# Controlled Experimentation

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DSC 96

In the 1700s, a British ship's captain observed the lack of scurvy among sailors serving on the naval ships of Mediterranean countries, where citrus fruit was part of their rations.

He then gave half his crew limes (the Treatment group) while the other half (the Control group) continued with their regular diet.

Despite much grumbling among the crew in the Treatment group, the experiment was a success, showing that consuming limes prevented scurvy.

While the captain did not realize that scurvy is a consequence of vitamin C deficiency, and that limes are rich in vitamin C, the intervention worked.

British sailors eventually were compelled to consume citrus fruit regularly, a practice that gave rise to the still-popular label limeys

https://blog.optimizely.com/2010/11/29/how-obama-raised-60-million-by-running-a-simple-experiment/

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# Button Variations

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# What would you choose?

*The fewer the facts, the stronger the opinion*

– Arnold Glasow

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| Relevance Rating ? | Variation | Est. conv. rate ? | | Chance to Beat Orig. ? | Observed Improvement ? | Conv./Visitors ? |
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# Results

Running a different image and button provided:

- $60M in additional donations
- 2.8M additional email addresses
- 200k additional volunteers

A/B test results are often surprising!

# Experimenting on the Web

The web provides an unprecedented opportunity to evaluate ideas quickly using controlled experiments.

Also called randomized experiments, A/B tests (and their generalizations), split tests, Control/Treatment tests, MultiVariable Tests.

Controlled experiments embody the best scientific design for establishing a causal relationship between changes and their influence on user-observable behavior.

Experience indicates that significant learning and return-on-investment are seen when development teams listen to their customers, not to the highest paid person's opinion.
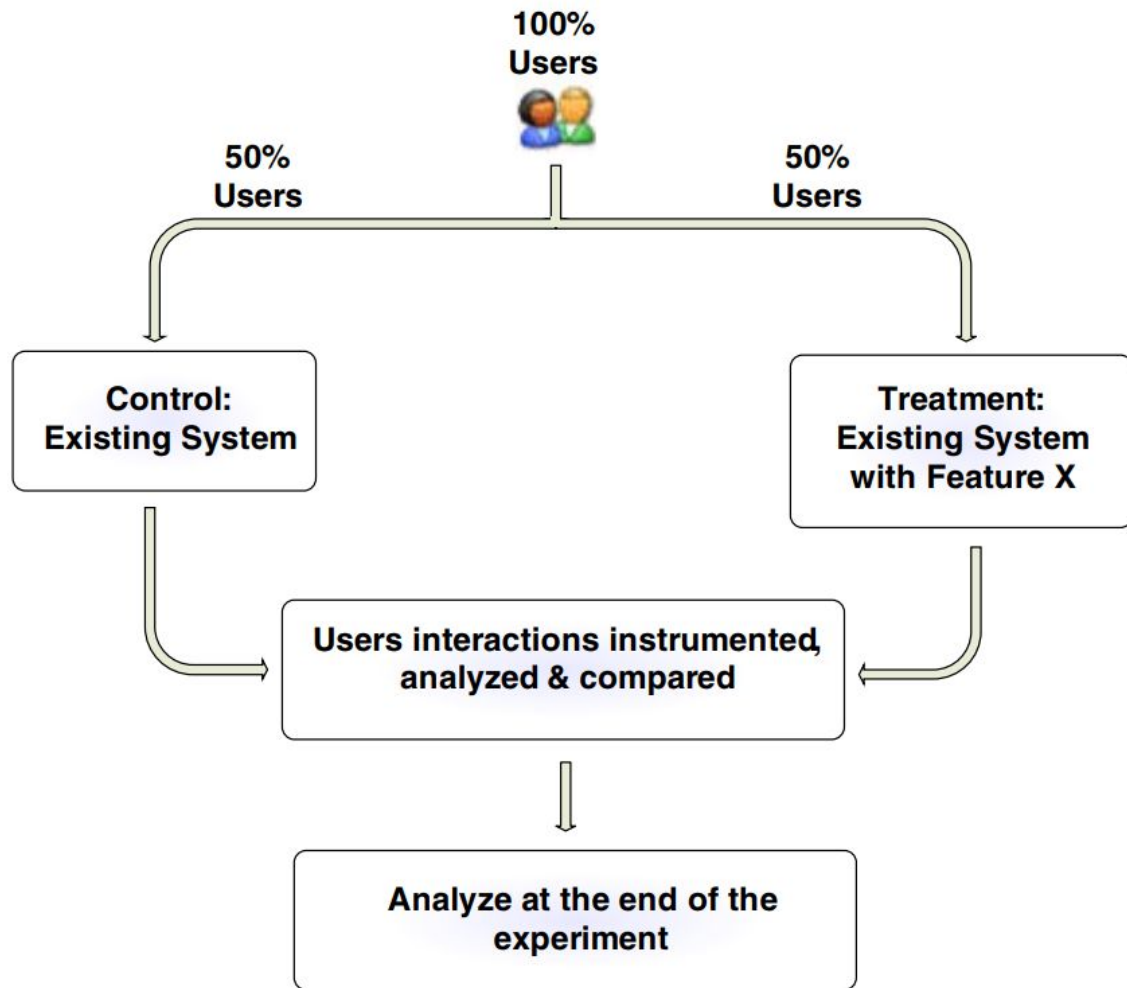
# Minimum sample size

$$n = 16\sigma^2/\Delta^2$$

$\sigma^2$ is the variance of the outcome metric

$\Delta$ is the sensitivity (amount you want to detect) at 80% power

$n$ is the sample size

# Welch's *t*-test

For populations that may not have equal variance or sample size

$$t = \frac{m_1 - m_0}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_0^2}{N_0}}}$$

$m_{0,1}$ are estimated values of the outcome metric (mean of sample)

$\sigma_{0,1}$ are the estimated standard deviations of the two outcome metrics

$N_{0,1}$ are the sample sizes

*t* is the test result. For large samples, it is 95% confident to be significant at 1.96

# Data *Science*

*"A man conducting a gee-whiz science show with fifty thousand dollars' worth of Frankenstein equipment is not doing anything scientific if he knows beforehand what the results of his efforts are going to be. A motorcycle mechanic, on the other hand, who honks the horn to see if the battery works is informally conducting a true scientific experiment. He is testing a hypothesis by putting the question to nature."*

- Zen and the Art of Motorcycle Maintenance