Microsoft

Online Controlled Experimentation at Scale

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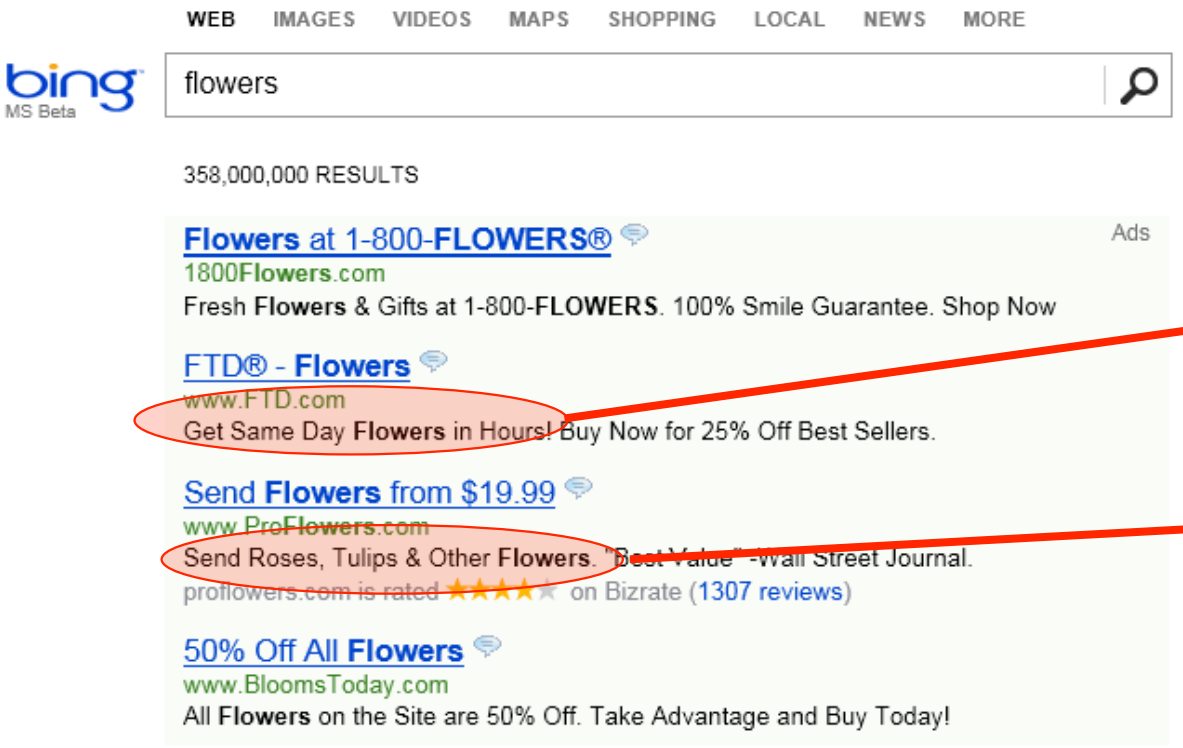
Joint work with many members of the A&E/ExP platform team

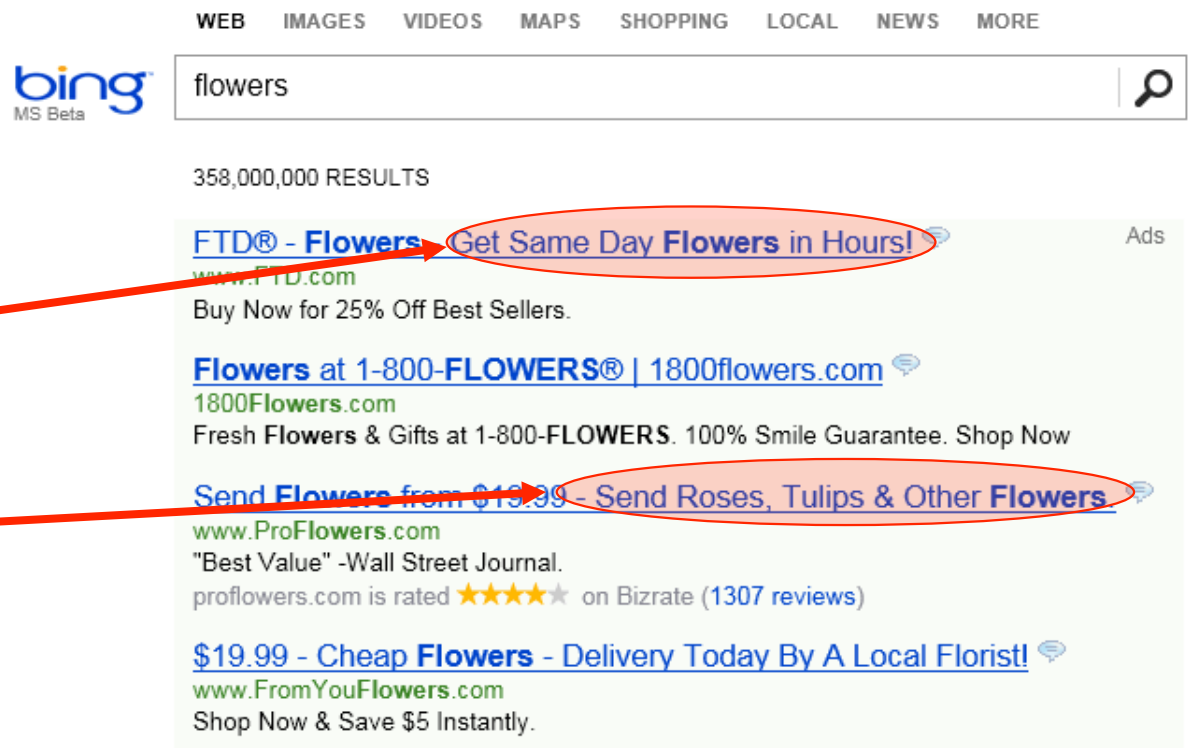
The Life of an Idea (2012)

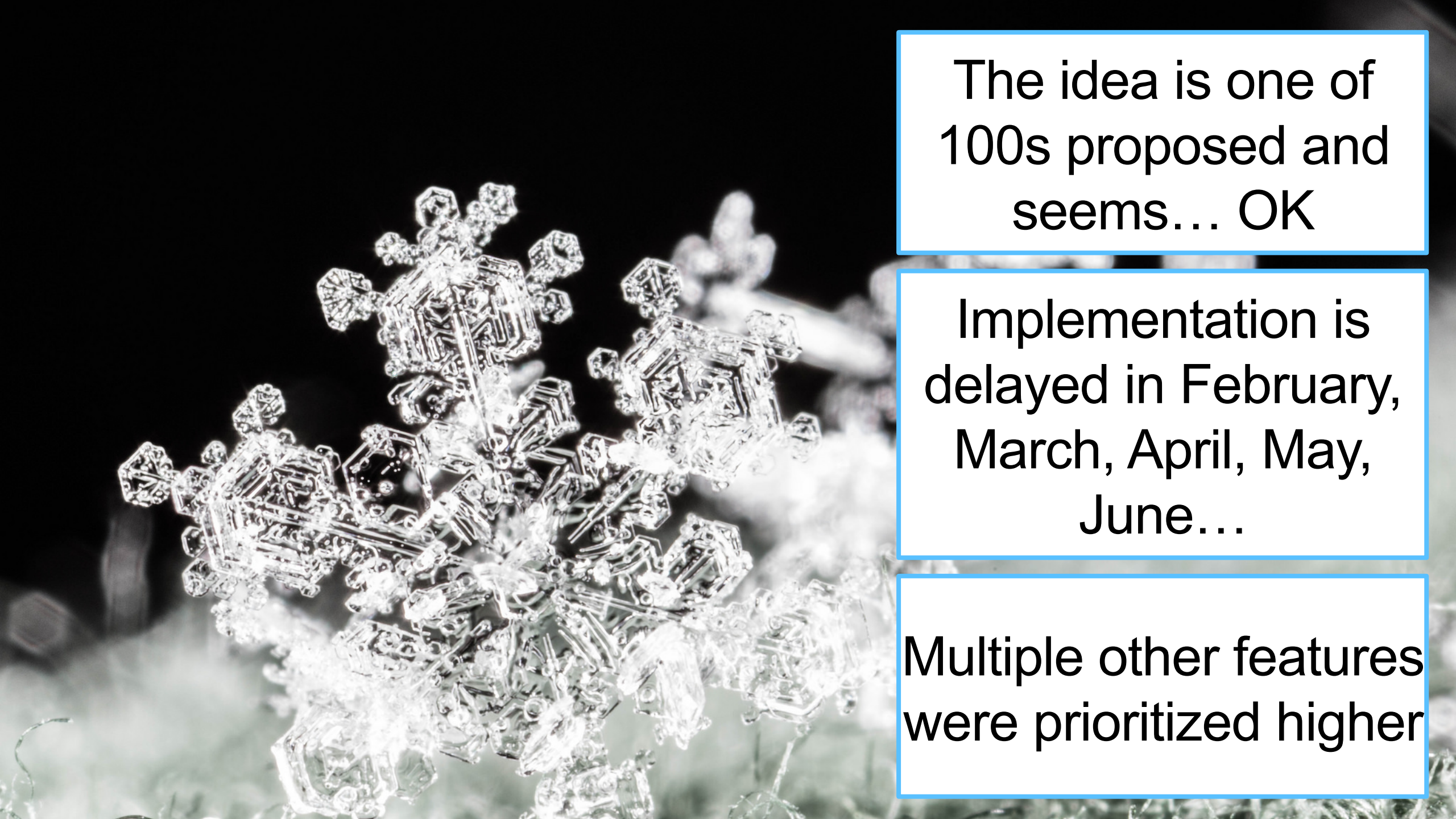
On Bing.com, move ad text to the title line to make it longer

Control – Existing UI



Treatment – Long Ad Titles





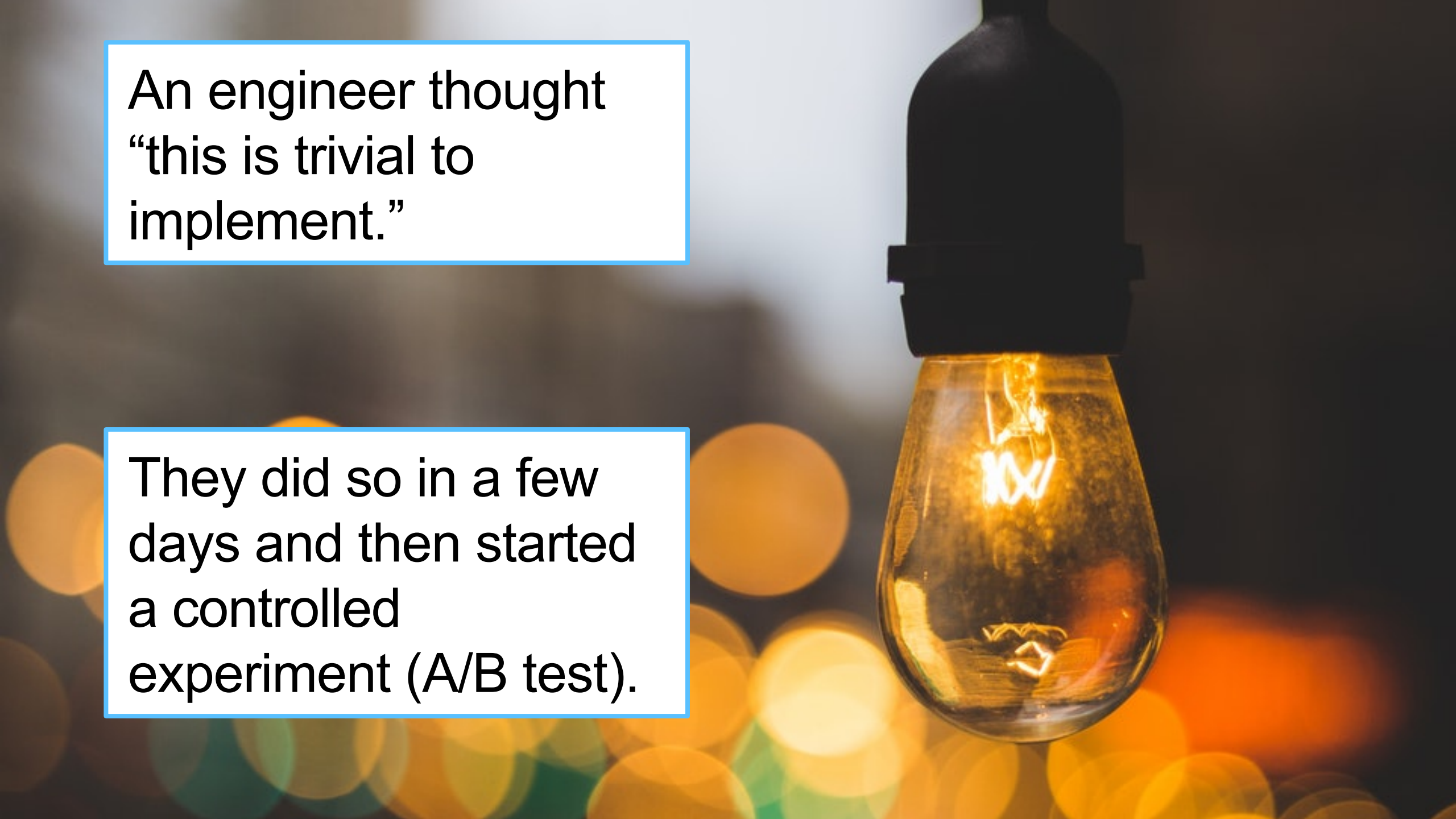
The idea is one of 100s proposed and seems… OK

Implementation is delayed in February, March, April, May, June…

Multiple other features were prioritized higher

An engineer thought “this is trivial to implement.”

They did so in a few days and then started a controlled experiment (A/B test).



What happened?

- An alert fired to say something was wrong with revenue (it was too high).
- This is useful in case you do something like log revenue twice.

- But in this case, it was not a logging bug.

- The change increased Bing's revenue by 12% (over $120M at the time) without hurting any guardrail metrics.

- **We are terrible at assessing the value of ideas.**
- Few ideas generate over $100M in incremental revenue (as this idea), but the **best revenue-generating** idea in Bing's history to that point was badly rated and delayed for months!

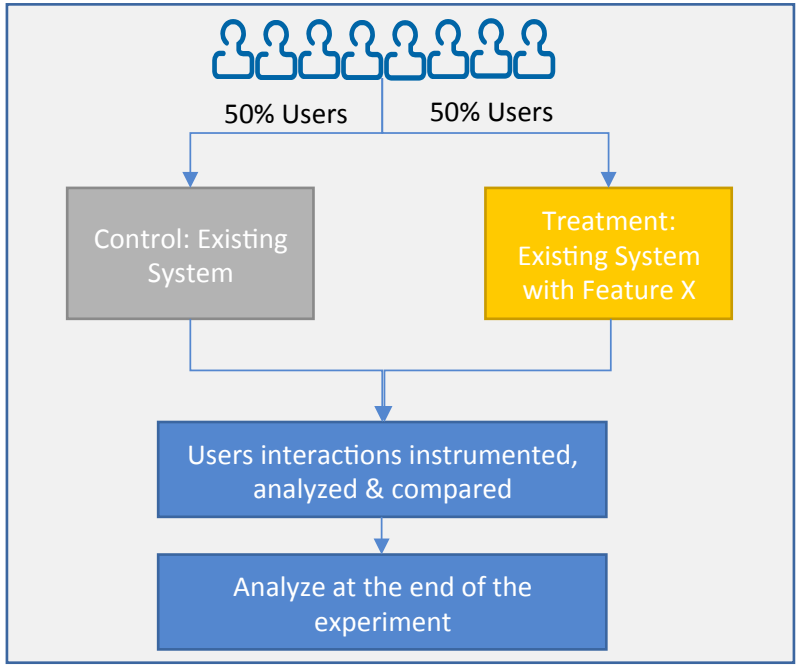
Agenda

- **Experimentation at scale:** How to manage an experimentation lifecycle for over 24,000 experiments/year
- **Three examples of real A/B tests:** You are the decision maker
- **Four important lessons:** Take home wisdom for online experiments at scale.

Online Controlled Experiments (A/B/n Tests)

- Simple concept:
  1. Randomly split traffic between two (or more) versions
     - Control: Existing System
     - Treatment(s): Feature(s) being tested
  2. Collect metrics of interest
  3. Analyze
- Must run statistical tests to confirm differences are not due to chance
- Sample of real users
  Not WEIRD (Western, Educated, Industrialized, Rich, and Democratic) like many academic research samples
- Scientific way to prove causality,
  i.e., the changes in metrics are caused by changes introduced in the treatment(s)
- Used by Microsoft, Google, Facebook, Netflix, LinkedIn, and many others

Is my new **Feature X** effective?



Our Mission:

Accelerate innovation through trustworthy analysis and experimentation

EXPERIMENT EVERYTHING

- Currently serving multiple Microsoft organizations

TRUSTWORTHINESS

- Empower the HiPPO (Highest Paid Person's Opinion) with data

Bing
Cortana
Windows
Office

Exchange
OneNote
Skype
Teams
Edge

msn
Store
Photos
Visual Studio
XBOX

Team of 110+ people

~60 developers

~40 data scientists

~10 program managers

Three Real Examples

1. Bing Search Engine Results Page Truncation
2. Windows Search Box
3. Killer Instinct Initial Character

About the Real Examples

Three real **experiments that ran at Microsoft**

All had **enough users for statistical validity**

For each, I provide the **Overall Evaluation Criterion (OEC)**

The challenge: You predict which variant will do best (by the OEC).

- Everyone please stand up.
- You will be given three options and answer by raising **left hand**, **right hand**, or **neither hand**.
- If you're wrong, please sit down.
- Random guessing implies 100%/(3^3) = ~4% will get all three questions right.
- **Let's see if the room can beat random guessing!**

Example 1: Bing SERP Truncation

SERP = Search Engine Result Page

Version A: show 10 algorithmic search results

Version B: show 8 algorithmic search results by removing the last 2 results

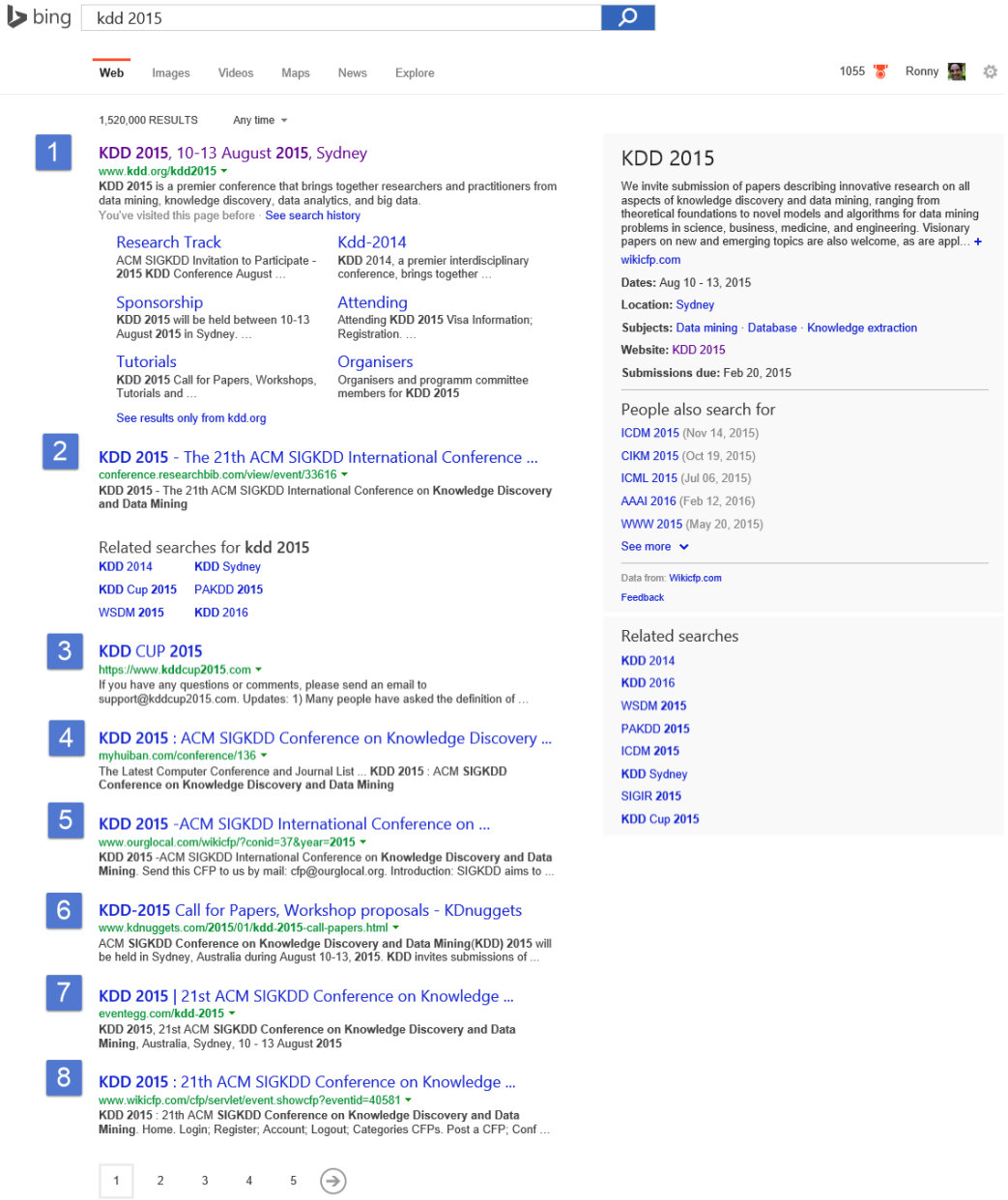
OEC: Clickthrough Rate on 1st SERP per query

The challenge:

Raise your left hand if you think **A Wins**

Raise your right hand if you think **B Wins**

Don't raise your hand if you think they are **about the same**



Bing SERP Truncation Results

If you raised any hand, please sit down

While there are obviously exceptions, most of the time users click at the same rate.

In this case, with over 3M users in each variant, we could not detect a stat-sig delta.
Users simply shifted the clicks from the last two algorithmic results to other elements of the page.

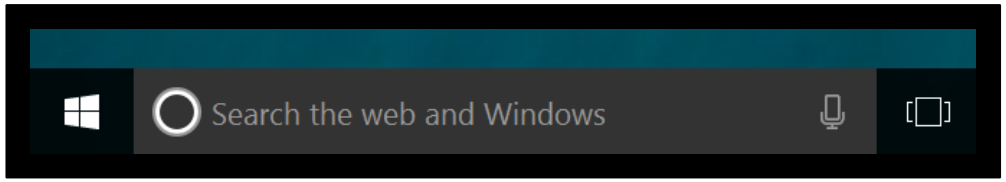
A&E wrote a paper with several rules of thumb (http://bit.ly/expRulesOfThumb)

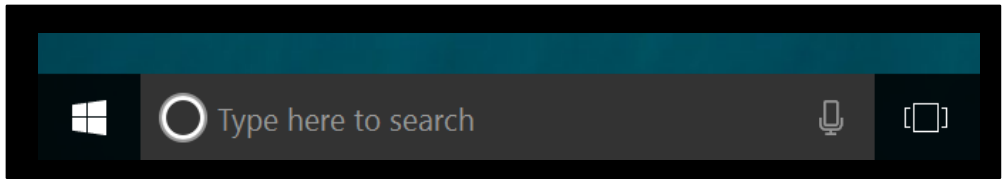
Rule of Thumb: Reducing abandonment (1-clickthrough-rate) is hard.
Shifting clicks is easy

Example 2: Windows Search Box

The Search box is the lower left part of the taskbar for most of the ~500M machines running Windows 10

Here are the two variants:





Version A: search box says “Search the web and Windows”

Version B: search box says “Type here to search”

OEC: User engagement, i.e. more searches (and thus more Bing revenue)

The challenge:
Raise your left hand if you think **A Wins**
Raise your right hand if you think **B Wins**
Don’t raise your hand if you think they are **about the same**

Windows Search Box Results

If you didn’t raise a hand, please sit down

If you raised your left hand, please sit down

If you raised your right hand, you are good! (or you’ve looked closely at the lower left of your Windows 10 UI sometime since 2017)

We actually tested 4 variants here (listed in order of performance):

1. “Type here to search” (**WINNER**)
2. “What can I help you find?”
3. “Ask me anything” (Control – the design that shipped with Windows 10)
4. “Search the web and Windows” (the one shown in prior slide)

This change was worth several million dollars/year

Example 3:
Xbox – Killer Instinct

Fighting video game that runs on the Xbox One console

Freemium Model: can play one character for free (Jago) but must pay to play others

Team hopes to **increase revenue** by getting players to purchase additional characters

Example 3: Xbox – Killer Instinct

Should Killer Instinct use Jago or Glacius as initial free character?

Here are the two variants:

Version A: Jago as initial free character

Version B: Glacius as initial free character

OEC: Revenue

The challenge:
Raise your left hand if you think **A Wins**
Raise your right hand if you think **B Wins**
Don’t raise your hand if you think they are **about the same**

Killer Instinct

If you didn’t raise a hand, please sit down

If you raised your left hand, please sit down

If you raised your right hand, you are right!

Revenue increased, but here engagement (time in game) decreased

*Takeaway: Stop debating or voting on what to ship → **get the data**.*

Four Important Lessons

1. Agree on a Good Overall Evaluation Criteria (OEC)
2. Most Ideas Fail
3. Small Changes can have Big Impacts
4. Validate the Experimentation System

Lesson #1: Agree on a good OEC

- Overall Evaluation Criteria → OEC
- Getting agreement on the OEC in an org is a huge step forward
- OEC should:
  - Predict long-term value
  - Be hard to game
- Criterion could be function of various factors, such as:

  Conversion/action, time to action, visit frequency

See also:
http://exp-platform.com/advanced-topics-in-online-experiments/

Example of a Bad OEC

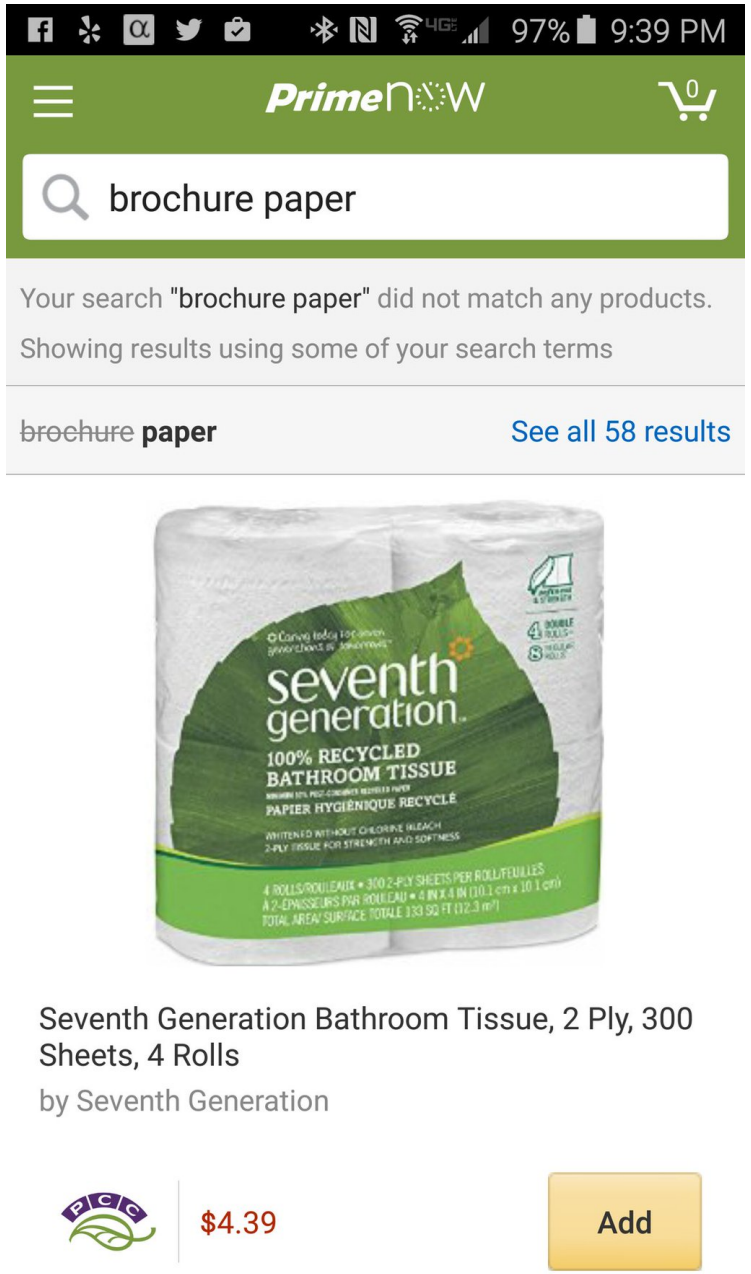
Your data science team makes an observation:

2% of queries end up with "No results."

Team decides to minimize the "count of no results" metric

… But this optimization can have unintended consequences

This is a real example from Amazon Prime Now search (via @RonnyK).



Lesson #2: Most Ideas Fail

Features are built because teams believe they are useful.
But most experiments show that features fail to move the metrics they were designed to improve

Based on experiments at Microsoft (paper)

- 1/3 of ideas were positive ideas and statistically significant
- 1/3 of ideas were flat: no statistically significant difference
- 1/3 of ideas were negative and statistically significant

Experiment often

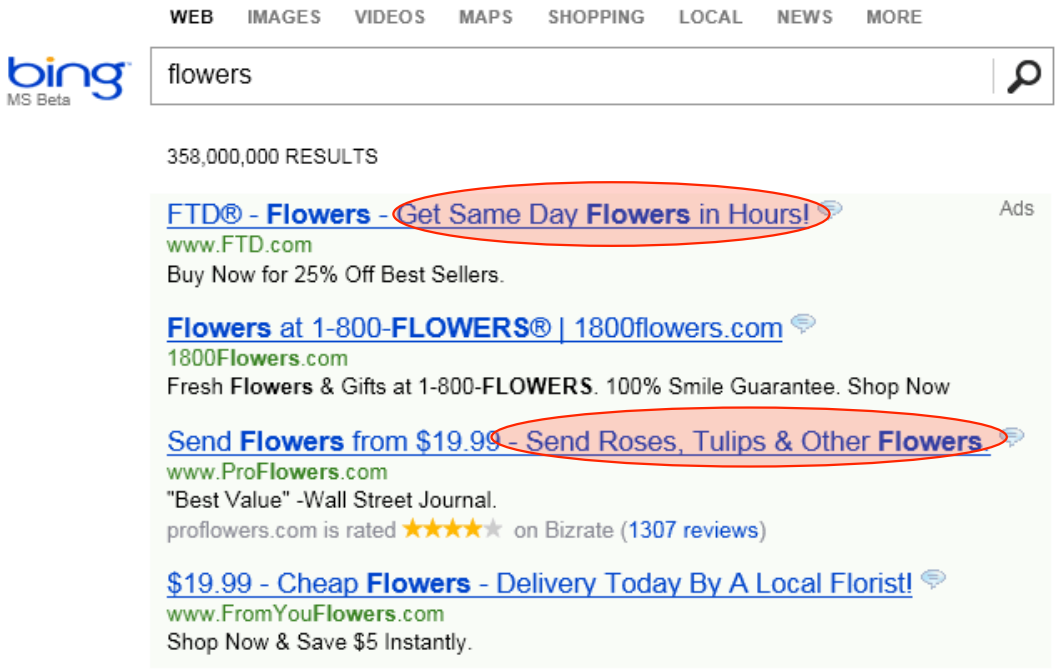
"If you have to kiss a lot of frogs to find a prince, find more frogs and kiss them faster and faster"
-- Mike Moran, Do it Wrong Quickly

Try radical ideas. You may be surprised

- Doubly true if it's cheap to implement

Lesson #3: Small Changes can have a Big Impact to Key Metrics

Opening example (Bing Ads) worth over $120M annually



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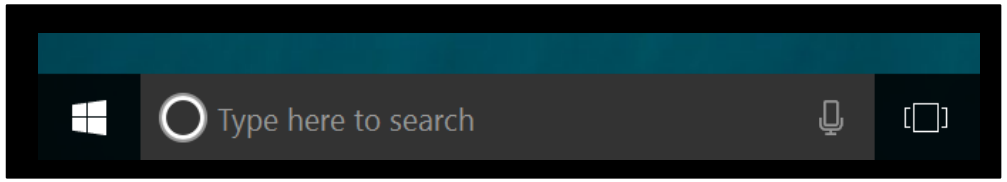
Windows Search box example: $5M+



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Site Links in Ads: $50M annually

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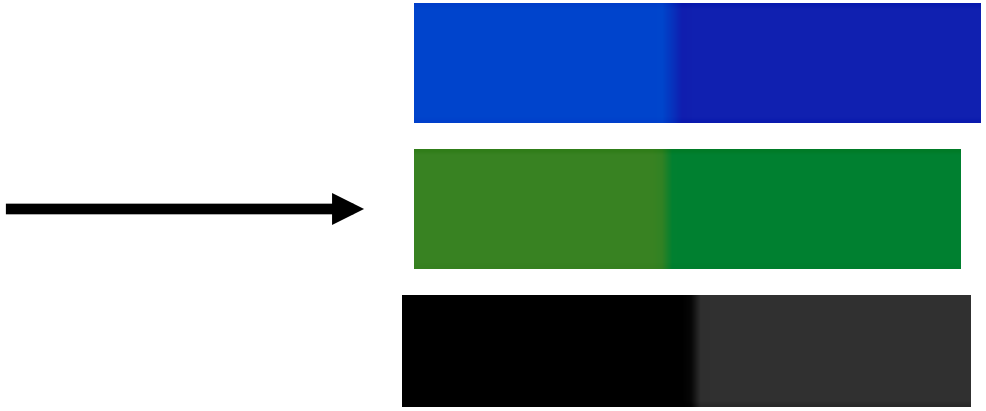
Site Links in Ads: $50M annually

Changed text color for fonts in Bing: $10M annually



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Opening example (Bing Ads) worth over $120M annually

Windows Search box example: $5M+

Site Links in Ads: $50M annually

Changed text color for fonts in Bing: $10M annually

100msec improvement in Bing server perf: $18M annually

Bing

Lesson #3: Small Changes can have a Big Impact to Key Metrics

But these are the rare gems amongst tens of thousands of experiments

4,000+	2,000+	250,000+
Users/month	Experiments/month	Scorecards/year

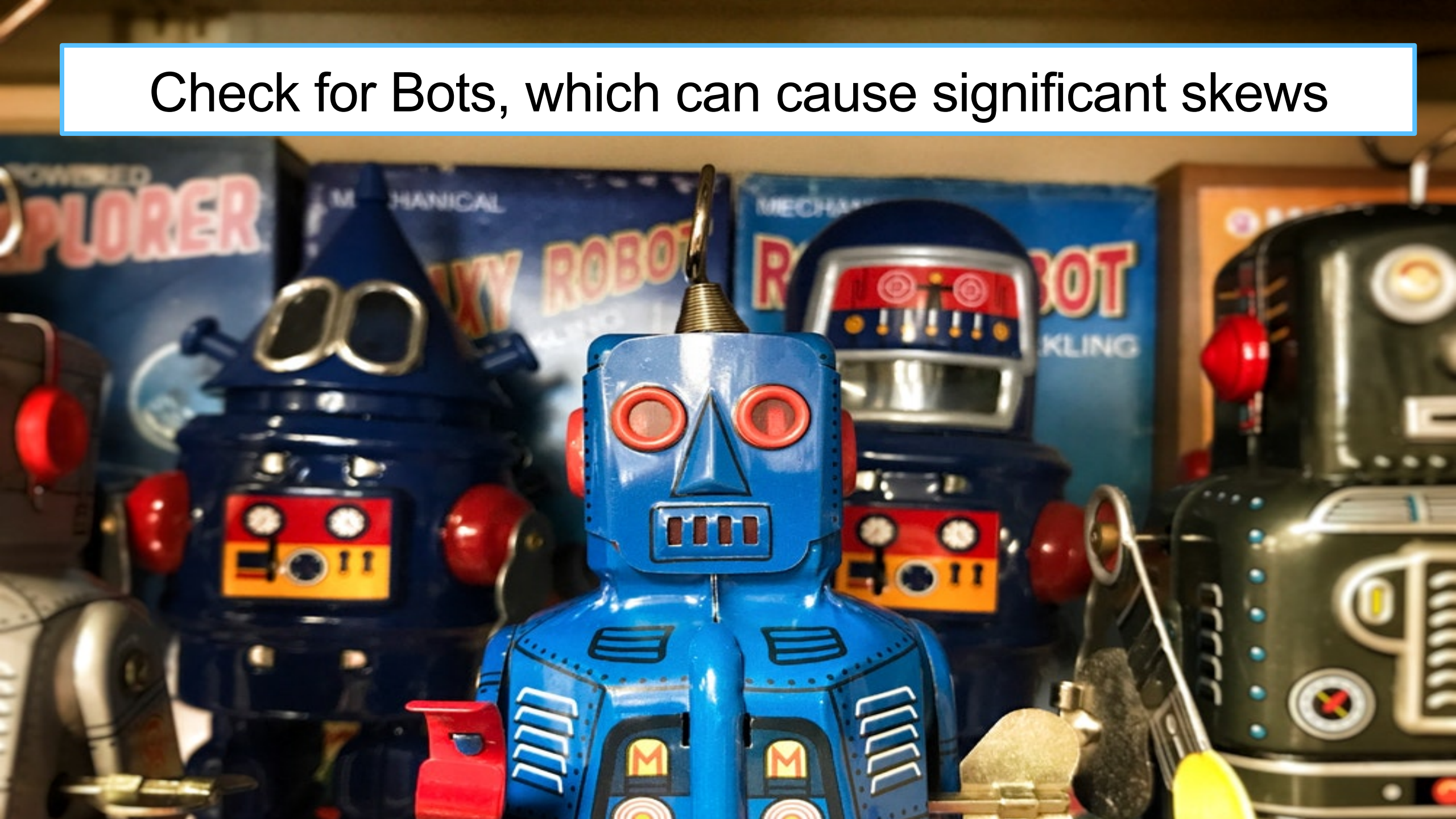
Office XBOX Windows Bing Microsoft Teams Skype msn

Lesson #4: Validate the Experimentation System

- Software that shows p-values with many digits of precision leads users to trust it, but the statistics or implementation behind it could be buggy
- **Getting numbers is easy; getting numbers you can trust is hard**

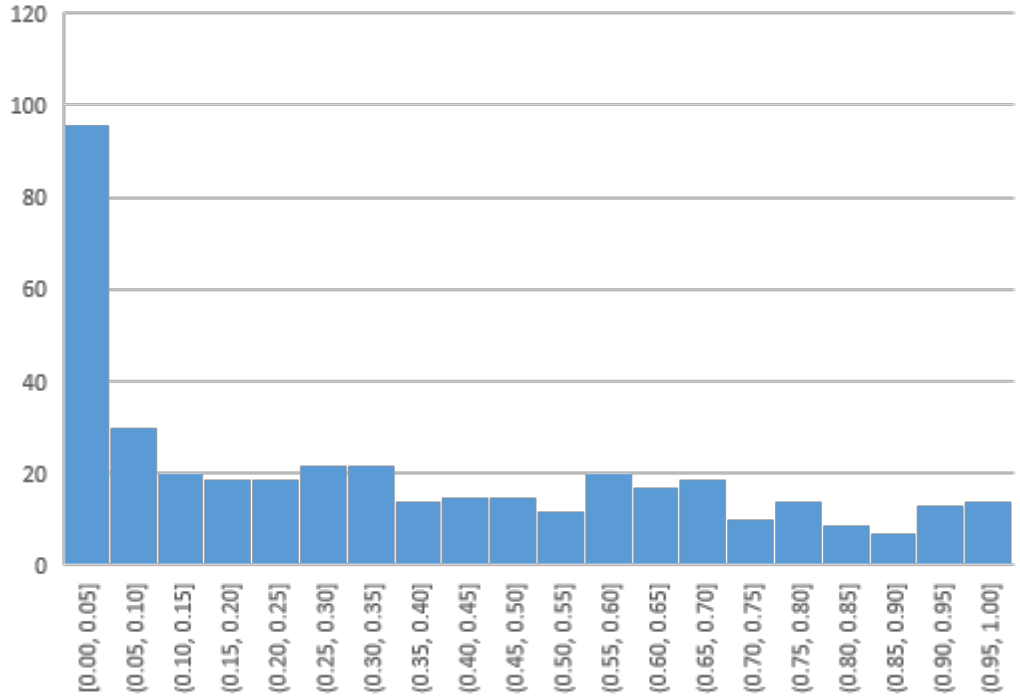
- Let’s cover 3 validation recommendations
  - Bot Detection
  - A/A Tests
  - Sample Ratio Mismatch (SRM) Checks

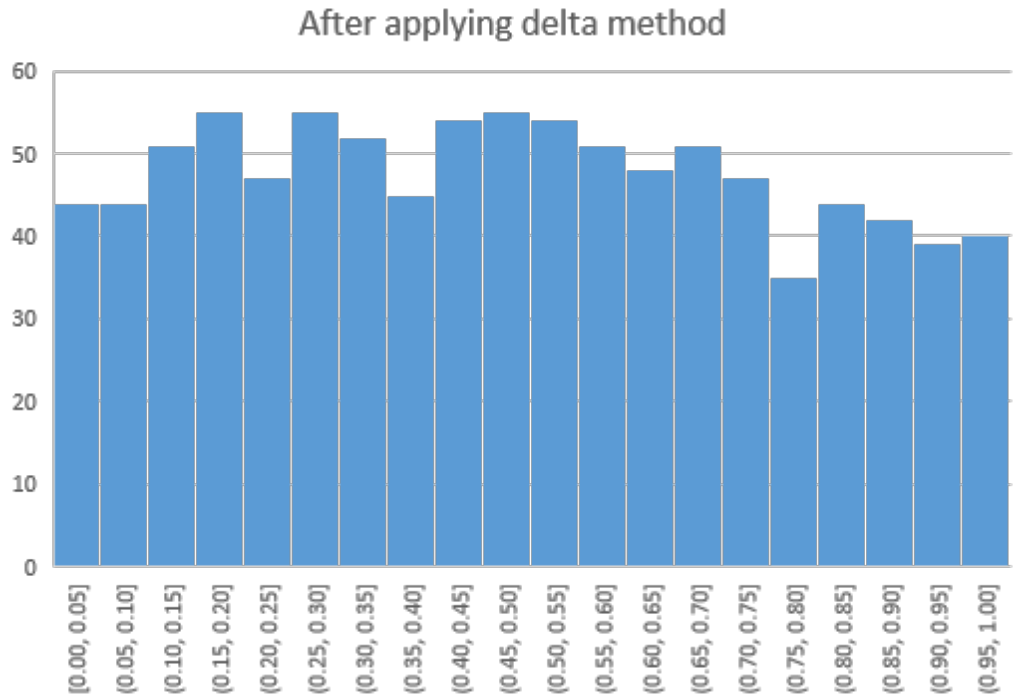
Check for Bots, which can cause significant skews



Run A/A Tests

- If the system is operating correctly, the system should find a stat-sig difference only about 5% of the time.
- P-value distribution for metrics in A/A tests should be uniform
- Do 1,000 A/A tests, and check if the distribution is uniform for each metric
- We tried this for some Skype metrics, and we had to correct things (delta method)





Run Sample Ratio Mismatch (SRM) Checks

Real example

- Control: 821,588 users
- Treatment: 815,482 users
- Ratio: 50.2% (should have been 50%)

Should I be worried?

Absolutely!

The p-value is 1.8e-6, so the probability of this split (or more extreme) happening by chance is less than 1 in 500,000

(the Null hypothesis is true by design)

Summary

- Think about the OEC. Agree on what to optimize and measure it.
- Compute the statistics carefully
  - Getting numbers is easy. Getting a number you can trust is harder
- Be skeptical and triple check things before you celebrate. See http://bit.ly/twymanLaw

Any figure that looks interesting or different is usually wrong

- Experiment often:
  - Triple your experiment rate and you triple your success (and failure) rates. Fail fast & often!
  - Accelerate innovation by lowering the cost of experimenting.
- See http://exp-platform.com for papers

Are we hiring?

Yes!

Email me for details:

kaadotey@microsoft.com

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