



# Arc

# Big Data, Personalization, Automation

Shailesh Prakash, CIO  
The Washington Post





Excellence in Journalism

HI



LO

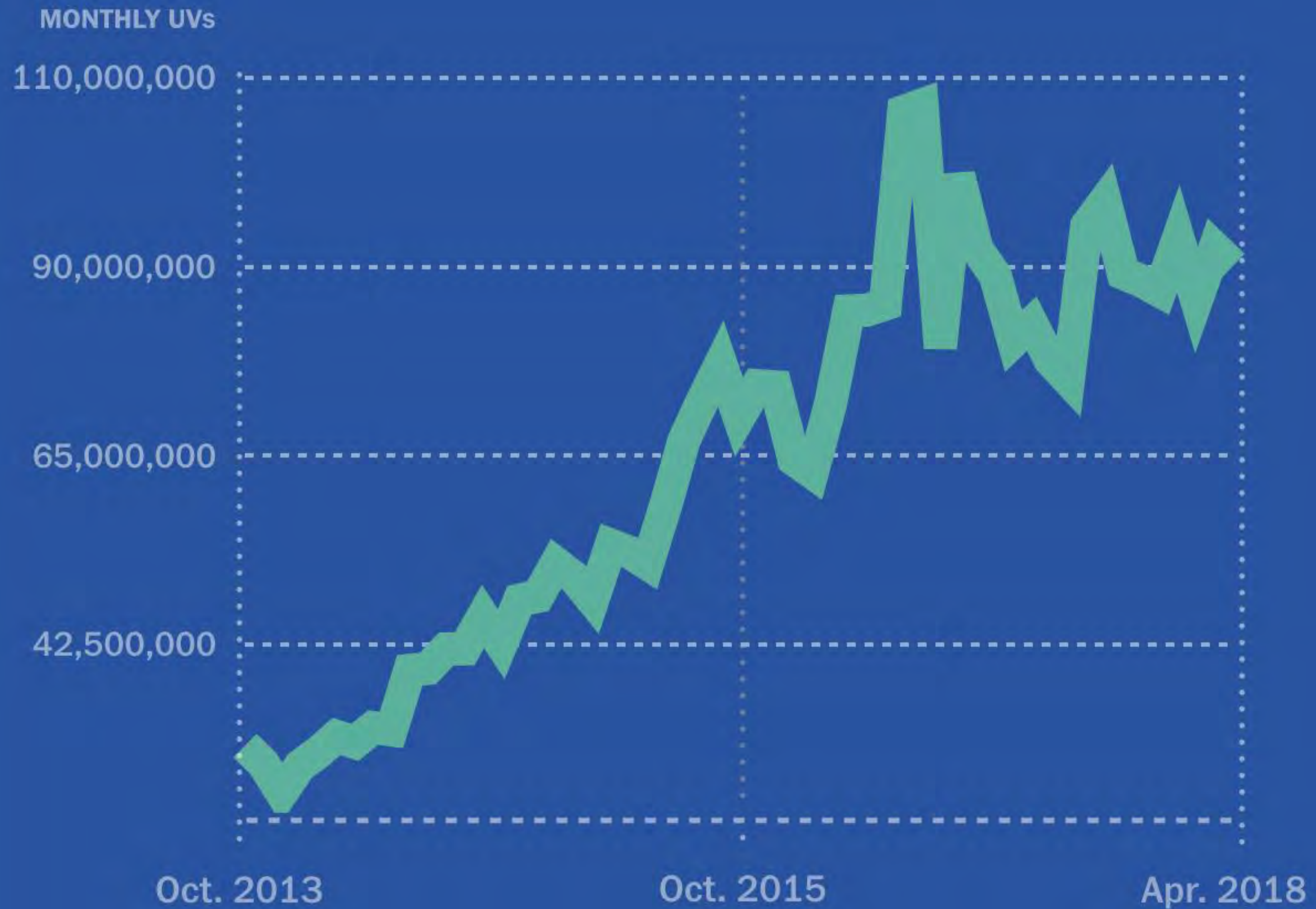


HI

Excellence in Engineering

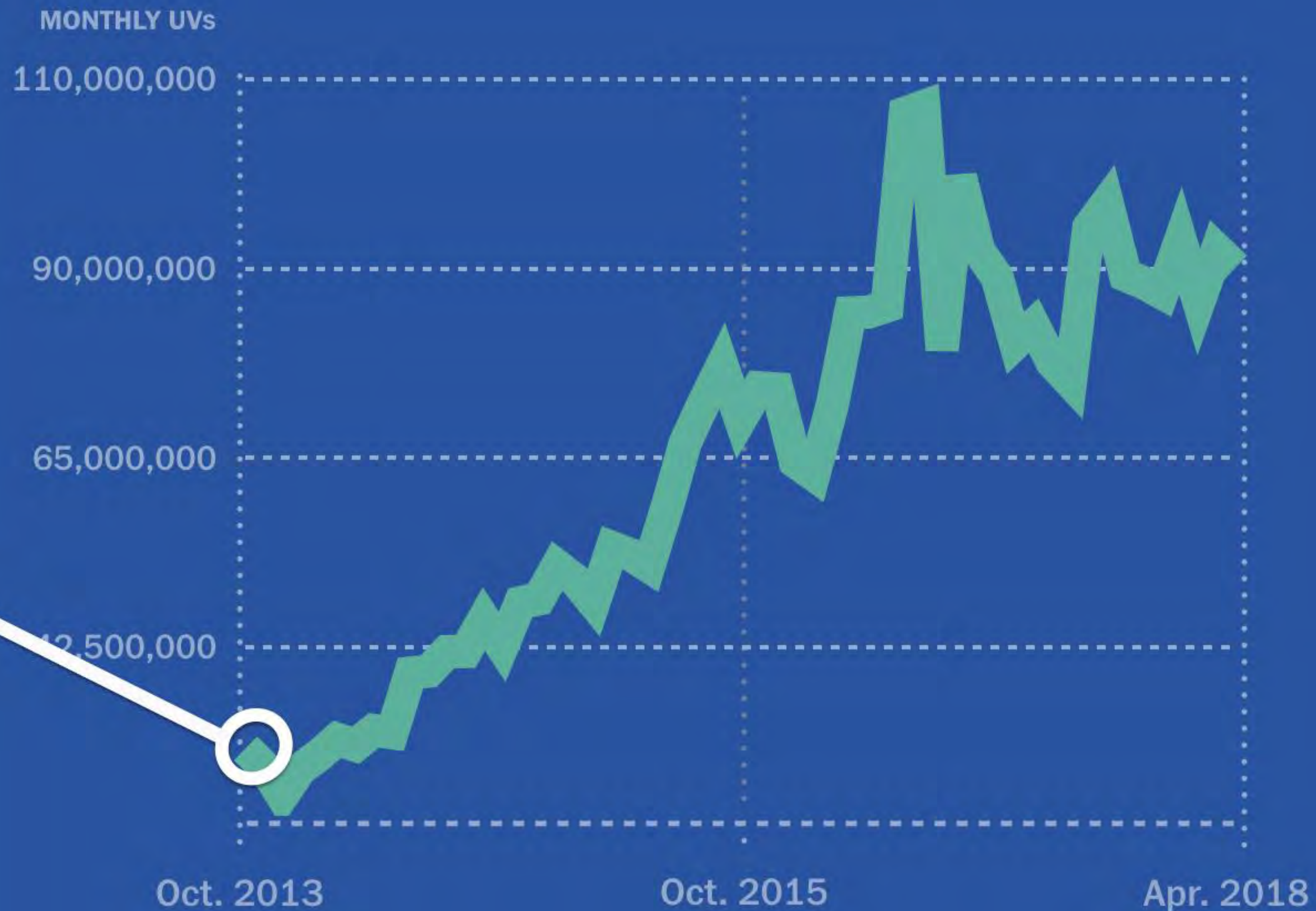
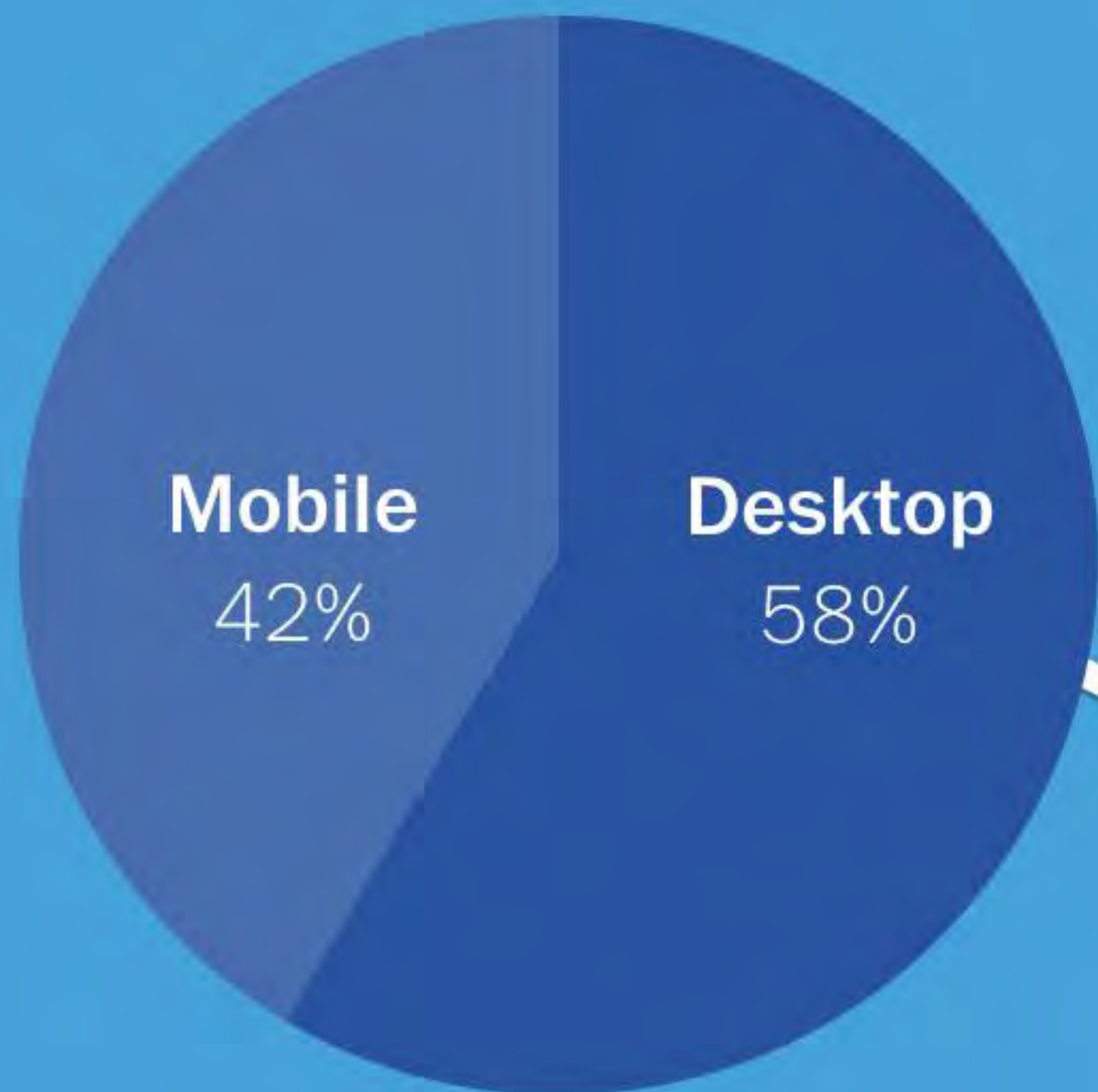


# Growth

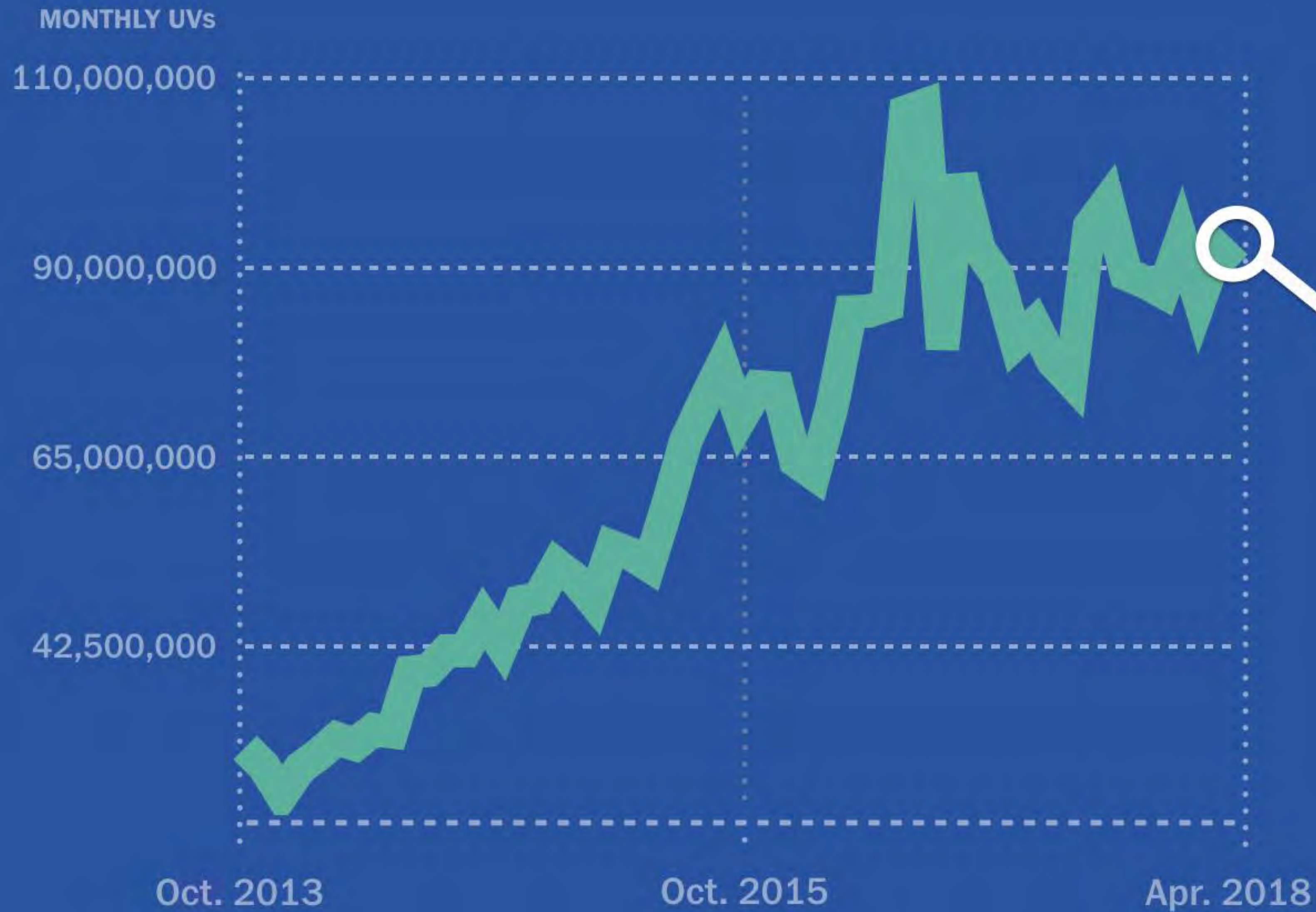




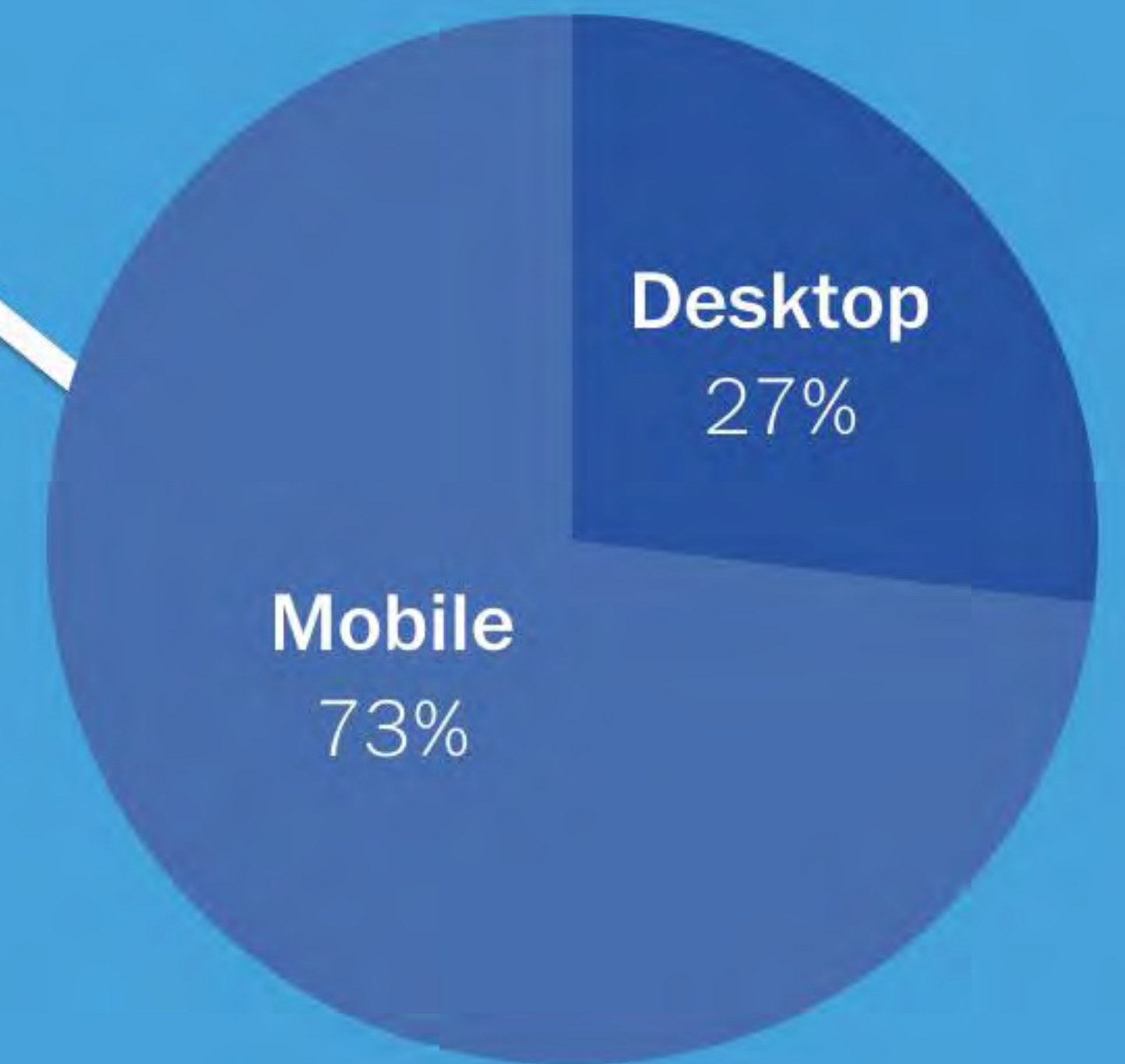
**Oct. 2013**



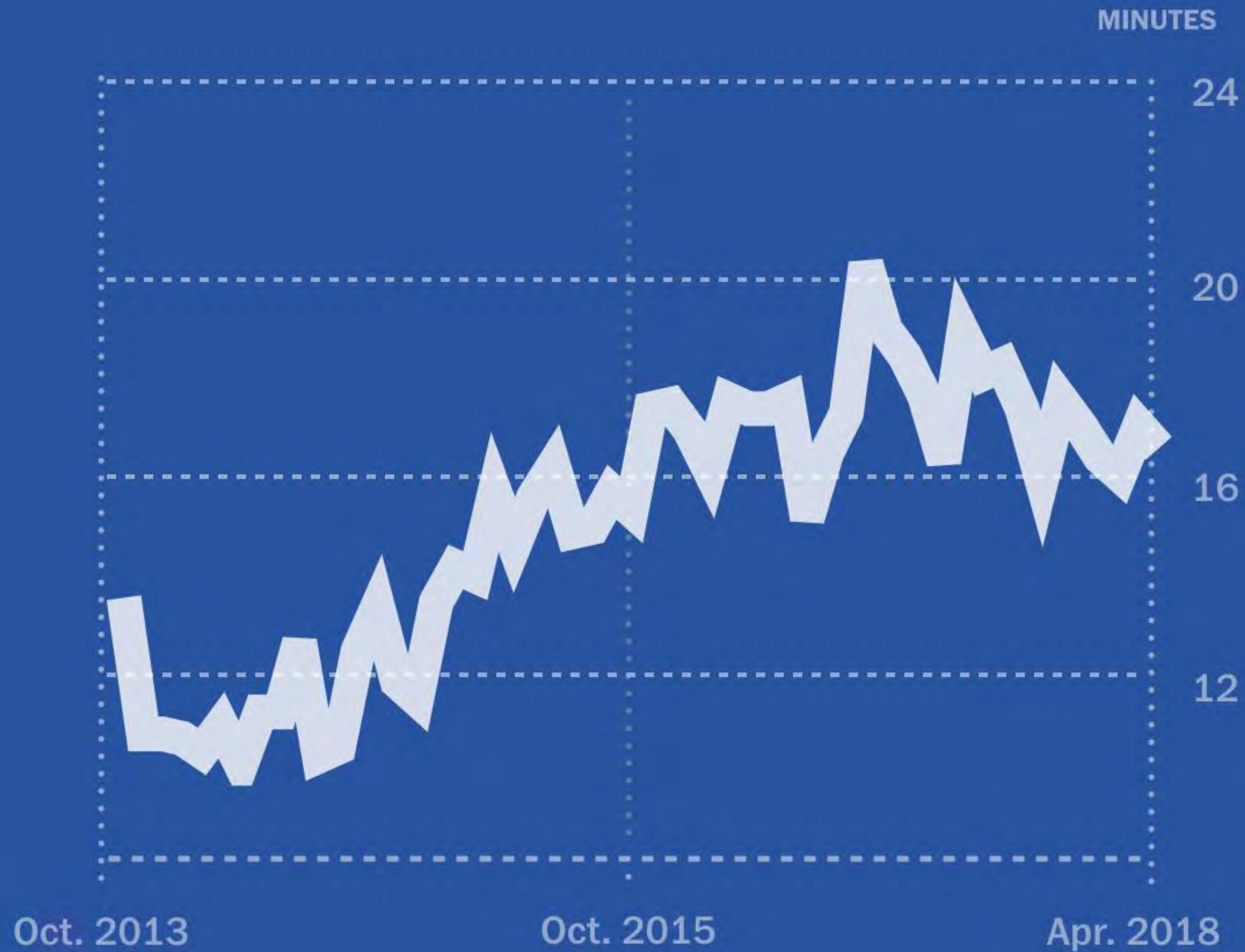




## April 2018

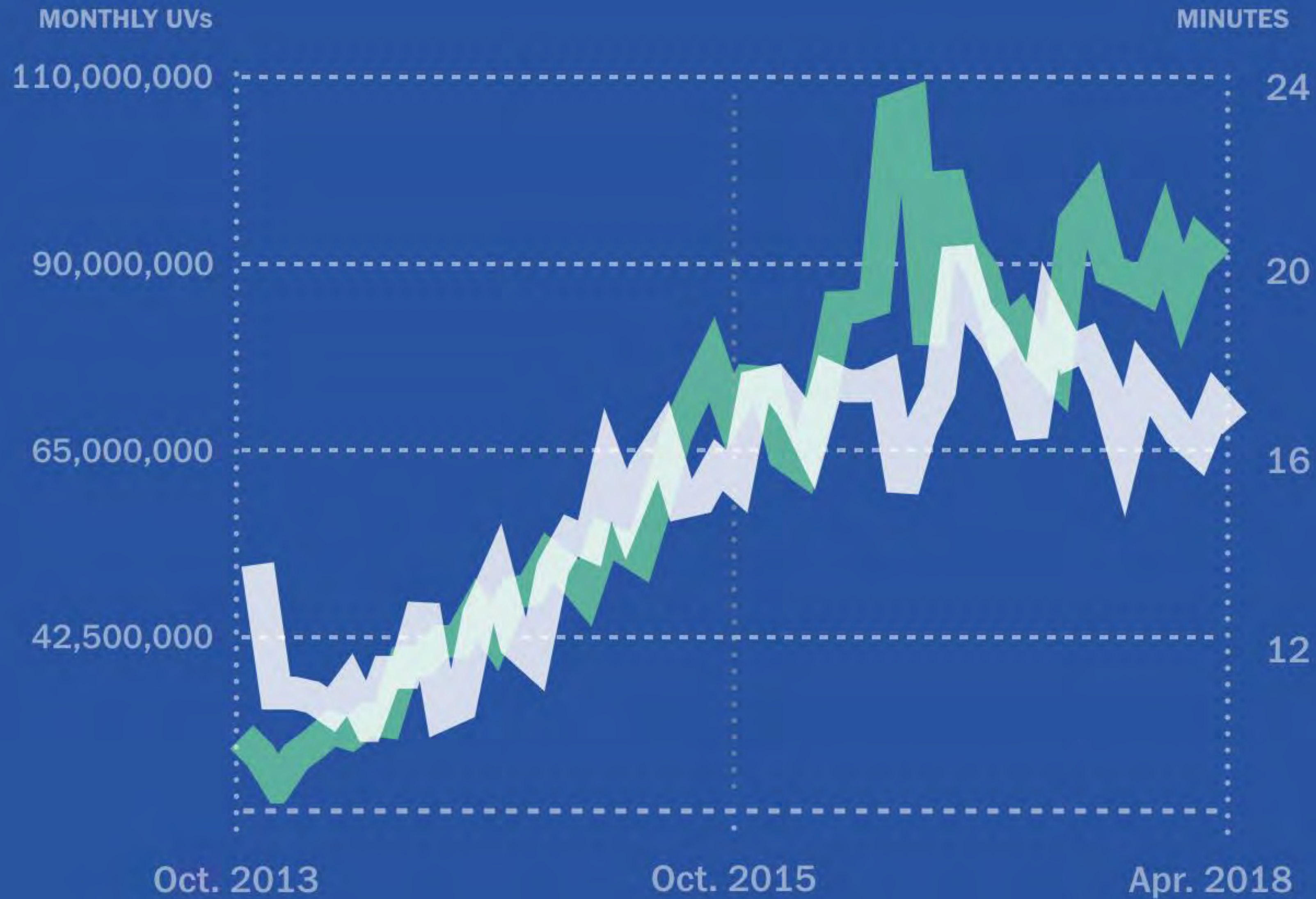






# Time Spent





**Growth  
+ Depth**



**01**

Most Innovative  
Media Company

**08**

Most Innovative  
Company

**FAST COMPANY**

---

**THE WORLD'S**

**MOST INNOVATIVE**

**COMPANIES 2018**



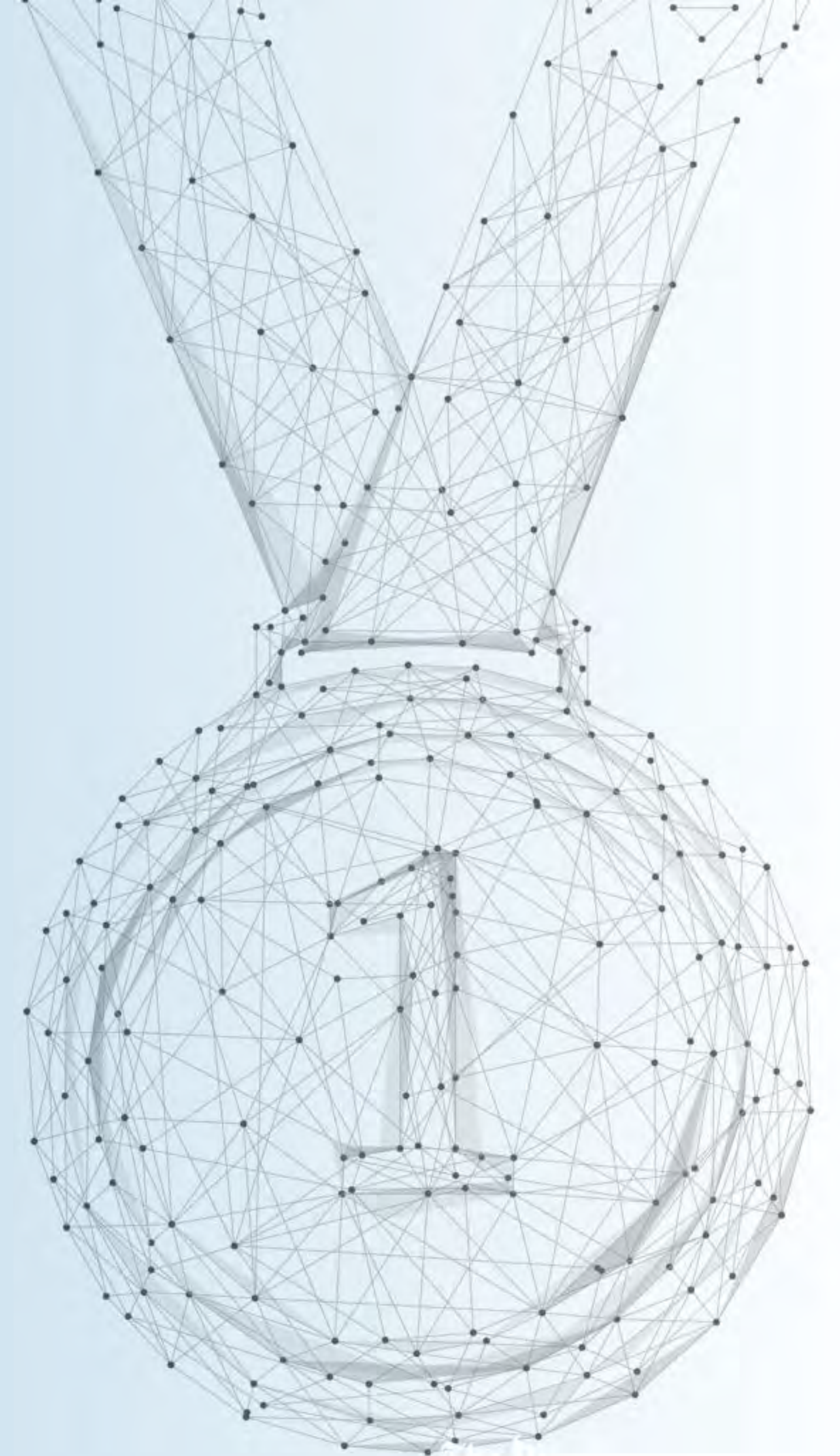


# Heliograf

Excellence in Use of Bots

# ModBot

Excellence in Use of Artificial Intelligence





# 1st Place

Best News Website

Best New Product

Innovation (Arc)



The Washington Post



**CLICK STREAM**

**CIRCULATION**

**SUBSCRIBER**

**CONTENT**

**ADVERTISING**

**SOCIAL**

**PERFORMANCE**

**REGISTRATION**



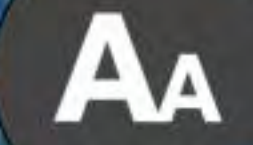
**CLAVIS**



**VIRALITY**



**BANDITO**



**HEADLINER**



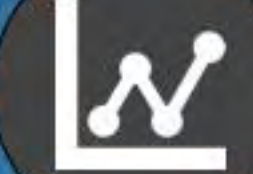
**HELIOGRAF**



**HELIOVIDEO**



**MODBOT**



**LOXODO**



# Clavis

Suite of audience-targeting technologies

- Analyze everything we publish
- Unique understanding of every reader
- Personalized content and brand messaging





# Personalized Experience

- Recommendation module
- Location-specific content
- Segment-based personalization
- Newsletter recommendations
- Ability to follow topics
- Video recommendations

## The Post Recommends



### A doctor flew into a sudden rage and threatened to decapitate, disembowel employees and patients

Terrified employees said they were calling the police, authorities said. The doctor warned them they would be dead before the cops got there.

Apr 30



### Perspective

### I was judged for having sex after my husband died. I think he would have understood.

In the depths of my grief, I wanted sex and intimacy without having to date or be emotionally available.

Apr 20



### Analysis

### Why a South Korean newspaper asked experts to look at photos of Kim Jong Un's shoes

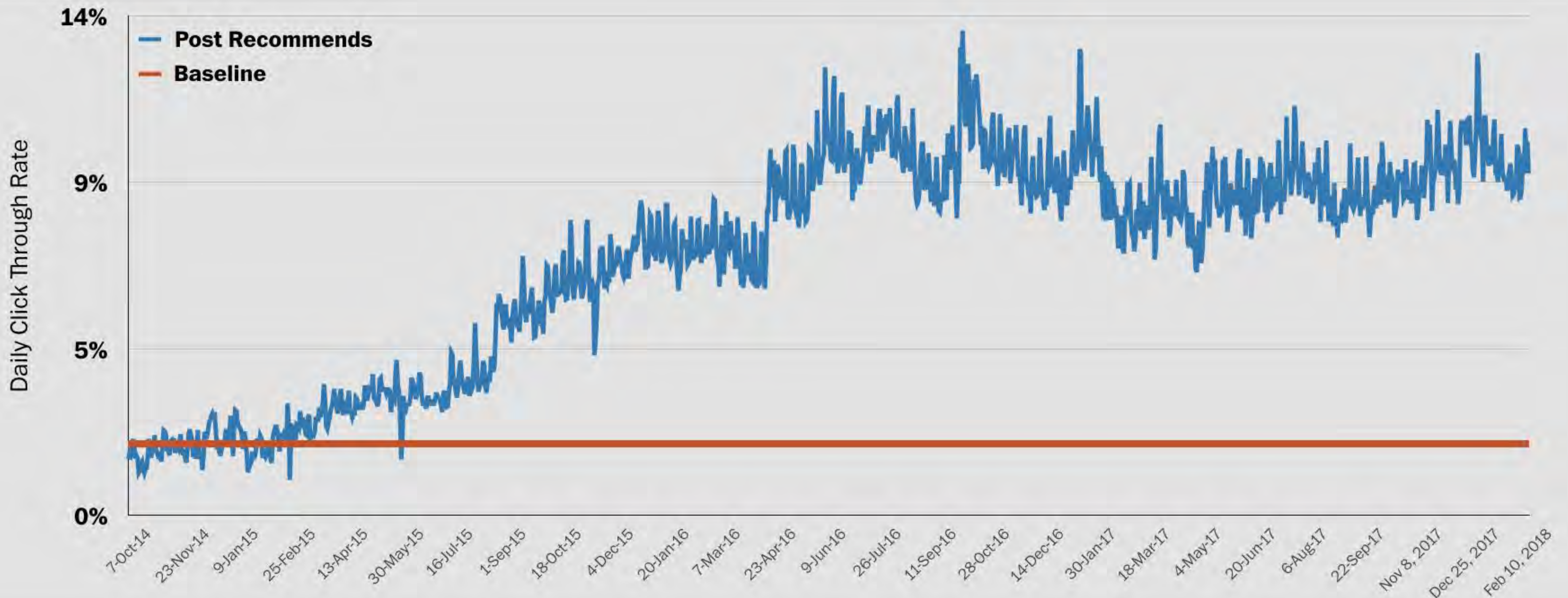
Footage of North Korea's leader is under intense scrutiny for what it says about Kim's lifestyle.

4 days ago



# Recommendation Module Daily CTR

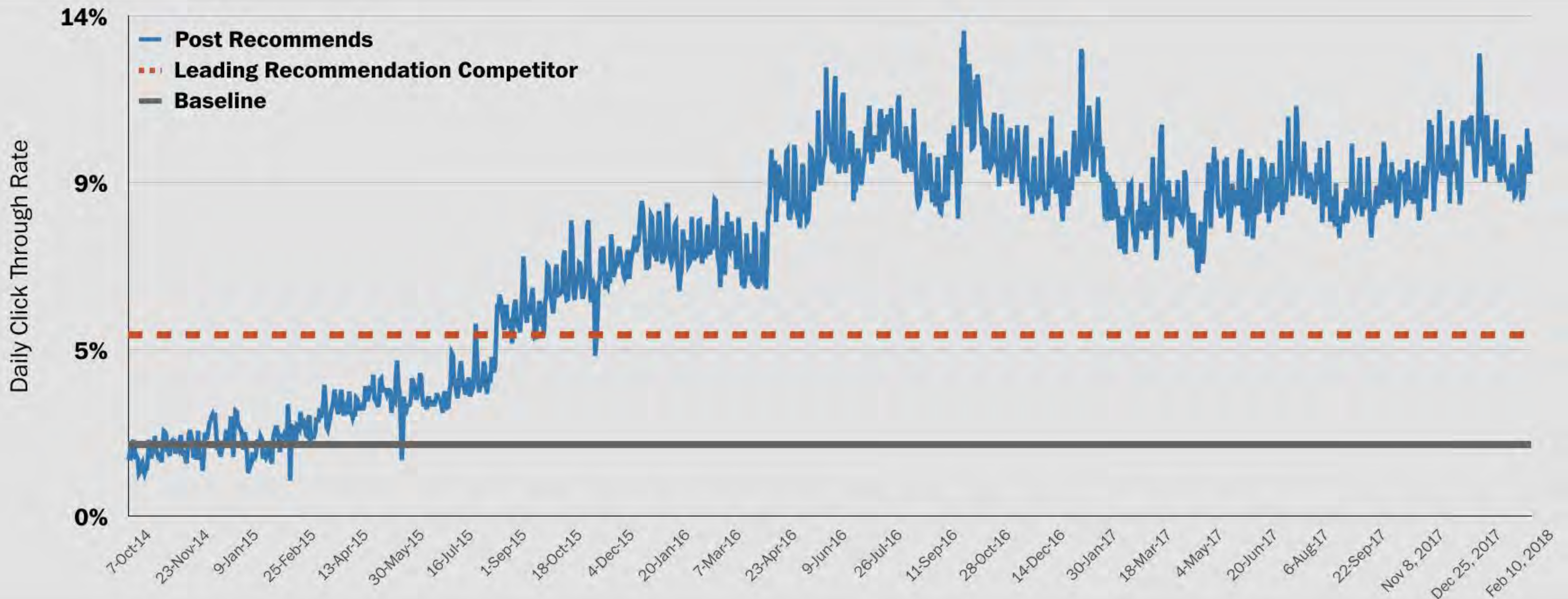
Clavis





# Recommendation Module Daily CTR

Clavis

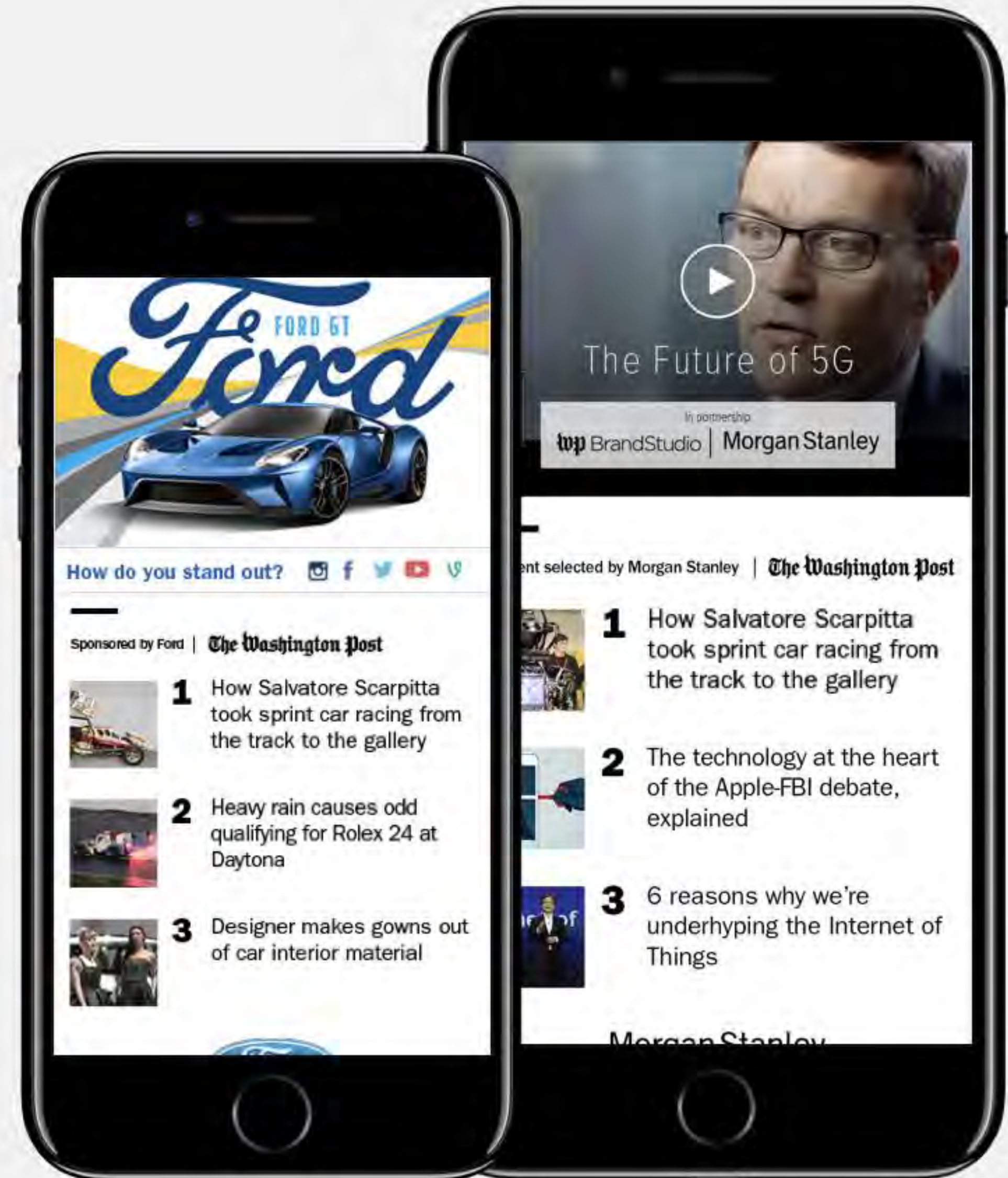




# Advertising

## Clavis

- **Aggregate** all of the assets relevant to your campaign
- **Curate** and filter assets using Clavis and WP+ audience extension
- **Deliver** a tailored personalized experience to the right user, in the right place, at the right time across mobile, desktop and tablet
- **Follow** that desired audience as they click through to read the content aggregated in PostPulse and remain surrounded by your brand message







# Ad Click Through Rate (CTR)

Clavis

Advertiser	CTR
Advertiser A	0.40%
Advertiser B	0.30%
Advertiser C	0.36%
Advertiser D	0.30%

INDUSTRY AVERAGE CTR:

**.04%-.07%**

WASHINGTON POST NON-CLAVIS  
AVERAGE CTR

**.18%**



# Virality

Article Popularity Prediction

- Allows editors to prioritize stories
- Identifies under-performing articles for content variation testing
- Supports advertising opportunities





# Popularity Forecast Slack Room

The "Virality Oracle" Bot

**Washington Post**  
Joey Marburger

# virality-forecast

#virality-forecast  
49 | 1 | Add a topic

Yesterday

**virality-oracle** APP 1:57 PM  
This article may be popular soon! 4270 visits 12 mins since its first visit and > 100K visits @24 hours forecast.  
[Retired Lt. Col. Oliver North slated to become president of the NRA](#)

Washington Post  
[Retired Lt. Col. Oliver North slated to become president of the NRA](#)  
Retired Marine Lt. Col. Oliver North, a central figure of the Iran-Contra affair in the 1980s, will become president of the National Rifle Association in coming weeks, the NRA announced. North, a member of the NRA board, author, and political commentator, plans to retire from Fox News immediately to take on the role. North will [...] (50 kB) +

**virality-oracle** APP 2:23 PM  
This article may be popular soon! 4060 visits 18 mins since its first visit and > 100K visits @24 hours forecast.  
[Oliver North named president of the National Rifle Association](#)

The central figure in Iran-contra affair and Fox News commentator will start in a few weeks.

Washington Post  
[Oliver North named president of the National Rifle Association](#)  
The central figure in Iran-contra affair and Fox News commentator will start in a few weeks. (164 kB) +

+ Message #virality-forecast



# Performance in Production

Virality

Predictions with only clicks @ 30 minutes (baseline)

Predictions with all signals - predicted  $R^2$  of 81.3%

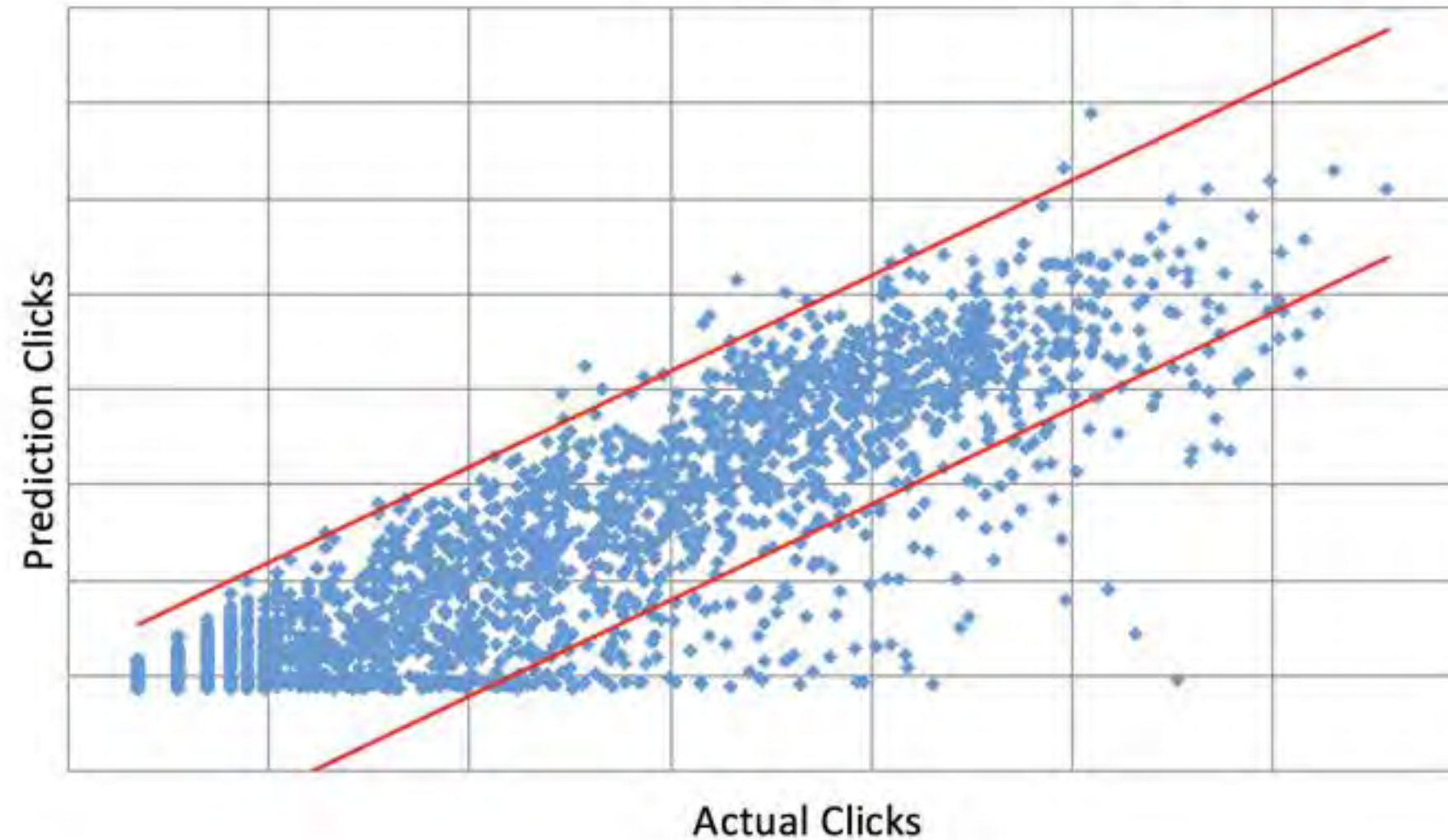
**Baseline**

— Linear (Error Bounds)



**All Signals**

— Linear (Error Bounds)



**Metadata:** article type, section, publication time, author

**Contextual:** sentiment, named entities, readability of text, recency of topics

**Temporal:** page view time series, page view acceleration

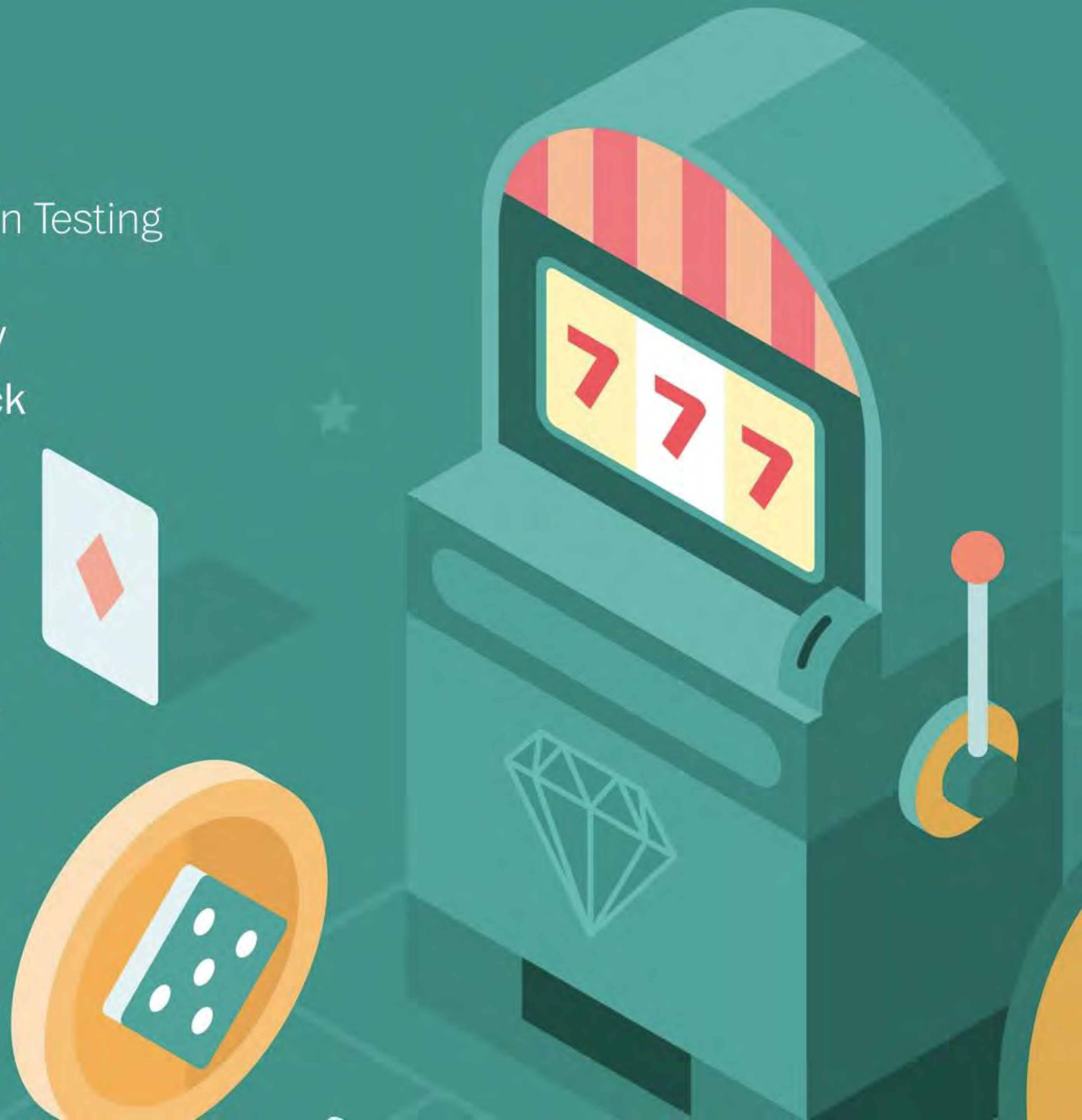
**Social:** tweet volume time series, number of followers acceleration



# Bandito

Multi-Armed Bandit for Content Variation Testing

- Dynamic optimization of variants by real-time user engagement feedback
- More traffic directed to the winning variant automatically
- Flexible to add new variants during live tests
- Newsroom perspective: Fire and forget!







## Juuling: If you don't know what it is, ask your kids

Parents worry the slim e-cigarettes that look like USB drives will create a new generation of addicted smokers. One principal in Maryland removed bathroom doors to keep students from sneaking hits.

3.1%



## In a rush to confront Juuling, schools are removing bathroom doors and banning USB drives

Across the country, parents worry the slim e-cigarettes will create a new generation of addicted smokers.

4.1%



# Headliner

## An Integrated Headline Suggestion System

- Automatic generation of headlines based off of story content
- Suggest different headlines for different channels and devices

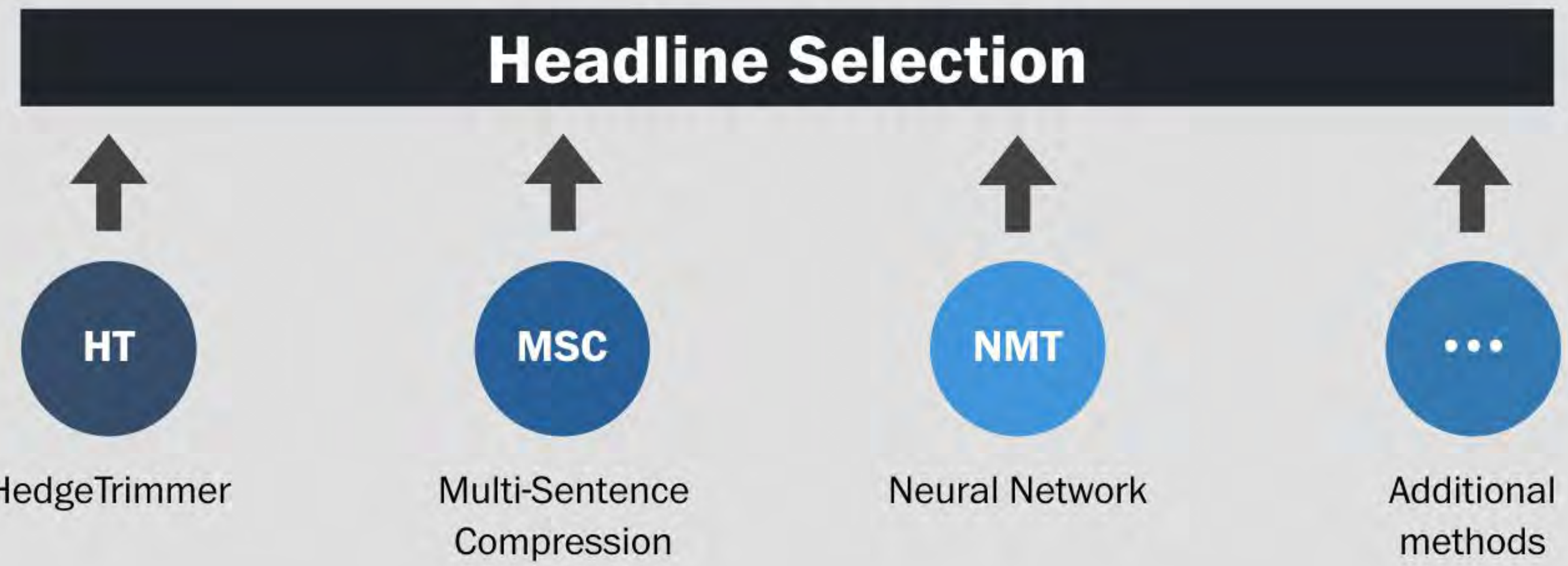






# Headline Suggestion System

Headliner





# Headline Generation Comparison

Headliner

## FIRST SENTENCE OF ARTICLE

A joyous ceremony marked the inauguration of the new U.S. Embassy in Jerusalem on Monday, a largely symbolic step that nonetheless is of deep political significance, here and in the Palestinians territories, as well as farther away.

### Method

### Headline

#### Human Reporter

Under banner of peace, U.S. opens embassy in Jerusalem. Sixty miles away, dozens of Palestinians are killed.

#### HedgeTrimmer

A joyous ceremony marked the inauguration of the new U.S. Embassy in Jerusalem

#### Multi-Sentence Compression

Under banner of peace new U.S. embassy in Jerusalem

#### Neural Network

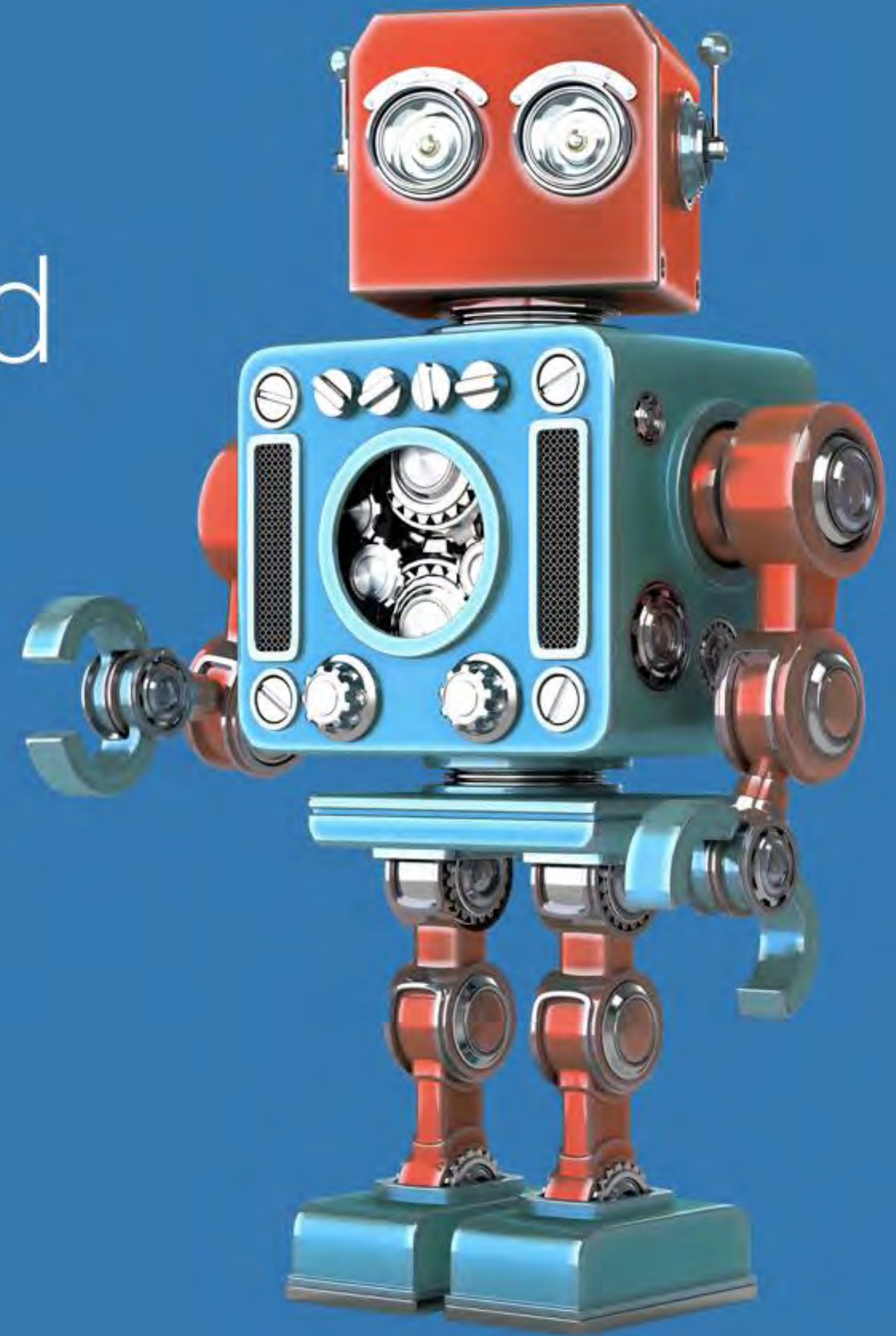
New U.S. Embassy in Jerusalem, Palestinian protesters are killed



# Heliograf

## An Intelligent, Automated Storytelling Agent

- Automatic story generation from real-time data sources
- Delivery of channel-specific stories
- Personalized stories for readers





# Automated Story Process

Heliograf





# National bestsellers: Paperback fiction

Next Week ▶

...s in the **Nation**

by Stephen King is the nation's top-selling book. "The Handmaid's Tale" by Margaret

For the second consecutive week, "It" by Stephen King is the nation's top-selling book. "The Handmaid's Tale" by Margaret Atwood is the fastest rising title on the list, up five spots to No. 8. "The Fix" by David Baldacci and "American Assassin: A Thriller (A Mitch Rapp Novel)" by Vince Flynn are new to the list this week. This week features the first appearance of Baldacci on this bestsellers list with the novel The Fix. "The Woman in Cabin 10" by Ruth Ware is currently the longest running book in the list: it has continuously been in the list for 15 weeks. Ware has two books on the list: "The Woman in Cabin 10" and "In a Dark, Dark Wood."



**QB** Washington Redskins

Height: 6'3" Weight: 202  
College: Michigan State Age: 29

17 Stats

	RUSH	YDS	TD
17	33	2,796	17
		141	3

K Cousins completed 22 of 32 passes for 322 yards in the Redskins 34-31 loss to the Saints on Sunday, including three touchdowns. As of Week 11, Cousins' average of 299 passing yards over the last three games ranks third in the NFL.

Opp	Passing			Rushing			RAT	
	YDS	TD	I/F	ATT	YDS	TD		
vs MIN	30-38	327	1	1	4	5	2	78.7
vs NO	31-34	322	3	0	3	11	0	132.6

### Post Oly Bot

860 Tweets

Tweets Tweets & replies Media Lik

**Post Oly Bot @WPOlyBot · 14h**  
American Chloe Kim captures the gold medal in the women's snowboard halfpipe event. Liu Jiayu of China wins silver and American Arielle Gold takes the bronze.

**Post Oly Bot @WPOlyBot · 15h**  
The women's snowboard halfpipe event starts in five minutes.

**Post Oly Bot @WPOlyBot · 14h**  
American Chloe Kim captures the gold medal in the women's snowboard halfpipe event. Liu Jiayu of China wins silver and American Arielle Gold takes the bronze.

**Post Oly Bot @WPOlyBot · 15h**  
The women's snowboard halfpipe





# Madison at South Lakes

[Schedule](#) · [Schools](#) · [Report a Score](#) · [Rankings](#) · [Leaders](#) · [Standings](#) ·

[Football](#) · [November 17, 2017](#) · [Virginia](#)

**Madison**

Overall: (9-3) Conf: (2-1)

**0-35**

	1	2	3
● M	0	0	0
● SL	14	7	14

Updated Nov. 18 at 6:16 p.m.

## Game Summary:

The [South Lakes Seahawks](#) shut out the [Madison Warhawks](#), 35-0, on

The Seahawks opened the game with a two-yard touchdown run by [Alb](#) even further ahead following [Devin Miles](#)'s one-yard touchdown run, b

In the second quarter, South Lakes extended its lead on [Xavier May](#)'s 2

# High School Sports

## LEDE VARIATIONS

The South Lakes Seahawks **shut out** the Madison Warhawks, 35-0, on Friday.

The Yorktown Patriots **triumphed over** the visiting Wilson Tigers **in a close game** on Thursday, 20-14.

The Centreville Wildcats **barely beat** the visiting South County Stallions **in a close game** on Friday, 31-27.

The Walter Johnson Wildcats **claimed victory over** the visiting Poolesville Falcons **in an overtime game** on Friday, 27-26.





# HelioVideo

Teaching Machines to Produce Video



# Summaries

- When we think of the Houston Rockets, we think of a team that loves to shoot the three.
- The Rockets are on pace to set the NBA record for three-point attempts for the third time in four seasons.
- It has become so extreme that Fox Sports 1 host Nick Wright asked Rockets General Manager Daryl Morey on the 'Take That for Data' panel at the Sloan Sports Analytics Conference in Boston on Saturday if Morey felt an obligation to the sport to lessen his team's focus behind the arc.
- The Rockets, the top team in the West, coasted to a 119-114 victory — their 12th in a row — over the Denver Nuggets on Sunday night, hitting 15 of 35 from long range.

The Washington Post  
Democracy Dies in Darkness

Sections

Joey Marburger

Fancy Stats • Analysis

## The NBA is a copycat league, but good luck imitating the Rockets

By Neil Greenberg February 26 at 12:14 PM Email the author




The Houston Rockets have made at least 15 three-pointers in 35 games this season, 20 more than the next-closest team. (Wilfredo Lee/AP)

When we think of the Houston Rockets, we think of a team that loves to shoot the three. Coach Mike D'Antoni's squad has taken more than half its shots from behind the three-point line this season (50.5 percent), the most of any team since 1983-84, the first year data is available. The Rockets are on pace to set the NBA record for three-point attempts for the [third time in four seasons](#).

It has become so extreme that Fox Sports 1 host Nick Wright asked Rockets General Manager Daryl Morey on the "Take That for Data" panel at the Sloan Sports Analytics Conference in Boston on Saturday if Morey felt an obligation to the sport to lessen his team's focus behind the arc. Morey's response: "No, my job is to win."

So far, so good. The Rockets, the top team in the West, coasted to a 119-114 victory — their 12th in a row — over the Denver Nuggets on Sunday night, hitting 15 of 35 from long range. That was their 35th game this

**2018 Olympics: Your Way**  
Love the velocity, precision, endurance or creativity of the Games? The Post gives you just the stories you want.

**SPEED**  
 **Mass-start speedskating debut yields gold for hosts, more disappointment for U.S.**

**ACCURACY**  
 **Germany comes oh-so-close to its own 'Miracle on Ice,' but Russians win Olympic gold**

**DISTANCE**  
 **Friendship medals: Sweden's Charlotte Kalla, Norway's Marit Bjørgen take gold, silver**

**ARTISTRY**  
 **Enter the 'Bloody Dracula' — and American Kyle Mack exits with big air silver**

**Most Read Sports**

- 1 Golden State Warriors to visit African American Museum with kids today in lieu of White House appearance 
- 2 NFL plans to impose penalty of more than \$2 million on Cowboys owner Jerry Jones 
- 3 'That's not my record to have': An Iowa basketball star pays tribute with a missed free throw 
- 4 The Olympic flame has been extinguished. The USOC should be next 







# ModBot

Automatic Content Moderation

- Measures the quality of comments automatically
- Reduce the number of comments that need to be reviewed by human moderators
- Maintain a high quality online comment section





# Performance

ModBot

## TRAINING

20,900 Comments

Classifier	Accuracy
Linear Kernel SVM	0.85
Ensemble Classifier	0.84
Decision Tree	0.78
Naïve Bayes	0.60

## TEST

3,796 Comments

Accuracy	0.88	
Confusion Matrix	Predict Approve	Predict Delete
True Label Approve	<b>2906</b>	113
True Label Delete	332	445



# How ModBot Works in Production





# Loxodo

Real-Time Data Analysis

- Aggregates most important and actionable metrics
- Suite of easy-to-read dashboards
- Helps newsroom identify key performance indicators







# Would you read this?

---

## Ben Carson's Gray Matter

According to Carson, the human brain stores a perfect, indelible record of everything that it has seen, heard and done, and if he just drilled a hole through my skull and planted electrodes in the right region, bingo! I'd have access to the whole wondrous trove.

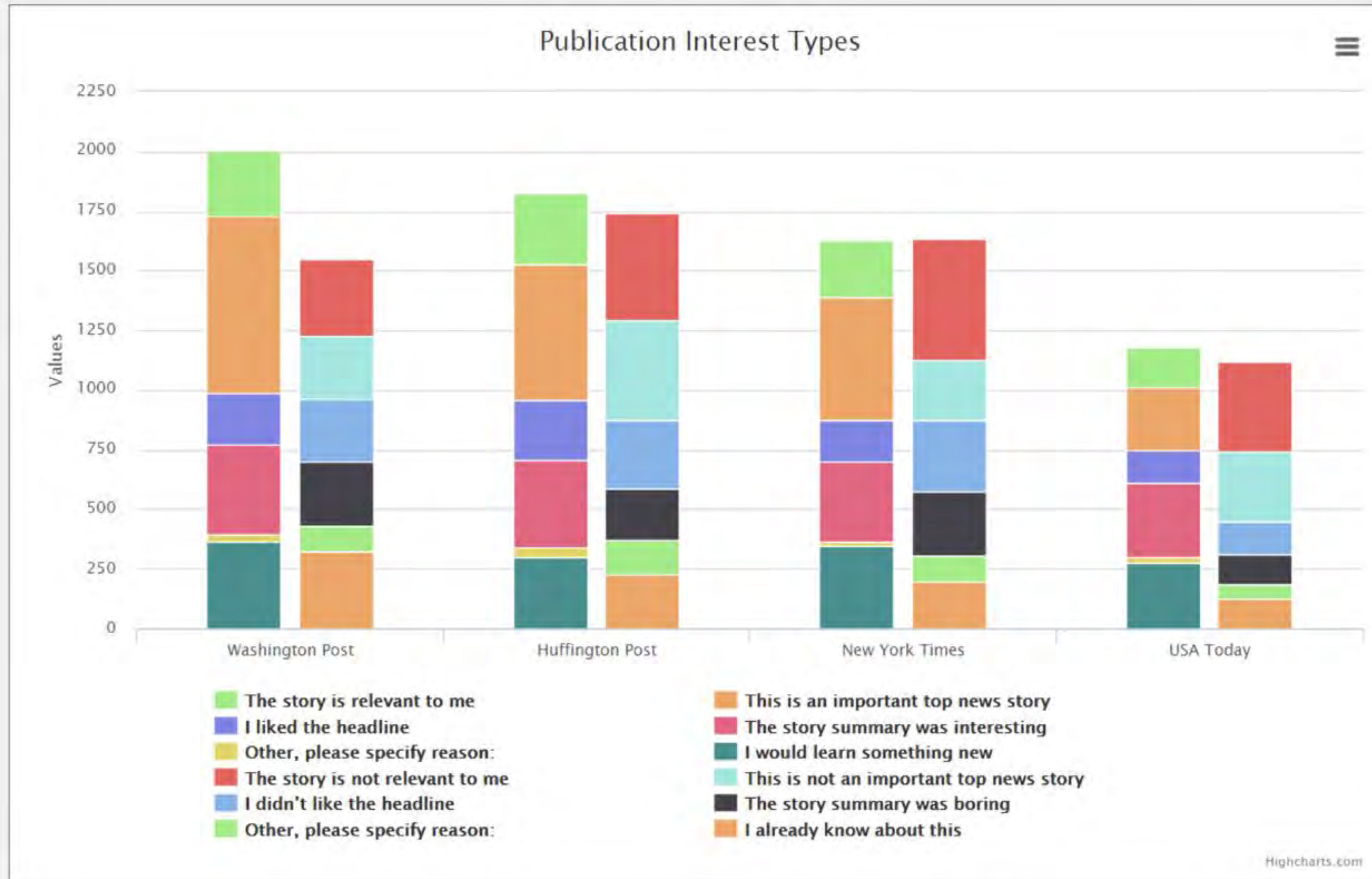
[+ Read Full Article](#)

Yes

No



# Riveting





# BreakFast

## Mobile Alerts

Ranking* for This Week	
Rank	Source
1	WP Classic
2	WP Rainbow
3	NYTimes
4	USA TODAY
5	WSJ
6	HuffPost
7	NBC NEWS
8	CBS News
9	Bloomberg
10	WUSA9

Alerts that the Washington Post Classic Mobile sent out <sup>1</sup>			
Alert	Time	WaPo Rank	Leader and Gap (mins)
Local Alert - Kevin Maxwell the embattled leader of Prince Georges County Public Schools to step down	May 01, 15:15	2	WUSA9, 0
Wash Post - California sues EPA over push to overturn Obama-era vehicle efficiency rules setting up fight over climate change	May 01, 13:03	1	-
Wash Post - EPA chief Scott Pruitts \$100000 trip to Morocco was set up by a lobbyist an unusual arrangement that ethics experts say raises questions	May 01, 17:28	1	-
Wash Post - Mueller raised possibility of presidential subpoena in tense meeting with Trumps legal team	May 01, 20:06	1	-
Sports Alert - Capitals fight back to beat Penguins 4-3 in Game 3 on a late goal from Alex Ovechkin	May 01, 22:21	1	-
Wash Post - White House lawyer Ty Cobb is exiting and will be replaced by Clinton impeachment attorney Emmet Flood	May 02, 12:50	2	NYTimes, 17
Wash Post - Two black men arrested at Starbucks settle with Philadelphia for \$1 each	May 02, 13:11	1	-
Wash Post - Cambridge Analytica shuts U.S. and U.K. operations after Facebook scandal	May 02, 15:02	4	WSJ, 56
Sports Alert - Washington Capitals' Tom Wilson suspended three playoff games for illegal hit to head of Pittsburgh Penguins' Zach Aston-Reese	May 02, 19:54	2	WUSA9, 0
Wash Post - Giuliani says Trump personally repaid Michael Cohen \$130000 in hush money given to Stormy Daniels	May 02, 22:15	2	HuffPost, 6
Wash Post - Charlie Roses sexual misconduct was widespread at CBS and three managers were warned Post investigation finds	May 03, 06:57	1	-



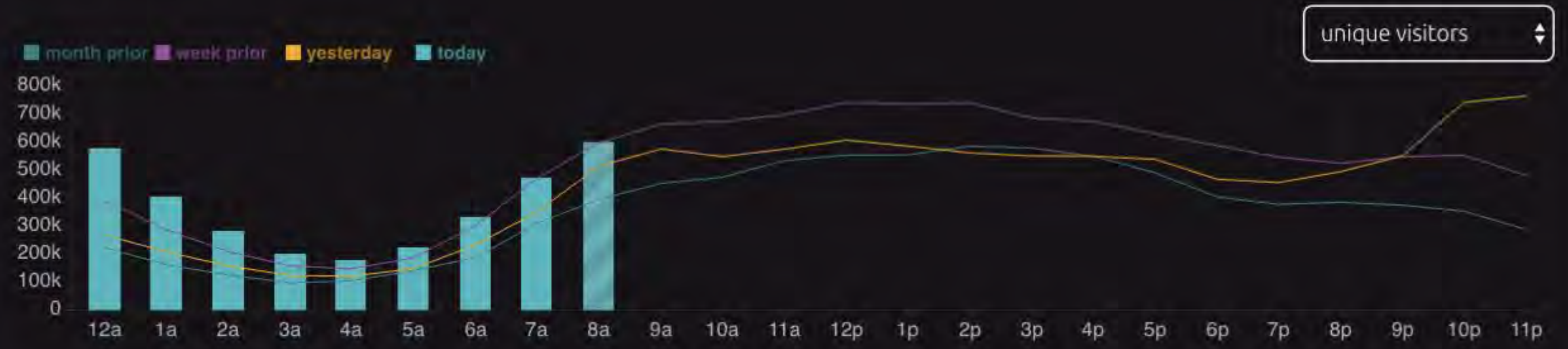
traffic ...

124,594  
active users now



	TODAY	YESTERDAY	LAST WEEK
UNIQUE VISITORS	3,275,145	2,702,306	3,413,511
PAGE VIEWS	6,963,542	5,003,243	5,866,477

traffic performance...



site speed ...

1,519  
speed now (ms)



	TODAY	YESTERDAY	LAST WEEK
DESKTOP	1,519	1,415	1,348
MOBILE	2,282	1,793	1,734

top content ...

- sort by active users
- Trump is no longer the worst person in government. Pence is. - The Washington Post (9,901)
  - Regional Homepage (6,563)
  - Israel launches massive military strike against Iranian targets in Syria - The Washington Post (5,016)
  - 'I'm crushing it': How Michael Cohen, touting his access to President Trump, convinced co... (3,629)
  - The Daily 202: Why John McCain opposes Gina Haspel leading the CIA — and why it matte... (3,253)
  - Trump announces June 12 summit in Singapore with North Korean leader - The Washingto... (2,913)
  - Trump announces June 12 summit in Singapore with North Korean leader - The Washingto... (2,701)
  - These are the 3,400 Facebook ads purchased by Russia's online trolls around the 2016 elec... (2,561)
  - A taxonomy of Michael Cohen and potential Trump corruption - The Washington Post (2,397)
  - Suddenly, Pence suggests, investigations into the president have expiration dates - The W... (1,893)
  - Tom Cotton is filled with rage. Thank God he wasn't tapped as CIA director - The Washingt... (1,693)

amp speed ...

387  
amp speed now (ms)







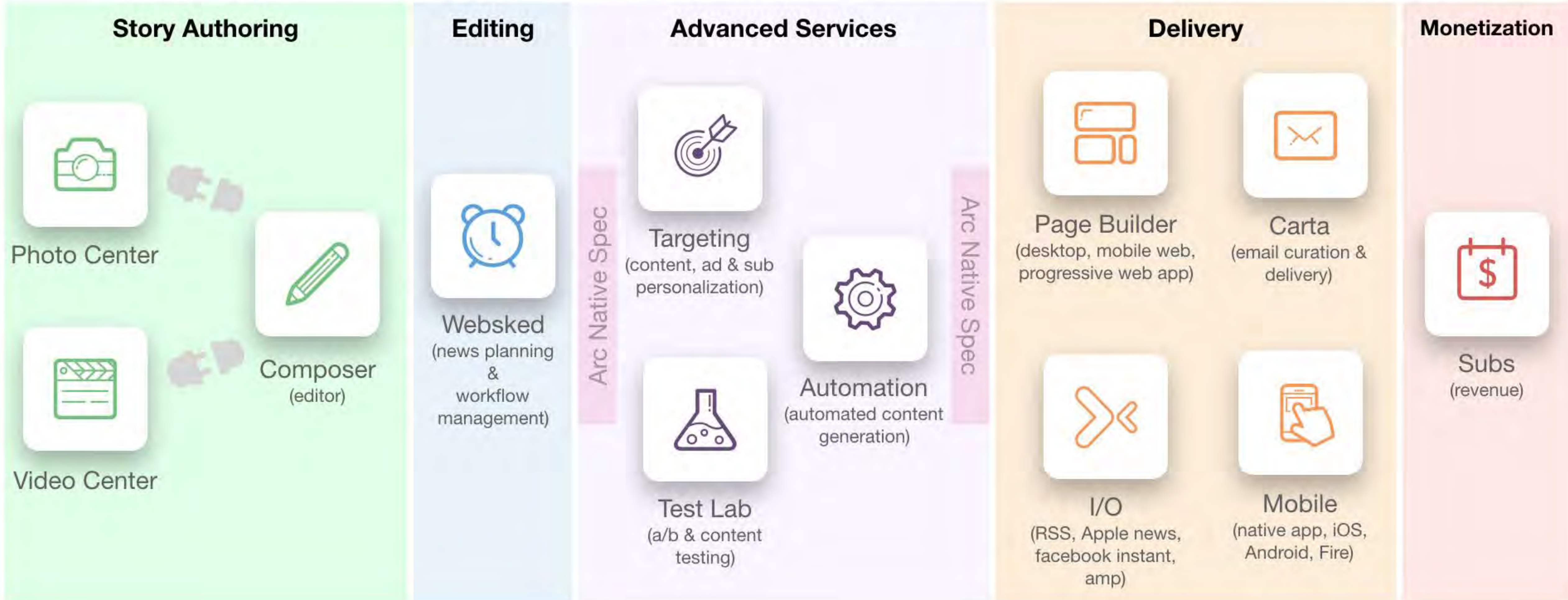
# Arc

*The Platform for Digital Innovation*



# Arc Ecosystem

End-to-end hosted suite of interconnected tools hand-picked by publishers to meet your needs.







# Thank You

Shailesh Prakash, CIO  
The Washington Post