
 ntotal=1075494    /* total N */
 groupweights= (1 9) (2 8) (25 75) (3 7) (4 6) (5 5)  ; /proportion in each group */
 ;
run;
```

**Note: this treated and control difference could result in the sale of an additional 338 vehicles**

# Power Analysis In Direct Marketing

## 5% improvement Treated vs. Control

| Fixed Scenario Elements | |
|---|---|
| Distribution | Asymptotic normal |
| Method | Normal approximation |
| Number of Sides | U |
| Alpha | 0.1 |
| Group 1 Proportion | 0.0063 |
| Group 2 Proportion | 0.006615 |
| Nominal Total Sample Size | 1075494 |
| Null Proportion Difference | 0 |

Computed Power

| Index | Weight1 | Weight2 | Actual N Total | Power |
|---|---|---|---|---|
| 1 | 1 | 9 | 1075490 | 0.472 |
| 2 | 2 | 8 | 1075490 | 0.634 |
| 3 | 25 | 75 | 1075400 | 0.684 |
| 4 | 3 | 7 | 1075490 | 0.720 |
| 5 | 4 | 6 | 1075490 | 0.763 |
| 6 | 5 | 5 | 1075490 | 0.776 |

## 10% improvement Treated vs. Control

| Fixed Scenario Elements | |
|---|---|
| Distribution | Asymptotic normal |
| Method | Normal approximation |
| Number of Sides | U |
| Alpha | 0.1 |
| Group 1 Proportion | 0.0063 |
| Group 2 Proportion | 0.00693 |
| Nominal Total Sample Size | 1075494 |
| Null Proportion Difference | 0 |

Computed Power

| Index | Weight1 | Weight2 | Actual N Total | Power |
|---|---|---|---|---|
| 1 | 1 | 9 | 1075490 | 0.872 |
| 2 | 2 | 8 | 1075490 | 0.975 |
| 3 | 25 | 75 | 1075400 | 0.987 |
| 4 | 3 | 7 | 1075490 | 0.992 |
| 5 | 4 | 6 | 1075490 | 0.996 |
| 6 | 5 | 5 | 1075490 | 0.997 |

# Power Analysis In Direct Marketing

```
proc power  ;
 twosamplefreq
 power = .          /* calculate power */
 alpha = .1
 sides = U
 grouppproportions = (0.0063, 0.006615)            /*5% improvement in sales */
 ntotal= 500000 1000000 1500000  2000000          /*vary the total sample size */
 groupweights= (1 9) (2 8) (25 75) (3 7)  (5 5) ;       /* same group weights as before */
 plot x = n  YOPTS=(REF=0.8 0.9 ) vary(color by groupweights);
    /* request a plot  x= parameter on x axis, yopts is asking for a reference line, request
different      colors for groupweights lines*/
run;
```

# Power Analysis In Direct Marketing